Essays in Taxation:
Capacity, Compliance and Complexity

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Chapter 1

General Introduction

More than 250 years ago, Adam Smith pointed out that an appropriate tax system would be a crucial determinant of a country's economic success. According to him, "little else is requisite to carry a state to the highest degree of opulence from the lowest barbarism, but peace, *easy taxes*, and a tolerable administration of justice: all the rest being brought about by the natural course of things." (Smith, 1755). Since then, generations of economists have investigated various aspects of taxation, such as the optimal design of tax systems, the factors which shape tax policy across countries or the effects of taxation on individual behavior and overall welfare. However, several aspects within the broad field of taxation are still unexplored and quite a number of questions have not been answered yet. Therefore, this thesis contributes to the vast existing literature by singling out three particular topics related to taxation which are examined in the following chapters.

Broadly speaking, taxation is "a means by which governments finance their expenditure by imposing charges on citizens and corporate entities" (Business Dictionary, 2014). As this simple definition points out, taxation creates a relationship between the state which levies taxes, i.e. establishes tax laws, manages tax administration and ensures enforcement, on the one side, and individual persons and firms who and which react on it by paying taxes, avoiding or evading it on the other side. Figure 1.1 illustrates this basic relationship and indicates on which of these parties the focus of the following chapters rests on.

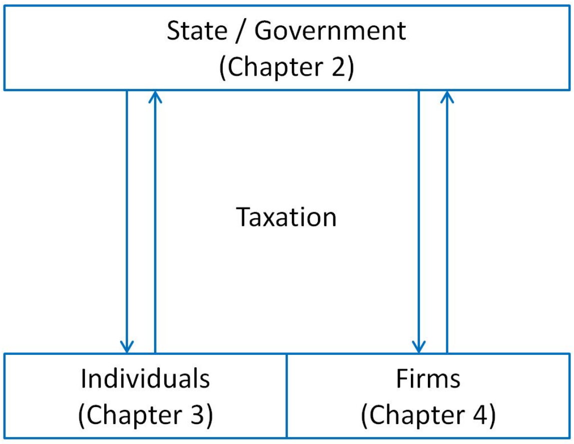


Figure 1.1: Thesis overview

In each of the three following chapters, the focus is on a different party involved in taxation. Since taxation emanates from *the state*, Chapter 2 starts with examining its role while the further chapters examine the responses of *individuals* (Chapter 3) and *firms* (Chapter 4) on taxation. More precisely, Chapter 2 theoretically analyzes how governments invest in their fiscal capacity, i.e. their ability to raise taxes, in an environment which includes the possibility to raise debt. Chapter 3 experimentally investigates the tax compliance behavior of individuals, especially in the context of a permanent tax amnesty. Chapter 4 empirically examines how the complexity of the corporate tax system influences the location choice of multinational firms. All chapters are written in such a way that they can be read independently of each other.

Chapter 2 (co-authored with Christoph Esslinger) is a political economy analysis which investigates the incentives of governments to accumulate public debt and state capacity, i.e. the capacity of the state to raise taxes (fiscal capacity) and to support markets, particularly by providing a functioning legal system (legal capacity). As the Greek debt crisis has shown, high public debt combined with low state capacity can put even developed countries into turmoil. However, the existing political economy literature of state capacity does not investigate the interaction of these capacities with public debt. Therefore, this chapter analyzes the incentives behind raising debt and building state capacity in an integrated analytical framework. We examine the impact of political stability, cohesiveness of institutions (which corresponds to the degree to which clientele politics are prevented), and income fluctuations on the political outcome, while allowing for sovereign default.

We find that the possibility to raise debt can provide a novel incentive to invest in state capacity because debt allows bringing future state capacity at the disposal of the current government. As long as debt can be used to protect the current government from an adverse use of future public funds, it is no longer necessary to use low investments in state capacity as a protection device. However, we also find that this novel mechanism can be weakened in a world with income fluctuations and the possibility of default. When high costs of raising debt make it very expensive to draw all relevant future public funds to the present, the mechanism of lowering investments resurfaces. Specifically, this mechanism is more prominent for high income fluctuations because they increase the proportion of public funds that can only be drawn to the present at high costs. For such an environment, we get results that are closest to the original model without debt by Besley and Persson (2011). In particular, an unstable political environment combined with non-cohesive institutions can lead to a situation of low state capacity. Furthermore, in our model allowing for the possibility to raise debt, this weak state situation is even worsened by a high built up of debt, leading to a positive probability of sovereign default.

Chapter 3 experimentally examines the question how a permanent tax amnesty influences compliance behavior of tax payers. A number of countries, including Germany, allow for voluntary disclosures regarding tax evasion, granting exemption from legal prosecution under certain conditions, which can be seen as permanent tax amnesties. While several empirical studies about the effects of tax amnesties exist, no empirical or experimental analyses of permanent tax amnesties exist so far. Therefore, studying permanent tax amnesties seems desirable since its effects on tax compliance are likely to be different from those of a one-time or repeated tax amnesty. The reason is that a permanent tax amnesty might reduce tax compliance if people anticipate that they can choose a voluntary disclosure at any time in the future. This might lead to an increase in tax evasion since the permanent possibility of a voluntary disclosure creates a kind of ‘insurance’, for instance against a rise in the audit rate or the punishment.

In my experiment, all participants earn and declare income in an environment with a fluctuating audit rate. In one treatment, the current audit rate is announced, in a second treatment, the participants are informed about the audit rate of the previous round while in a third treatment, the audit rates are completely unknown to the participants. Within these treatments, a permanent tax amnesty is introduced which allows for voluntary disclosures to repay evaded taxes in order to go unpunished in case of future audits. The treatments allow me to explore whether a permanent tax amnesty lowers compliance by creating an insurance as explained above, whether this insurance effect decreases with less information about the audit rate and whether or not a permanent tax amnesty has an impact on tax compliance even beyond the insurance effect, for example by influencing social norms.

My main finding is that, if the audit rates are announced, the permanent tax amnesty significantly lowers tax compliance but that this effect vanishes if information about the audit rate is reduced. So, the experimental results suggest that a permanent tax amnesty lowers tax compliance if the informational setting allows using a permanent tax amnesty as an 'insurance' against an increase in the detection probability.

Chapter 4[1] (co-authored with Johannes Voget) contributes to the empirical literature about corporate taxation and Foreign Direct Investment (FDI) by investigating the impact of tax complexity, employing a large database of German multinational enterprises. More precisely, we analyze the impact of tax complexity on the location choice of about 4500 new German FDI projects in OECD countries from 2005 to 2009. The question whether and how much tax complexity suppresses investment is highly relevant for policy making since, if tax compliance indeed suppresses investment, simplifying the tax system would be a source for stimulating economic activity without decreasing the tax revenue. In order to measure tax complexity, we use the Doing Business data published by the World Bank. The topic Paying Taxes of this database includes variables which have been constructed by defining a fictive, standardized firm for which tax experts calculated taxes and answered some survey questions for a large set of countries. We use the variable which captures the time it takes to comply with taxes, i.e. to prepare, file and pay taxes in the respective

[1] This chapter is based on and includes parts of my dissertation proposal which counted as a Master thesis in the "Economic Research" track of the Master in Economics at the University of Mannheim (cf. Müller (2011))

country, as a measure for tax complexity.

The contribution of this chapter to the literature is twofold. First, we evaluate the impact of tax complexity on FDI using firm-level data to analyze the issue on the economic level where the decision process regarding FDI actually takes place, which allows us to test firm-level hypotheses. Second, we analyze the effects of tax complexity on FDI employing a panel dataset, which allows us to estimate the effect of within-country changes in tax complexity on FDI.

We find two main results. First, our estimates suggest that a higher level of tax complexity significantly decreases the probability to locate an FDI project in that country. Second, we investigate the interaction between the corporate income tax rate and tax complexity and find that the negative effect of tax complexity becomes weaker if the corporate income tax rate increases. This finding is consistent with the explanation that, in addition to the negative effect caused by compliance cost, tax complexity also has a positive effect since it creates room for tax optimization, which becomes more valuable if taxation is high.

Chapter 2

State Capacity and Public Debt: A Political Economy Analysis

2.1 Introduction

The combination of high public debt and low capacities of the state to raise taxes and to support markets can upset even developed economies. A recent example is the case of Greece. Its rather high shadow economy[1] points to a low level of fiscal capacity, the institutional infrastructure necessary to collect and enforce taxes. Furthermore, low property rights protection[2] indicates a low level of legal capacity, the legal infrastructure necessary to provide a secure investment climate. State capacity, the combination of legal and fiscal capacity, is a crucial determinant of a state's financial strength. A country with low state capacity that has at the same time a tendency to accumulate high public debt might run into severe problems. The European debt crisis has exemplified this in an inglorious way. In light of this, it is important to understand the mechanisms underlying the combined evolution of state capacity and public debt.

However, the political economy literature of public debt[3] usually takes the insti-

[1] Buehn and Schneider (2012) estimate that the average size of the Greek shadow economy between 1999 and 2007 amounted to 27.5 percent of official GDP.

[2] The International Property Rights Index 2013 ranks Greece on the 62th place behind China and India, which is the lowest rank of a western European country (see Property Rights Alliance, 2013).

[3] A review of the recent contributions to this literature can be found in Battaglini (2011). For a survey of the earlier contributions see Alesina and Perotti (1995).

tutional infrastructure necessary to raise taxes as given and does not consider this fiscal capacity as an investment object of the government. The legal infrastructure necessary for the proper functioning of a market economy is also not modeled as an endogenous political choice in this literature. In contrast, the recent political economy literature of state capacity, pioneered by Besley and Persson (2009), endogenizes fiscal and legal capacity as investment objects of the state. However, this literature does not include public debt. Analyzing the combined evolution of state capacity and public debt necessitates an integrated analytical framework. Otherwise, important aspects of the *interaction* between these dynamic variables will remain unexplored. We provide such an integrated model, and we uncover interactions between state capacity and public debt that cannot be understood by studying the two issues separately.

We generalize the baseline model of state capacity investment in Besley and Persson (2010, 2011) to include public debt, fluctuating incomes, and the possibility of default. In a dynamic framework, an incumbent government cannot be sure to remain in power in the future. It wants to benefit its own clientele, and decides about investments in the future fiscal and legal capacities. The incumbent government can additionally spend on a common-interest public good or redistribute money towards its own clientele. The 'cohesiveness' of institutions determines to what degree this redistribution is possible. Following Besley and Persson, we say a country has low cohesiveness, when it is very easy to do clientele politics to the benefit of the own group. Importantly, the incumbent can also raise debt now. Debt is restricted by future state capacity, because the latter determines repayment capacity in the second period. The income level attainable for a given legal support as well as the value of public goods fluctuate over time, introducing a business cycle component into the model. The implied possibility of default gives us a tractable way to study the effects of increasing costs of debt financing.

We derive two main sets of results. First, in a simple basic model without fluctuating incomes and without default, we show that the possibility to raise debt can create an additional incentive to invest in state capacity. The intuition is that debt allows to draw future tax resources to the present. This circumvents the problem of a use of future public funds that is not in line with the current incumbent's objective. Specifically, high political instability and low cohesiveness make the first period incumbent afraid of giving additional state capacity to the future government. By high political instability, this government is likely to be from the opposed group, and by low cohesiveness, it can use the higher taxing power to heavily redistribute away from the period-1 incumbent group. In the model without debt (c.f. Besley and Persson, 2010, 2011), the only possibility to protect against such an adverse use of future public funds is to lower investments in fiscal and legal capacity. We call this the low-investment-mechanism. However, if debt can be used to bring future public funds at the disposal of the first period incumbent, then this incumbent can decide about their use. Given that there are profitable uses of tax resources in the first period, the incumbent now has higher incentives to invest in state capacities in order to increase the amount of public funds at its disposal. We call this the debt-mechanism. The strength of this mechanism depends on how easy it can be used. For the basic model without default, there are no restrictions on using this mechanism. Therefore, it can completely cancel out the original low-investment-mechanism.

However, our second set of results shows how the debt-mechanism can be weakened, thereby allowing the original low-investment-mechanism to partly resurface. Specifically, with fluctuating incomes, the cost of raising additional debt depends on the possibility of default. When debt is raised to the point where default becomes possible, it becomes increasingly expensive to use the debt channel to draw future public funds to the present. In particular, for investments in fiscal capacity, a part of the implied future public funds can then only be drawn to the present at high costs. To the extent that it is very costly to draw newly created future public funds to the present, the low-investment-mechanism resurfaces. Specifically, it resurfaces the stronger, the higher are the income fluctuations. For high income fluctuations, we therefore get results close to the original no-debt model. In particular, a country with low cohesiveness and high political instability will invest only little in state capacities. Furthermore, this 'weak state' situation is now worsened by a built-up of high debt, leading to a positive probability of default.

From these results, we can draw the following policy implications. Besides political instability, cohesiveness is identified as an important driving force behind the combined evolution of state capacity and public debt. Cohesiveness enters as an exogenous parameter in our model, but our comparative static results show which implications follow from changing it. In our model, a country with high cohesiveness will be close to the social planner optimum. Increasing cohesiveness in the real world necessitates deep reforms that go at the core of the functioning of the state. Examples of such reforms include implementing a functioning system of checks and balances, establishing an independent press that names and shames clientele politics, creating provisions in the constitution that prevent clientele politics, or strengthening the constitutional court in its power to enforce such provisions. Comprehensive reforms in these directions should prevent a country from running into a situation of high debt and low state capacity.

The rest of this chapter is organized as follows. Section 2.2 discusses the relation of this chapter to the existing literature. Section 2.3 sets out a basic model of state capacity and public debt which does not yet include fluctuating incomes or default. We extend the setup of Besley and Persson (2010, 2011) by introducing the possibility to raise debt to the government's policy set. Comparing the results to the model without debt, we find that the possibility to raise debt can create a novel incentive to invest in state capacity. In Section 2.4, we introduce exogenous income fluctuations into the model to allow for sovereign default. We investigate when public debt and state capacity investments move in the same or opposite directions in response to exogenous parameter changes. In the latter case, countries can run into the situation with low state capacity and high public debt. We take a brief look at cross country data and find correlations which are mostly in line with the results of our model. Section 2.5 generalizes our model by introducing quasi-linear utility functions. This allows us to establish the robustness of the previous results and to gain a deeper understanding of the underlying mechanisms. Section 2.6 concludes and discusses topics for future research.

2.2 Relation to the Literature

Analyzing the political incentives behind investing in state capacity and raising public debt, we bring together the two strands of the political economy literature that have analyzed these concepts in isolation. The concept of state capacity was brought back to the minds of economists by Timothy Besley and Torsten Persson in a series of recent papers (Besley and Persson, 2009, 2010).[4] These were condensed into their book *Pillars of Prosperity* (Besley and Persson, 2011). All of these models include two aspects of state capacity, legal and fiscal capacity, in a tractable political economy model with two periods.

Our model builds on the workhorse model in Besley and Persson (2011). This model has been extended in several directions. Besley and Persson (2009), for instance, provide a micro foundation for the growth enhancing effect of legal support by explicitly modeling a credit market whose effectiveness depends on the level of legal support. Besley et al. (2013) drop legal capacity and extend the remaining fiscal capacity model to comprise multiple periods and to include decreasing marginal benefits of public good spending. They show that the main results from the two-period model generalize to this setup.

The main novel feature of this chapter is that we consider in one model the interaction of the strategic use of debt and the decision of an incumbent government to invest in its future powers to raise taxes and to grant legal support. With regard to the state capacity literature, we find that the possibility to raise debt can provide an additional mechanism to incentivize state capacity investments that cannot be seen in a model without debt. However, debt might be used to tie down the additional investments for uses that are not in accordance with the social planner's objective. However, we also derive conditions under which the link between debt and state capacity investments is weak. In this case, the 'weak' state situation of low investments in state capacity, identified by Besley and Persson, is worsened by an additional buildup of high debt.

While the state capacity literature has not included the debt channel at all, the debt literature usually includes taxes. Nevertheless, this latter literature takes fiscal capacity as given. Implicitly, institutional capacity to raise taxes is often assumed to be maximal in this context. In particular, when labor taxes are considered, the upper bound on taxation is given by the tax rate maximizing the resulting Laffer

[4]Early studies concerning state capacity are the ones of Cukierman et al. (1992) regarding fiscal capacity and Svensson (1998) regarding legal capacity. In recent years, Acemoglu (2005) and Acemoglu et al. (2011) made further contributions to the literature on state building.

curve. Therefore, fiscal capacity is not included as an *endogenous dynamic* variable in this literature.

The strand of the debt literature closest to our setup is the literature on strategic debt initiated by Persson and Svensson (1989), Alesina and Tabellini (1990) and Tabellini and Alesina (1990).[5] Persson and Svensson (1989) and Alesina and Tabellini (1990) consider debt in the setup of distortionary labor taxes. The cost of raising debt therefore involves higher tax distortions in the future. Both papers show that in political competition between parties with differing objectives, too much debt is raised compared to a normative benchmark. This happens because a currently ruling government cannot be sure to remain in power in the future and therefore uses debt to bind its successor's hands. Since our model has non-distortionary taxation, it is more closely related to the one of Tabellini and Alesina (1990). They examine a two-period model with non-distortionary taxation and a group of heterogeneous individuals with different preferences over two public goods. Again, the social planner would run a balanced budget, but in the political equilibrium the uncertainty regarding the future median voter leads to a positive debt level to bind the hands of the future median voter.

A similar trade-off as in these models also arises in our setup. The spending purpose on which groups have differing preferences is now redistributive transfers. Also similarly, our model can produce the incentive to over-accumulate debt compared to a social planner. In our setup, redistributive transfers correspond to clientele politics which are not beneficial from a social planner's point of view. A social planner will therefore only spend money on public goods. This implies that the social planner will not raise debt when the future value of public goods is expected to be higher than in the present. At the same time, a political government might still accumulate debt in order to finance redistribution towards its own clientele in the present.

In addition to the literatures about state capacity and public debt, the model of Section 2.4 is related to a third strand of literature, the literature about sovereign default. The literature of borrowing with default goes back to the seminal study of

[5] Recent models in the field of political economy of public debt with rich dynamic frameworks can be found in Battaglini and Coate (2008), Yared (2010), Song et al. (2012). For a political economy model of debt which endogenizes political turnover but shares the two-period setup with our model see Lizzeri (1999).

Eaton and Gersovitz (1981). Arellano (2008) extends their approach and applies it to sovereign debt default, especially in the context of developing countries. Both studies use an infinite horizon model in which the borrower can choose to default. The incentives to not default are given by an embargo on future borrowing, an additional penalty, or direct output costs. Due to the two period setting, our model does not include the embargo on future borrowing. It is therefore somewhat in the spirit of Alesina and Tabellini (1989), who also rely an a two period model of sovereign debt default. Furthermore, we only model *ability-to-pay* default and not *willingness-to-pay* default. The reason is that the modeling of default is used here mainly to include increasing costs of debt financing in a tractable way. A more involved modeling of the default decision is left to future research.

2.3 Basic Model Setup

To focus ideas and establish a benchmark for our further analysis, we first extend the simple workhorse model of state capacity investment in Besley and Persson (2011) to include public debt. The following presentation of the basic model setup is therefore mainly a condensed presentation of the model set out in Besley and Persson (2011) with the necessary modifications for the inclusion of public debt. The full model with fluctuating incomes and the possibility of default will be presented in the next section.

The model has two periods $s = 1, 2$ and considers a country consisting of two equally sized groups of individuals. The total size of population is normalized to 1. One of the groups holds governmental power in the first period. Individuals that are a member of the *incumbent* group in a given period are superscripted by the letter I, whereas members of the *opposition* group are superscripted by the letter O. With exogenous probability γ, power is transferred to the other group after the first period. Higher γ thus captures higher political instability from the point of view of the first period incumbent group.

In period s, an individual of group $J \in \{I, O\}$ has an income of $\omega(p_s^J)$, where $\omega(\cdot)$ is an increasing and concave function of legal support p_s^J granted to group J. More broadly, one can think of p_s^J as any kind of market supporting policies that increase the private income of individuals of group J. Following Besley and Persson (2009, 2010), we interpret p_s^J as legal enforcement which is conducive to a more efficient functioning of capital markets.[6]

The utility of an individual of group $J \in \{I, O\}$ in period s is linear in private consumption c_s^J and public good consumption g_s:[7]

$$u_s^J = \alpha_s g_s + c_s^J \tag{2.1}$$

where α_s parametrizes the marginal value of public good consumption relative to that of private consumption. Income available for private consumption is determined by the non-distortionary tax rate t_s on income ω and the per-capita transfers r_s^I, r_s^O awarded by the government to the different groups. Therefore, individual utility in period s becomes:

$$u_s^J = \alpha_s g_s + (1 - t_s)\omega(p_s^J) + r_s^J \tag{2.2}$$

Future utility is discounted with the discount factor $\delta \in (0, 1)$.

The value of public goods fluctuates over time. In a developing country setup, a period with a high value of public good spending can be interpreted as a situation with a high threat of an external war. For a developed country, it is harder to find a perfect real world match for this assumption. Nevertheless, we can think of certain rescue actions in times of an economic crisis whose benefit to the overall economy exceeds possible additional private benefits by far. The stabilization of the economy can then be interpreted as a *quasi*-public good whose value is high in crisis times. One example would be the nationalization of a system-relevant bank.

To model this fluctuation in the simplest possible way, the value of public goods is drawn each period from a two-point distribution: $\alpha_s \in \{\alpha_H, \alpha_L\}$, with $\alpha_H > 2 > \alpha_L > 1$, and $\text{Prob}[\alpha_s = \alpha_H] = \phi$. As will become clear in the subsequent analysis, the high value α_H is chosen such that public good spending in this state of the world will be preferable to transfer spending. In a situation with α_L, this is not necessarily the case. Since public goods benefit everybody the same, the desired size of fiscal

[6]Note however, that we do not model these capital markets explicitly. For a microfoundation of the above reduced form modeling, see Besley and Persson (2009).

[7]Note that the whole analysis is in *per-capita* terms.

infrastructure will depend on the probability ϕ of ending up in a situation where the state definitely spends on common-interest public goods.

The crucial feature of the model in Besley and Persson (2011) is that it includes two aspects of state capacity, fiscal capacity τ_s and legal capacity π_s. Existing fiscal capacity τ_s puts an upper bound on the tax rate that can be raised from income in period s: $t_s \leq \tau_s$. In this simple model, $(1 - \tau_s)$ can be interpreted as the fraction of income that an individual can earn in an informal sector. To increase second period fiscal capacity τ_2, the period-1 government can invest in the built-up of $[\tau_2 - \tau_1]$ additional units of fiscal capacity.[8] For the sake of parsimony, we assume zero depreciation of the stocks of state capacity, in contrast to Besley and Persson (2011). We require $[\tau_2 - \tau_1] \geq 0$, so disinvestment is not allowed. There is an increasing and convex cost $F(\tau_2 - \tau_1)$ of carrying out the investment, with $F(0) = F_\tau(0) = 0$. Here, as in the following, subscripts on functions denote partial derivatives, and the last equation can be interpreted as the first marginal investment having negligible costs.

Legal capacity π_s puts an upper bound on the legal support to both groups: $p_s^J \leq \pi_s$ for $J \in \{I, O\}$. The idea is that existing legal infrastructure restricts the level of legal support a government can grant to any group. The government in period 1 can invest in the future legal capacity that becomes available in period 2 via an increasing and convex cost function $L(\pi_2 - \pi_1)$ with $L(0) = L_\pi(0) = 0$. As for fiscal capacity, we require $[\pi_2 - \pi_1] \geq 0$, so disinvestment is not allowed.

Our main innovation in this section is to introduce the possibility to raise debt. Specifically, the country is assumed to start with a stock of debt equal to zero, $b_0 = 0$. The period-1 incumbent government can now issue one-period risk-free bonds $b_1 \geq 0$ on an international bond market. These bonds have to be repaid in the second period. The interest rate which has to be paid on bonds is given by $\rho = 1/\delta - 1$, where δ is the discount factor of the individuals. Since the bonds are supposed to be risk-free, the maximal amount of bonds is determined by the

[8] There will be a technological maximum $\bar{\tau} < 1$ above which fiscal capacity cannot be expanded ($\tau_s \leq \bar{\tau}$). Here, this would be determined by the fact that some small black market jobs just cannot be detected. Besley et al. (2013) interpret $\bar{\tau}$ as "the highest technologically feasible tax rate" (while τ_s is "the highest institutionally feasible tax rate", p. 212) and argue that in a richer model with distortionary taxation, $\bar{\tau}$ could be the peak of the Laffer curve. However, in the following, we focus on a situation where the optimal level τ_2 will not hit this upper bound.

requirement that fiscal and legal capacity in the second period must be high enough to repay the bonds: $b_1 \leq \frac{\tau_2 \omega(\pi_2)}{1+\rho}$. The right-hand side of this inequality is the discounted maximal tax revenue that can be raised in the second period. Following Besley and Persson (2011) we still assume that the citizens themselves cannot save or borrow. Firstly, due to the linearity of the utility function, this assumption does not alter the results. Secondly, at least for the developing world, there is evidence for private agents' lack of access to credit markets (see Claessens, 2006).

The incumbent group government is assumed to maximize its own group's utility subject to a usual budget constraint and a constraint imposed by the country's 'cohesiveness' of institutions. The budget constraint requires that government revenues are enough to finance all government expenditures:[9]

$$\sum_{J \in \{I,O\}} \frac{t_s \omega(p_s^J)}{2} + b_s \geq g_s + m_s + n_s + \frac{r_s^I + r_s^O}{2} + (1+\rho) b_{s-1} \tag{2.3}$$

where m_s and n_s represent the investment costs in fiscal and legal capacity, which only occur in period 1, and hence are given by

$$m_s = \begin{cases} F(\tau_2 - \tau_1) & \text{if } s = 1 \\ 0 & \text{if } s = 2 \end{cases} \tag{2.4}$$

and

$$n_s = \begin{cases} L(\pi_2 - \pi_1) & \text{if } s = 1 \\ 0 & \text{if } s = 2. \end{cases} \tag{2.5}$$

Since the groups have equal size, $\frac{r_s^I + r_s^O}{2}$ is the *average* per-capita transfer that the government pays out.

The institutional constraint requires that for each unit of transfers awarded by the government to its own group it must transfer at least $\sigma \in [0, 1]$ units to the other group. Besley and Persson (2011) introduce the parameter $\theta = \frac{\sigma}{1+\sigma} \in [0, \frac{1}{2}]$ to describe the 'cohesiveness' of institutions. $\theta = \frac{1}{2}$ refers to completely cohesive institutions which make sure that the opposition is treated in exactly the same way as the incumbent group. For $\theta < \frac{1}{2}$, clientele politics are possible that lead to a redistribution of money towards the incumbent group. Given that the incumbent

[9] Recall that total population is normalized to 1.

government respects the institutional setting as just another constraint, but ultimately is only concerned about its own group's utility, it will set transfers to the opposition as small as possible:

$$r_s^O = \sigma r_s^I = \frac{\theta}{1-\theta} r_s^I \tag{2.6}$$

In the following, we therefore assume the government is choosing only transfers r_s^I to its own group, while implicitly setting r_s^O according to (2.6).

Plugging (2.6) into the budget constraint (2.3), we arrive at a modified budget constraint that already includes the constitutional constraint:

$$\sum_{J \in \{I,O\}} \frac{t_s \omega(p_s^J)}{2} + b_s \geq g_s + m_s + n_s + \frac{r_s^I}{2(1-\theta)} + (1+\rho) b_{s-1}, \tag{2.7}$$

with $b_0 = b_2 = 0$.

The timing of the whole two-period model is now as follows:

1. The initial stock of fiscal capacity is τ_1 and group I_1 is in power. Nature draws the public good value α_1.

2. The government from the currently incumbent group I_1 chooses the set of period-1 policies $\left\{t_1, g_1, r_1^I, b_1, p_1^I, p_1^O\right\}$ and by its investment decision chooses the period-2 stocks of fiscal capacity τ_2 and legal capacity π_2.

3. I_1 remains in power with probability $1-\gamma$, and nature draws α_2

4. The government from the future incumbent group I_2 chooses period-2 policies $\left\{t_2, g_2, r_2^I, p_2^I, p_2^O\right\}$ while honoring the debt commitments.

The applied solution concept is the subgame perfect equilibrium.

2.3.1 Analysis of the Basic Model

Debt and state capacity investments generate a dynamic link across periods. However, given the linear utility function, we can derive the optimal policy decision between public good spending and transfer spending for any period taking as given the levels of state capacity, state capacity investments and debt. Furthermore, the non-distortionary nature of taxes makes the level of taxes in a given period depend only on the level of fiscal capacity in that period. In a second step, the optimal debt level will be determined using the optimal policy functions on public good and transfer spending and still taking state capacity and state capacity investments as given.[10] Having derived the optimal policy decisions on spending and debt for different levels of state capacity investments, the optimal level of these investments can then be determined in a last third step.

Intra-temporal policies

Turning to the first step, legal protection will be set maximally for both groups: $p^I_s = p^O_s = \pi_s$. This is because, first, the incumbent group gains from an increase of the own income. Second, it also benefits from an increase of the other group's income, because the resulting higher tax revenues can be used for additional public good or transfer spending.

Taxes will be used up to the full fiscal capacity: $t_s = \tau_s$. The reason is the following: The marginal benefit of public spending is always at least as high as the opportunity cost of lost private consumption, since $max\{\alpha_s, 2(1-\theta)\} \geq 2(1-\theta) \geq 1$.

Compared to the model without debt, the introduction of debt does not change the trade-off between public goods and transfers. This trade-off depends solely on the *constant* marginal benefits of these two forms of spending. The only effect is on the *level* of spending. Specifically, the residual revenues have to be adjusted for the net inflow of money after issuing new debt and repaying old debt, $b_s - (1+\rho)b_{s-1}$. The optimal policy function for public good spending becomes

$$G(\alpha_s, \tau_s, \pi_s, m_s, n_s, b_s, b_{s-1}) = \begin{cases} \tau_s\omega(\pi_s) - m_s - n_s + b_s - (1+\rho)b_{s-1} & \text{if } \alpha_s \geq 2(1-\theta) \\ 0 & \text{otherwise.} \end{cases} \tag{2.8}$$

That is, public goods are provided at the maximal level, if the gross marginal value of public good spending, α_s, exceeds the gross marginal value of transfers for the

[10] The reason that the debt decision can be analyzed *before* the state capacity decisions has to do with the constancy of the marginal value of spending in each period.

incumbent group, $2(1-\theta)$. At the same time, transfers and therefore redistribution towards the incumbent group are zero. If the ordering between the marginal values is the opposite way, we only get redistributive transfers and no public goods.

Using the new budget constraint (2.7) with t_s set to τ_s and p_s^J set to π_s, the indirect payoff function for group $J \in \{I, O\}$ in period s becomes:

$$W(\alpha_s, \tau_s, \pi_s, m_s, n_s, b_{s-1}, b_s, \beta^J) = \alpha_s G + (1-\tau_s)\omega(\pi_s) + \beta^J[\tau_s \omega(\pi_s) - G - m_s - n_s + b_s - (1+\rho)b_{s-1}] \tag{2.9}$$

where $\beta^I = 2(1-\theta)$ and $\beta^O = 2\theta$ can be interpreted as the gross marginal value of transfer spending for the incumbent (I) and for the opposition (O), respectively. Note that we have suppressed the arguments of the G function. Furthermore, $\beta^J[\tau_s \omega(\pi_s) - G - m_s - n_s + b_s - (1+\rho)b_{s-1}] \geq 0$ are the transfers to group J.

The 'value functions' capturing the within-period utility in the second period for a group that is the incumbent (I) or the opposition (O) become:

$$\begin{aligned} & U^I(\tau_2, \pi_2, b_1) \qquad\qquad (2.10) \\ &= \phi W[\alpha_H, \tau_2, \pi_2, 0, 0, b_1, 0, 2(1-\theta)] + (1-\phi)W[\alpha_L, \tau_2, \pi_2, 0, 0, b_1, 0, 2(1-\theta)] \\ &= \phi[\alpha_H(\tau_2\omega(\pi_2) - (1+\rho)b_1) + (1-\tau_2)\omega(\pi_2)] + (1-\phi)W[\alpha_L, \tau_2, \pi_2, 0, 0, b_1, 0, 2(1-\theta)] \end{aligned}$$

$$\begin{aligned} & U^O(\tau_2, \pi_2, b_1) \qquad\qquad (2.11) \\ &= \phi W[\alpha_H, \tau_2, \pi_2, 0, 0, b_1, 0, 2\theta] + (1-\phi)W[\alpha_L, \tau_2, \pi_2, 0, 0, b_1, 0, 2\theta] \\ &= \phi[\alpha_H(\tau_2\omega(\pi_2) - (1+\rho)b_1) + (1-\tau_2)\omega(\pi_2)] + (1-\phi)W[\alpha_L, \tau_2, \pi_2, 0, 0, b_1, 0, 2\theta] \end{aligned}$$

Note that, when the value of the public good is high, whatever is left after repaying debt, $(\tau_2\omega(\pi_2) - (1+\rho)b_1)$, will be spent on the public good. Finally, the total expected utility of the period-1 incumbent group, as seen from the first period, is:

$$W(\alpha_1, \tau_1, \pi_1, F(\tau_2-\tau_1), L(\pi_2-\pi_1), 0, b_1, 2(1-\theta)) + \delta([1-\gamma]U^I(\tau_2, \pi_2, b_1) + \gamma U^O(\tau_2, \pi_2, b_1)) \tag{2.12}$$

Intra-temporal policies

Having solved for the optimal intra-temporal policies, we now turn to the inter-temporal policies b_1, τ_2 and π_2. To make the following analysis easier, we define λ_1, the gross marginal benefit of public funds in period 1, and $E(\lambda_2)$, the expected gross marginal benefit of public funds in period 2. We have

$$\lambda_1 \equiv max\{\alpha_1, 2(1-\theta)\}$$

and

$$E(\lambda_2) \equiv \phi\alpha_H + (1-\phi)\lambda_2^L \tag{2.13}$$

with

$$\lambda_2^L = \begin{cases} \alpha_L & \text{if } \alpha_L \geq 2(1-\theta) \\ (1-\gamma)2(1-\theta) + \gamma 2\theta & \text{otherwise,} \end{cases} \tag{2.14}$$

since $E(\lambda_2)$ depends on the use of public funds in the future, which is uncertain.

With this notation, the inter-temporal maximization problem of the incumbent group in period s=1 becomes:

$$max_{\tau_2,\pi_2,b_1}\ EV^{I_1}(\tau_2,\pi_2,b_1) - \lambda_1(F(\tau_2-\tau_1) + L(\pi_2-\pi_1) - b_1) \tag{2.15}$$
$$\begin{aligned} s.t.\ \tau_2 &\geq \tau_1, \\ \pi_2 &\geq \pi_1, \\ b_1 &\leq \frac{\tau_2\omega(\pi_2)}{1+\rho}, \\ \lambda_1 &\equiv max\{\alpha_1, 2(1-\theta)\} \end{aligned}$$

with:

$$EV^{I_1}(\tau_2,\pi_2,b_1) = \delta((1-\gamma)U^I(\tau_2,\pi_2,b_1) + \gamma U^O(\tau_2,\pi_2,b_1)) \tag{2.16}$$

Choice of debt

The three dynamic variables fiscal capacity, legal capacity and debt are interlinked by the following fact. The amount of debt which can be raised is limited by the amount of future fiscal and legal capacity. The latter two determine the money the state can raise to repay debt. Furthermore, the investment and debt decisions determine the amount of *residual* revenue a government has at its disposal for financing public good spending or transfers after all other expenditures are covered. We now analyze the choice of debt taking the levels of fiscal and legal capacity investments as given.

The simple linear model has the advantage that, in each period, the use of residual government revenues either on public goods or transfers is exactly determined. Furthermore, the marginal benefit of that residual use is constant in either case. This marginal benefit is what we referred to as the gross marginal benefit of public funds and denoted by λ_s.

Debt allows to make future public funds available in the present. Therefore, the optimal debt level can be found by a simple comparison of the gross marginal benefit of public funds in the two periods. Specifically, if λ_1, the gross marginal benefit in the first period, is higher than $E(\lambda_2)$, the expected gross marginal benefit in the second period, then it is optimal to raise the maximal debt that is allowed by future state capacity: $b_1 = \frac{\tau_2 \omega(\pi_2)}{1+\rho}$. If $E(\lambda_2) > \lambda_1$, then no debt is raised: $b_1 = 0$.[11,12]

Summarizing the above analysis in a policy function for the debt level chosen in period 1, we have:

$$B(\alpha_1, \tau_2, \pi_2) = \begin{cases} \frac{\tau_2 \omega(\pi_2)}{1+\rho} & \text{if } \lambda_1 > E(\lambda_2) \\ 0 & \text{otherwise.} \end{cases} \tag{2.17}$$

Choice of fiscal and legal capacity

With this, we have arrived at the third step of the analysis, the decision about fiscal and legal capacity investment. We substitute the policy function (2.17) for b_1 in (2.12) and maximize the resulting function with respect to future fiscal capacity τ_2 and legal capacity π_2, subject to the constraints that fiscal and legal capacity investments cannot be negative, $[\tau_2 - \tau_1] \geq 0$ and $[\pi_2 - \pi_1] \geq 0$, and transfers must

[11]The implicit assumption behind $b_1 \geq 0$ is that the government cannot *invest in assets* on the bond market.

[12]Furthermore, this result requires Assumptions (2.22) and (2.23) which will be introduced after having derived the optimal state capacity investments. We need these additional technical assumptions here because for $E(\lambda_2) > \lambda_1$, we could otherwise get that all first-period tax revenue is used for investments in future state capacity. With low enough costs of investment, it could then be beneficial to use debt for bringing future tax revenues to the present and finance even more future state capacity.

also be weakly positive. From this, we get the following 'Euler equations'

$$\begin{aligned}
&\delta([1-\gamma]\frac{dU^I[\tau_2,\pi_2,B(\alpha_1,\tau_2,\pi_2)]}{d\tau_2}+\gamma\frac{dU^O[\tau_2,\pi_2,B(\alpha_1,\tau_2,\pi_2)]}{d\tau_2}) \\
&+W_{b_1}[\alpha_1,\tau_1,\pi_1,m_1,n_1,B(\alpha_1,\tau_2,\pi_2),0,2(1-\theta)]\frac{\partial B(\alpha_1,\tau_2,\pi_2)}{\partial\tau_2} \\
&\leq -W_m[\alpha_1,\tau_1,\pi_1,m_1,n_1,B(\alpha_1,\tau_2,\pi_2),0,2(1-\theta)]F_\tau(\tau_2-\tau_1) \\
&c.\ s.\ \tau_2-\tau_1\geq 0
\end{aligned} \tag{2.18}$$

and

$$\begin{aligned}
&\delta([1-\gamma]\frac{dU^I[\tau_2,\pi_2,B(\alpha_1,\tau_2,\pi_2)]}{d\pi_2}+\gamma\frac{dU^O[\tau_2,\pi_2,B(\alpha_1,\tau_2,\pi_2)]}{d\pi_2}) \\
&+W_{b_1}[\alpha_1,\tau_1,\pi_1,m_1,n_1,B(\alpha_1,\tau_2,\pi_2),0,2(1-\theta)]\frac{\partial B(\alpha_1,\tau_2,\pi_2)}{\partial\pi_2} \\
&\leq -W_n[\alpha_1,\tau_1,\pi_1,m_1,n_1,B(\alpha_1,\tau_2,\pi_2),0,2(1-\theta)]L_\pi(\pi_2-\pi_1) \\
&c.\ s.\ \pi_2-\pi_1\geq 0,
\end{aligned} \tag{2.19}$$

where $\frac{dU^I}{d\tau_2}$, $\frac{dU^O}{d\tau_2}$, $\frac{dU^I}{d\pi_2}$ and $\frac{dU^O}{d\pi_2}$ are *total* derivatives. The trade-off is between the marginal benefit of future fiscal or legal capacity (left-hand side) against the marginal cost of financing that fiscal or legal capacity (right-hand side). Also analogously to the model without debt:

$$\begin{aligned}
\lambda_1 &\equiv -W_m[\alpha_1,\tau_1,\pi_1,m_1,n_1,B(\alpha_1,\tau_2,\pi_2),0,2(1-\theta)] \\
&= -W_n[\alpha_1,\tau_1,\pi_1,m_1,n_1,B(\alpha_1,\tau_2,\pi_2),0,2(1-\theta)] = max\{\alpha_1,2(1-\theta)\}
\end{aligned}$$

The opportunity cost of using government revenues for financing investments is the gross marginal benefit of period-1 public funds.[13] It depends on the form of residual spending (public goods or transfers) in period 1.

The crucial difference to a model without debt are the left-hand sides of (2.18) and (2.19). The left-hand side of (2.18) describes the marginal benefit of additional future fiscal capacity, as seen from the first period. If no debt is raised, it is $\delta\omega(\pi_2)[E(\lambda_2)-1]$. $E(\lambda_2)$ is the expected gross marginal benefit of future public funds and is given in (2.13) and (2.14). However, when debt is raised, it is raised *maximally* and uses up all public funds in the second period. Therefore, the gross

[13] This result depends again on Assumptions 2.22 and 2.23. These technical assumptions exclude the case where it is optimal (and through debt possible) that the marginal money to finance future fiscal capacity actually comes from the future. Cf. the previous footnote.

marginal value of public funds is then determined by the use of debt. Since debt is used to finance *first-period* expenditures on public goods or transfers, the gross marginal benefit of future public funds becomes λ_1. The point is that debt allows to make future public funds available in the present. Therefore, the benefit of future public funds is then given by the *present* benefit of residual spending. According to this discussion, the optimality condition (2.18) can be rewritten as:

$$\delta\omega(\pi_2)\left[max\{\lambda_1, E(\lambda_2)\} - 1\right] \leq \lambda_1 F_\tau(\tau_2 - \tau_1) \tag{2.20}$$
$$c.\ s.\ \tau_2 - \tau_1 \geq 0$$

Given the assumption $F_\tau(0) = 0$, a necessary and sufficient condition for positive investments in fiscal capacity is now $max\{\lambda_1, E(\lambda_2)\} > 1$, which is always satisfied. This is a crucial difference compared to the model without debt and is discussed in more detail in Section 2.3.3.

The left-hand side of (2.19) describes the marginal benefit of additional future legal capacity, as seen from the first period. Following the same reasoning as for fiscal capacity, the optimality condition (2.19) can be rewritten as:

$$\delta\omega'(\pi_2)[1 + \tau_2[max\{\lambda_1, E(\lambda_2)\} - 1]] \leq \lambda_1 L_\pi(\pi_2 - \pi_1) \tag{2.21}$$
$$c.\ s.\ \pi_2 - \pi_1 \geq 0$$

Given the assumption $L_\pi(0) = 0$, there is always positive investment in legal capacity.

Considering the left-hand sides of equation (2.20) and equation (2.21), we notice that an investment in one of the two state capacities increases the marginal return of the other. This is because we have $max\{\lambda_1, E(\lambda_2)\} > 1$. So, fiscal and legal capacity are complements. Note that the analogous condition in Besley and Persson (2011), $E(\lambda_2) > 1$, was not guaranteed to always hold. In contrast, the introduction of debt into the basic model implies that complementarity between the two forms of state capacity investment will always hold.

As in Besley and Persson (2011) this complementarity is not only an interesting fact, but also allows us to apply results on monotone comparative statics. By Theorem 5 and 6 of Milgrom and Shannon (1994), any factor that increases the left-hand sides of equation (2.20) and equation (2.21) leads to an increase of both fiscal and legal capacity investments.[14] This reasoning is used to establish the comparative statics stated in the propositions in the following two subsections.

For all of the subsequent analysis, we make the following assumptions.

Assumptions

$$\delta\omega(\pi_2)[\alpha_H - 1] < \alpha_L F_\tau(\bar{\tau}_2 - \tau_1) \tag{2.22}$$

$$\delta\omega'(\pi_2)[1 + \tau_2[\alpha_H - 1]] < \alpha_L L_\pi(\bar{\pi}_2 - \pi_1) \tag{2.23}$$

for some $\bar{\tau}_2$, $\bar{\pi}_2$, so that $L(\bar{\pi}_2 - \pi_1) + F(\bar{\tau}_2 - \tau_1) = \tau_1\omega(\pi_1)$. So, $\bar{\tau}_2$, $\bar{\pi}_2$ are levels of future state capacity which can be financed if the current tax revenue is only and fully used for that purpose. These assumptions mean that the curvature of the cost functions $F(\cdot)$ and $L(\cdot)$ is high enough for the marginal cost of increasing fiscal and legal capacity to surpass the marginal benefit at an interior level of investment. That is, we don't allow the marginal benefit of investment to still surpass the marginal cost at the point where all possible tax revenues are only used for investments in fiscal and legal capacity.[15] These technical assumptions are only necessary in the linear model. As we will see, they can be dispensed with in the quasi-linear setup of Section 2.5.

In the following, we first analyze the normative benchmark of a social planner.

2.3.2 The Social Planner's Solution

The maximization problem of a Utilitarian social planner who weights the utilities of both groups equally is equivalent to the version of the model where full cohesiveness ($\theta = 1/2$) restricts the incumbent group in both periods to provide the same transfers to both groups. Then, since $\alpha_L > 2(1-\theta) = 1$, the social planner always uses all residual money to provide public goods. For the basic model with debt, the results

[14] For a more detailed formal treatment, see the proofs in Appendix A.1.

[15] Note that the left-hand sides of (2.22) and (2.23) give the absolute maximum for the marginal benefits of fiscal and legal capacity investment. The right-hand sides give the absolute minimum for the marginal costs.

about debt and state capacity investments of a social planner are summarized in the following proposition:[16]

Proposition 2.3.1. *Suppose that the decisions about debt and state capacity investments are made by a Pigouvian planner with Utilitarian preferences. Then:*

1. *If $\alpha_1 = \alpha_L$:*
   - *(a) No debt is raised.*
   - *(b) No transfers are paid.*
   - *(c) There are positive investments in fiscal and legal capacity.*
   - *(d) Higher ϕ increases investment in fiscal and legal capacity.*
2. *If $\alpha_1 = \alpha_H$:*
   - *(a) Debt is raised maximally: $b_1 = \frac{\tau_2 \omega(\pi_2)}{1+\rho}$.*
   - *(b) No transfers are paid.*
   - *(c) There are positive investments in fiscal and legal capacity and the investments are higher than when no debt can be raised.*

For a social planner we have $\lambda_1 = \alpha_1$. That is, the gross marginal value of public funds in the first period corresponds to the value of public goods in the first period. Moreover, for the social planner the gross marginal value of public funds in the second period is $E(\lambda_2) = \phi\alpha_H + (1-\phi)\alpha_L > 1$.

For the first part, note that $\lambda_1 = \alpha_L < E(\lambda_2)$ implies that no debt will be raised. In a model without debt, the results of the first part are valid for both, $\alpha_1 = \alpha_L$ and $\alpha_1 = \alpha_H$ as stated in Proposition 2.1 in Besley and Persson (2011).

In the model with debt, if $\alpha_1 = \alpha_H$, we have $\lambda_1 = \alpha_H > E(\lambda_2)$ and debt will be raised maximally in order to make future public funds available in the present. Therefore, the net marginal benefit of future public funds is greater than it was without debt, which raises incentives to invest in fiscal capacity. Basically, debt allows the social planner to use the tax system of the future to finance a highly-valued public good today. Given a high need for public funds today versus a lower need tomorrow this increases incentives to invest in fiscal capacity for the purpose of increasing spending today. By complementarity, investments in legal capacity increase as well.

[16]The proofs of this and of all subsequent propositions are collected in Appendix A.1.

We now turn to the analysis of the political equilibrium.

2.3.3 Three Types of States Revisited

The outcome of the political game will depend on the interplay of the parameters governing how cohesive political institutions are (θ) and how stable the political system is (γ) with the public good parameters (ϕ, α_H, α_L) summarizing the main features of the economic environment. In Besley and Persson (2011), the following condition ensures that political institutions are sufficiently cohesive to make the political outcome coincide with the outcome under a social planner:

Cohesiveness: $\alpha_L \geq 2(1-\theta)$

This condition will hold if the parameter governing the cohesiveness of political institutions, θ, is close enough to $1/2$, the value it takes for a social planner. Recall that $\theta = 1/2$ ensures that both groups have to be treated equally and therefore captures perfectly cohesive political institutions.

If the cohesiveness condition fails, but the stability of the political system is high enough, Besley and Persson (2011) get a state that still has positive investments in state capacity. The corresponding stability condition is:

Stability: $\phi\alpha_H + (1-\phi)[(1-\gamma)2(1-\theta) + \gamma 2\theta] > 1$

This condition will hold when the probability of staying in political power, $1-\gamma$, is big enough. That is, from the point of view of the period-1 incumbent government, the political system is *stable* in the sense of not endangering its power. However, the condition goes further. In fact, it refers to stability in the sense of not endangering the *interests* of the period-1 government. This can also be ensured by the economic environment. For instance, if a high value of public good spending is expected with certainty ($\phi \to 1$), the stability condition will also hold. The interest of the period-1 government in future public good spending is then respected no matter who is in power in the future. In order to compare our results to the ones in Besley and Persson (2011), we consider the same three types of states that they derive and investigate if these types still arise after the introduction of debt.

Common-Interest State

In the case where the cohesiveness condition holds, we get the following result:

Proposition 2.3.2. *If Cohesiveness holds, then the outcome is the same as under a social planner (see Proposition 2.3.1).*

This result is analogous to the model without debt (Proposition 2.2 in Besley and Persson (2011)). The reason is that high cohesiveness makes redistribution unattractive compared to public good spending even when the latter has a low value. Therefore, by choice, each government will provide only public goods thereby behaving exactly like a social planner. Additionally to the model without debt, the shifting of public resources over time also follows the structure of the public good values and again coincides with the social planner behavior. In line with Besley and Persson (2011), we call this state the common interest state.

Redistributive State

Assume that Cohesiveness fails, but Stability holds. We get the following results:

Proposition 2.3.3. *If Cohesiveness fails and Stability holds, then:*

1. *If* $\alpha_1 = \alpha_L$ *and* $2(1-\theta) < \phi\alpha_H + (1-\phi)[(1-\gamma)2(1-\theta) + \gamma 2\theta]$*:*
   (a) *No debt is raised.*
   (b) *Residual revenues in period 1 are used to finance transfers.*
   (c) *There are positive investments in fiscal and legal capacity.*
   (d) *Higher* ϕ *increases investments in fiscal and legal capacity.*
   (e) *A lower value of* γ *unambiguously raises investments, whereas an increase in* θ *raises investments if* $\gamma > 1/2$.
2. *If* $\alpha_1 = \alpha_H$ *or if* $\alpha_1 = \alpha_L$ *and* $2(1-\theta) > \phi\alpha_H + (1-\phi)[(1-\gamma)2(1-\theta) + \gamma 2\theta]$*:*
   (a) *Debt is raised maximally:* $b_1 = \frac{\tau_2\omega(\pi_2)}{1+\rho}$.
   (b) *There are positive investments in fiscal and legal capacity and the investments are higher than when no debt can be raised.*
   (c) *If* $\alpha_1 = \alpha_H$*, the levels of fiscal and legal capacity investments are the same as those chosen by a social planner in the same situation (see Proposition 2.3.1 Part 2).*

(d) *If $\alpha_1 = \alpha_L$, residual revenues in period 1 are used to finance transfers.*

(e) *Political instability γ does not have an influence on the investment decisions. If $\alpha_1 = \alpha_H$, cohesiveness θ does not have an influence either.*

In an environment with a low public good value in the first period, the incumbent government prefers to spend on redistributive transfers in this first period. However, when the condition in Part 1 of the proposition holds, the expected value of future public spending is still higher than the value of this first-period transfer spending. The implied preference for future spending leads to the result that no debt is raised, because this would mean taking resources from the future. Therefore, the remaining results in the first part of the proposition are analogous to the model without debt.

When one of the conditions in Part 2 of the proposition holds, there is a preference for the present. Specifically, the incumbent group in period 1 can no longer be sure that spending in the second period will be in its interest in expectation. However, with debt, the period-1 government now has the possibility to bring future public funds at its disposal. Thereby, it can decide about the spending purposes which these future public funds will be used for. This will actually allow the incumbent group to solve the problem of future redistribution against itself and hence raises incentives for investing in fiscal and legal capacity.

Importantly, these bigger incentives can be driven by the desire to finance redistributive transfers in the present, which is not in the spirit of a Utilitarian social planner. Therefore, we do not only get spending on the 'wrong' issues, we can even get the incentive to finance more of this 'wrong' spending through the issuance of debt. In this case of the basic model, the additional debt-induced incentive to invest in fiscal and legal capacity therefore creates a bigger deviation of the political outcome from the social planner optimum.

'Weak' State

The last possibility arises when both the cohesiveness and the stability condition fail. Besley and Persson (2011) call such a state a "weak state" (p. 62). In their model without debt, such a state has no incentive to invest in fiscal capacity (Proposition 2.4 in Besley and Persson (2011)).

As we have already seen, the introduction of debt can raise incentives to invest because what drives these incentives is now the use that period-2 public funds can be put to in the *first* period. This strongly suggests that the weak state situation, which is based on the fear of future public funds being used against the own group, will no longer arise in this basic model with debt. The next proposition confirms this hypothesis:

Proposition 2.3.4. *In the basic model without the possibility of default, if Cohesiveness and Stability fail, then:*

1. *There is positive investment in fiscal capacity which is higher than the zero investment in the case without debt. Moreover, there is positive investment in legal capacity which is higher than in the case without debt.*
2. *If $\alpha_1 = \alpha_H$, the levels of investment in fiscal and legal capacity are the same as those chosen by a social planner in the same situation (see Proposition 2.3.1 Part 2).*
3. *Debt is raised maximally: $b_1 = \frac{\tau_2 \omega(\pi_2)}{1+\rho}$.*
4. *If $\alpha_1 = \alpha_L$, residual revenues are used to finance transfers.*

So, the weak state situation as in Besley and Persson (2011) does no longer arise when debt is allowed since the possibility to raise debt creates incentives for investing in state capacity. We even get the social planner's investment level if $\alpha_1 = \alpha_H$. For the case $\alpha_1 = \alpha_L$, we also get positive investments in state capacity, potentially even higher than the social planner's investments. However, from the perspective of a social planner, this case is now even worse than in the model without debt since all future tax revenue is now drawn to the present and used for transfers directed to the incumbents clientele.

The arguments for all these results and their interpretations are the same as for Part 2 of Proposition 2.3.3, which described a redistributive state.

It is important to note, however, that this result of the weak state situation no longer arising depends on the highly stylized setup of the basic model. As soon as we introduce the possibility of default, the costs of raising high debt enter the analysis. Doing so in the model of the next section, we can reestablish the possibility of a weak state.

2.4 Full Model

Despite providing a very good starting point for further analysis, the basic model needs some modification to accommodate the introduction of debt in a more realistic manner. Until now, the interest rate of government bonds is constant and so it is independent of the level of debt, future income and tax revenues are perfectly predictable, government default is impossible and the model has a bang-bang solution, i.e. either maximal debt or no debt at all. In the following section we extend the model by allowing income ω to be subject to shocks. As we will see below, this leads to varying interest rates, the possibility of government default and inner solutions for public debt.

In this section, we allow the income $\omega_s(\pi_s)$ of the economy in period s to fluctuate so that tax revenues $\tau_s\omega_s(\pi_s)$ are also uncertain. The following can thus be interpreted as a parsimonious way of including an exogenous business cycle component into the model. Specifically, we assume $\bar{\omega}(\pi_s) > \underline{\omega}(\pi_s)$, $\bar{\omega}'(\pi_s) = \underline{\omega}'(\pi_s) \equiv \omega'(\pi_s)$[17] and $\text{Prob}\left(\omega_s(\pi_s) = \bar{\omega}(\pi_s)\right) = \psi$.

In such a setting, the interest rate is endogenously determined by $R(b) = \rho + r(b)$. $r(b)$ is the risk premium, which is nonzero if b exceeds a certain threshold $\bar{b}$, characterized below. So far, the interest rate $\rho = 1/\delta - 1$ was pinned down by the discount factor δ of the consumers, and therefore it was independent of the debt level b. However, in reality the interest rate a country has to pay in order to issue government bonds depends on the level of public debt. The higher interest rate captures the risk premium due to a higher probability of default.

The analysis now requires a more precise description of the timing in the game. Let the timing be as described in Section 2.3. However, since the investment decision regarding fiscal capacity might influence the solvency of the state and therefore the credit terms, one has to be careful regarding the timing of issuing debt and investing in fiscal capacity. Let us divide stage 2 of the timing from Section 2.3 into two stages 2a and 2b. Assume that in stage 2a the government makes the decision regarding the

[17] Note that this is equivalent to assuming $\omega_s(\pi_s)$ to have the following form: $\bar{\omega}(\pi_s) = w(\pi_s) + \bar{v}$ and $\underline{\omega}(\pi_s) = w(\pi_s) + \underline{v}$. This means we assume the income shock (e.g. due to business cycles) to be additive and not depending on the level of legal capacity. Therefore, increasing legal capacity leads to a higher expected income (a positive growth trend), around which the actual income fluctuates with an amplitude that is constant with respect to π.

investments in fiscal and legal capacity and in stage 2b all other decisions including debt.[18] In such a setting, the investors that buy the government bonds condition their expectations regarding the future solvency of the state on the future levels of fiscal and legal capacity, τ_2 and π_2.

Besides lending money to the government, we assume that the international investors have the possibility to invest in riskless bonds which just compensate them for their time preference. These riskless bonds therefore have an interest rate of $\rho = 1/\delta - 1$. Since investors are assumed to be risk neutral, the expected return from lending money to the government has to be just high enough to equal the interest rate of the risk-free asset.

The threshold $\bar{b}$ is defined such that for $b \leq \bar{b}$, bonds plus interest are fully payed back even for the low income realization $\underline{\omega}(\pi_2)$. In this case, there is no risk that needs compensation, so $R(b) = \rho$. The threshold $\bar{b}$ is given by:

$$\bar{b}(\tau_2, \pi_2) = \frac{\tau_2 \underline{\omega}(\pi_2)}{1+\rho} \tag{2.24}$$

For $b > \bar{b}$, debt will be payed back fully in case of high income $\bar{\omega}(\pi_2)$ but partially else. The function for the risk premium, $r(b)$, that makes investors indifferent between lending to the country and investing in the risk-free asset is defined by

$$(1+\rho)b_1 = \psi \cdot \underbrace{(1+\rho+r(b_1))b_1}_{\textit{repayment in case of } \bar{\omega}(\pi_2)} + (1-\psi) \cdot \underbrace{(\tau_2 \underline{\omega}(\pi_2))}_{\textit{repayment in case of } \underline{\omega}(\pi_2)} . \tag{2.25}$$

Rearranging terms leads to the expression $r(b_1) = \frac{1-\psi}{\psi}(1+\rho-\frac{\tau_2\underline{\omega}(\pi_2)}{b_1})$.

It is clear that there has to be a maximum level of debt $\bar{\bar{b}}$. This is defined by the maximum debt that can be fully payed back including interest in the case of high income $\bar{\omega}(\pi_2)$. This level is given by $\bar{\bar{b}} = \frac{\tau_2\bar{\omega}(\pi_2)}{1+\rho+r(\bar{\bar{b}})}$. Solving for $\bar{\bar{b}}$, this leads to:

$$\bar{\bar{b}}(\tau_2, \pi_2) = \frac{\tau_2(\psi\bar{\omega}(\pi_2) + (1-\psi)\underline{\omega}(\pi_2))}{1+\rho} \tag{2.26}$$

When debt is not completely paid back, which means that there is sovereign debt default, the country incurs a penalty P. For reasons of tractability, the penalty is assumed to reduce the after-tax income. It would certainly be more realistic to have

[18] We can also think of these actions as taking place simultaneously under the constraint that the bundle of debt, interest rate and state capacity investments is so that investors are indifferent.

the penalty reduce gross income as in many models of sovereign debt default (e.g. Alesina and Tabellini (1989), Arellano (2008), Eaton and Gersovitz (1981)). However, the above assumption is made to avoid technical complications. The penalty can be interpreted, for instance, as credit restrictions on retailers which make it more expensive to supply imported goods. The ensuing reduction in the purchasing power of income is captured in our simple model by the direct reduction of after-tax income through the penalty.

We assume that the penalty has the following form (where Δ is the amount not repaid):

$$P = \begin{cases} 0 & if \quad \Delta = 0 \quad (no\ default) \\ P(\Delta) & if \quad \Delta = (1 + R(b_1))b_1 - (\tau_2 \underline{\omega}(\pi_2)) \quad and\ \omega_2(\pi_2) = \underline{\omega}(\pi_2) \\ P_{max} & else. \end{cases} \tag{2.27}$$

This means, as long as the government shows good will, in the sense that it repays as much debt as it can, the penalty depends on the amount of debt that is not repaid. $P(\Delta)$ is assumed to be increasing and convex for $\Delta \in [0, (1 + R(\bar{\bar{b}}))\bar{\bar{b}} - (\tau_2 \underline{\omega}(\pi_2))] = [0, \tau_2(\bar{\omega}(\pi_2) - \underline{\omega}(\pi_2))]$ with $P(0) = 0$. If the country repays less than possible and defaults purposely, we assume the punishment to be maximal, P_{max}. We assume P_{max} to be high enough to prevent the government from defaulting purposely. That is, we only consider *ability-to-pay* default and not *willingness-to-pay* default. This allows us to model rising costs of debt financing without having to burden the analysis with a more involved modeling of the default decision.

Concerning the intra-temporal policies, with the same reasoning as in the model without debt, fiscal and legal capacities are always fully employed. As for the policy function for public good spending, it also looks analogous to before:

$$G(\alpha_s, \tau_s, \pi_s, m_s, n_s, b_s, b_{s-1}, \omega_s) = \begin{cases} \tau_s \omega_s(\pi_s) - m_s - n_s + b_s & \\ -min\left\{(1 + R(b_{s-1}))b_{s-1}, \tau_s \omega_s(\pi_s)\right\} & \text{if } \alpha_s \geq 2(1-\theta) \\ 0 & \text{otherwise.} \end{cases} \tag{2.28}$$

where ω_s can now be the high or low income realization $\overline{\omega}$ or $\underline{\omega}$. For simplifying the notation, the following contains the 'expected' policy function $G = \psi G(\overline{\omega}) + (1 - \psi)G(\underline{\omega})$, where ψ is the probability for the high income realization $\overline{\omega}$.

The inter-temporal maximization problem of the incumbent group in period s=1 becomes:

$$
\begin{aligned}
max_{\tau_2,\pi_2,b_1}\ & EV^{I_1}(\tau_2,\pi_2,b_1) - \lambda_1(F(\tau_2-\tau_1) + L(\pi_2-\pi_1) - b_1) \\
& s.t.\ \tau_2 \geq \tau_1, \\
& \pi_2 \geq \pi_1, \\
& b_1 \leq \overline{\overline{b}}(\tau_2), \\
& \lambda_1 \equiv max\{\alpha_1, 2(1-\theta)\}
\end{aligned}
\tag{2.29}
$$

with

$$
\begin{aligned}
EV^{I_1}(\tau_2,\pi_2,b_1) &= \delta((1-\gamma)U^I(\tau_2,\pi_2,b_1) + \gamma U^0(\tau_2,\pi_2,b_1)) \\
&= \delta((1-\gamma)(\phi EW(\alpha_H,\tau_2,\pi_2,0,0,b_1,0,2(1-\theta)) \\
&+ (1-\phi)EW(\alpha_L,\tau_2,\pi_2,0,0,b_1,0,2(1-\theta))) \\
&+ \gamma(\phi EW(\alpha_H,\tau_2,\pi_2,0,0,b_1,0,2\theta) + (1-\phi)EW(\alpha_L,\tau_2,\pi_2,0,0,b_1,0,2\theta)))
\end{aligned}
\tag{2.30}
$$

and

$$
\begin{aligned}
& EW(\alpha_2,\tau_2,\pi_2,m_2=0,n_2=0,b_1,b_2=0,\beta^J) = \\
& \alpha_2 G + (1-\tau_2)(\psi\bar{\omega}(\pi_2) + (1-\psi)\underline{\omega}(\pi_2)) - (1-\psi)P + \beta^J[\tau_2(\psi\bar{\omega}(\pi_2) + (1-\psi)\underline{\omega}(\pi_2)) \\
& - G - \psi(1+R(b_1))b_1 - (1-\psi)min\left\{(1+R(b_1))b_1, \tau_2\underline{\omega}(\pi_2)\right\}\right] ,
\end{aligned}
\tag{2.31}
$$

which is the indirect payoff function for group $J \in I, O$ in period s. This function is now an expected value itself, because future income $\omega_2(\pi_2)$ is uncertain. Note that for the analysis here, we assume that the fluctuations in income and in the valuation of public goods are independent. In the quasi-linear setup of Section 2.5, we will consider the other extreme, a perfect correlation between the two in the sense that public good spending has a higher value in times with low income. The most realistic modeling probably lies at some intermediate level of correlation, but the extreme cases allow us to keep the analysis tractable.

Plugging (2.31) into (2.30), leads to:

$$\begin{aligned} EV^{I_1}(\tau_2, \pi_2, b_1) =& \delta[(\psi\bar{\omega}(\pi_2) + (1-\psi)\underline{\omega}(\pi_2))(1-\tau_2) - (1-\psi)P \\ & + \underbrace{[\phi\alpha_H + (1-\phi)\lambda_2^L]}_{\equiv E(\lambda_2)} \cdot [\tau_2(\psi\bar{\omega}(\pi_2) + (1-\psi)\underline{\omega}(\pi_2)) \\ & - \psi(1+R(b_1))b_1 - (1-\psi)min\{(1+R(b_1))b_1, \tau_2\underline{\omega}(\pi_2)\}]] \end{aligned} \quad (2.32)$$

with λ_2^L defined by (2.14).

2.4.1 Solution of the Model

Regarding the solution of this optimization problem, several cases can arise:

- case a) : $b_1 = 0$[19]

- case b) : $b_1 \in (0, \bar{b})$

- case c) : $b_1 = \bar{b}$

- case d) : $b_1 \in (\bar{b}, \bar{\bar{b}})$

- case e) : $b_1 = \bar{\bar{b}}$

When do these cases emerge? The first order conditions with respect to b_1 in case b) and d) lead us to the relevant conditions. In case b), the first order condition with respect to b_1 gives us $\lambda_1 = E(\lambda_2)$ and in case d) $\lambda_1 = E(\lambda_2) + \frac{(1-\psi)}{\psi}\frac{\partial P(\Delta)}{\partial \Delta}$. It follows immediately that if $E(\lambda_2) < \lambda_1 < E(\lambda_2) + \frac{(1-\psi)}{\psi}\left.\frac{\partial P(\Delta)}{\partial \Delta}\right|_{b=\bar{b}}$, we are in case c), if λ_1 exceeds $E(\lambda_2) + \frac{(1-\psi)}{\psi}\left.\frac{\partial P(\Delta)}{\partial \Delta}\right|_{b=\bar{\bar{b}}}$, we are in case e) and if λ_1 is smaller than $E(\lambda_2)$, we are in case a). Since the function $R(b_1)$ depends on the case and includes τ_2 and π_2, also the first order conditions that determine τ_2 and π_2 vary over the cases. Tables 2.1-2.3 summarize the respective expressions.[20]

In the following analysis, we consider an economy that has a low value of public good spending in the first period, $\alpha_1 = \alpha_L$. In this environment, a social planner will not want to raise debt. In particular, the social planner's solution is clearly case a), since the social planner has $\lambda_1 = \alpha_1 < (1-\phi)\alpha_L + \phi\alpha_H = E(\lambda_2)$.[21]

[19] This is because we assume $b_0 = 0$ and that governments cannot accumulate assets. If we allowed for assets, governments would use their revenue to buy bonds in this case. If we additionally allowed $b_0 > 0$, revenues would be used to reduce debt (and possibly to buy bonds).

[20] The FOCs for τ_2 and π_2 in case d) have been rearranged by using the FOC for b_1. The $\leq$ in the FOC for τ_2 in case c), d) and e) are due to the constraint $\tau_2 \geq \tau_1$ which might bind in these cases (Note that $\pi_2 \geq \pi_1$ does never bind).

[21] If we had $\alpha_1 = \alpha_H$, we would have $\lambda_1 > E(\lambda_2)$ for both the social planner and for a government

Table 2.1: Conditions for the cases a)-e)

Case	Condition
a)	$\lambda_1 < E(\lambda_2)$
b)	$\lambda_1 = E(\lambda_2)$
c)	$E(\lambda_2) < \lambda_1 < E(\lambda_2) + \frac{(1-\psi)}{\psi} \left.\frac{\partial P(\Delta)}{\partial \Delta}\right\|_{b=\bar{b}}$
d)	$\lambda_1 = E(\lambda_2) + \frac{(1-\psi)}{\psi}\frac{\partial P(\Delta)}{\partial \Delta}$
e)	$\lambda_1 > E(\lambda_2) + \frac{(1-\psi)}{\psi} \left.\frac{\partial P(\Delta)}{\partial \Delta}\right\|_{b=\bar{\bar{b}}}$

Table 2.2: First order conditions for fiscal capacity

Case	FOC for τ_2
a)	$\delta \left\{\psi\bar{\omega}(\pi_2) + (1-\psi)\underline{\omega}(\pi_2)\right\}(E(\lambda_2)-1) = \lambda_1 \frac{\partial F(\tau_2-\tau_1)}{\partial \tau_2}$
b)	$\delta \left\{\psi\bar{\omega}(\pi_2) + (1-\psi)\underline{\omega}(\pi_2))\right\}(E(\lambda_2)-1) = \lambda_1 \frac{\partial F(\tau_2-\tau_1)}{\partial \tau_2}$
c)	$\delta \left\{\psi[\bar{\omega}(\pi_2) - \underline{\omega}(\pi_2)](E(\lambda_2)-1) + \underline{\omega}(\pi_2)(\lambda_1-1)\right\} \leq \lambda_1 \frac{\partial F(\tau_2-\tau_1)}{\partial \tau_2}$
d)	$\delta \left\{\psi[\bar{\omega}(\pi_2) - \underline{\omega}(\pi_2)](E(\lambda_2)-1) + \underline{\omega}(\pi_2)(\lambda_1-1)\right\} \leq \lambda_1 \frac{\partial F(\tau_2-\tau_1)}{\partial \tau_2}$
e)	$\delta\{(\psi\bar{\omega}(\pi_2) + (1-\psi)\underline{\omega}(\pi_2))(\lambda_1-1) - (1-\psi) \left.\frac{\partial P(\Delta)}{\partial \Delta}\right\|_{b=\bar{\bar{b}}} (\bar{\omega}(\pi_2) - \underline{\omega}(\pi_2))\} \leq \lambda_1 \frac{\partial F(\tau_2-\tau_1)}{\partial \tau_2}$

Table 2.3: First order conditions for legal capacity

Case	FOC for π_2
a)	$\delta\omega'(\pi_2)[1+\tau_2(E(\lambda_2)-1)] = \lambda_1 \frac{\partial L(\pi_2-\pi_1)}{\partial \pi_2}$
b)	$\delta\omega'(\pi_2)[1+\tau_2(E(\lambda_2)-1)] = \lambda_1 \frac{\partial L(\pi_2-\pi_1)}{\partial \pi_2}$
c)	$\delta\omega'(\pi_2)[1+\tau_2(\lambda_1-1)] = \lambda_1 \frac{\partial L(\pi_2-\pi_1)}{\partial \pi_2}$
d)	$\delta\omega'(\pi_2)[1+\tau_2(\lambda_1-1)] = \lambda_1 \frac{\partial L(\pi_2-\pi_1)}{\partial \pi_2}$
e)	$\delta\omega'(\pi_2)[1+\tau_2(\lambda_1-1)] = \lambda_1 \frac{\partial L(\pi_2-\pi_1)}{\partial \pi_2}$

We want to see whether for such an environment, governments with a preference for the own group could exhibit a bias towards the present and hence towards excessive debt. Such a bias would make the political equilibrium differ from the social planner's solution in a significant way.

Furthermore, for the following analysis, we define 'free future revenues' as the discounted expected future tax revenues minus debt, $\delta E(\tau_2\omega_2(\pi_2)) - b_1$. Free future revenues refer to the expected future tax revenues that are not bound by debt and therefore measure the 'free' resources of the future government. We define this measure in order to measure debt in relation to a state's fiscal power, which is more informative than the absolute debt level itself.

So, what is the political equilibrium? Let's distinguish between countries with high and low cohesiveness θ. Assume first that cohesiveness is sufficiently high, in the sense that the cohesiveness condition of Section 2.3 holds: $\alpha_L > 2(1-\theta)$. Then the political equilibrium is case a), since we have $\lambda_1 = \alpha_1$ and $E(\lambda_2) = (1-\phi)\alpha_L + \phi\alpha_H$, as it was the case for the social planner. That is, high enough cohesiveness will make the political equilibrium coincide with the social planner outcome. The respective comparative statics are summarized in Part 1 of the following proposition.

Now, consider countries with low cohesiveness, in the sense that θ is sufficiently below 1/2. These countries can end up in each of the cases a)-e), depending on the parameters γ, ϕ and α_H summarized in $E(\lambda_2)$.[22] Part 2 of the following proposition summarizes the corresponding results:

with own group bias. Both would have a preference for the present and an incentive to raise debt, and we would end up in one of the cases c), d) or e).

[22]For the sake of completeness, further channels of influence are ψ, $\bar{\omega}(\cdot) - \underline{\omega}(\cdot)$ and $P(\cdot)$, which also enter the conditions of Table 2.1.

Proposition 2.4.1. *Suppose an economy in the model with sovereign default starts in the first period with $\alpha_1 = \alpha_L$. Moreover, suppose that the constraint $\tau_2 \geq \tau_1$ does not bind.*[23] *Then:*

1. *In the social planner's solution as well as in the political equilibrium, if $\alpha_L \geq 2(1-\theta)$*
   (a) *No debt is raised (case a) holds).*
   (b) *No transfers are paid.*
   (c) *There are positive investments in fiscal and legal capacity.*
   (d) *Higher ϕ increases investment in fiscal and legal capacity.*
   (e) *Higher ψ increases investment in fiscal and legal capacity.*
   (f) *Neither γ nor θ have an influence on the investment decisions.*
   (g) *Free future revenues are increasing in ϕ and ψ.*

2. *In the following, consider the political equilibrium for $\alpha_L < 2(1-\theta)$. That is, we have $\lambda_1 = 2(1-\theta)$ and $E(\lambda_2) = \phi\alpha_H + (1-\phi)[(1-\gamma)2(1-\theta) + \gamma 2\theta]$.*
   I. *If $\lambda_1 < E(\lambda_2)$*
      (a) *No debt is raised (case a) holds).*
      (b) *There are positive investments in fiscal and legal capacity.*
      (c) *Higher ϕ increases investment in fiscal and legal capacity.*
      (d) *Higher ψ increases investment in fiscal and legal capacity.*
      (e) *A lower value of γ unambiguously raises investments, whereas an increase in θ raises investments if γ is above 1/2.*
      (f) *Free future revenues are increasing in θ if $\gamma > 1/2$, and are increasing in ϕ, ψ and γ.*

   II. *If $E(\lambda_2) < \lambda_1 < E(\lambda_2) + \frac{(1-\psi)}{\psi} \frac{\partial P(\Delta)}{\partial \Delta}\Big|_{b=\bar{\bar{b}}}$*
      (a) *If $E(\lambda_2) < \lambda_1 < E(\lambda_2) + \frac{(1-\psi)}{\psi} \frac{\partial P(\Delta)}{\partial \Delta}\Big|_{b=\bar{b}}$, then $b_1 = \bar{b}$ is the optimal debt level. That is case c) holds.*
         i. *Higher ϕ as well as lower γ lead to an increase of both b_1 and free future revenues.*
         ii. *Higher ψ leads to an increase of both b_1 and free future revenues if $E(\lambda_2) > 1$.*

[23] It turns out that this is not a very restrictive assumption. It would only be violated if the high income realization $\overline{\omega}(\cdot)$ lied unrealistically high above the low income realization $\underline{\omega}(\cdot)$. A sufficient condition for this assumption is that $\overline{\omega}(\cdot) \leq 2\underline{\omega}(\cdot)$.

(b) *If* $\lambda_1 = E(\lambda_2) + \frac{(1-\psi)}{\psi}\frac{\partial P(\Delta)}{\partial \Delta}\Big|_{b=\tilde{b}}$, *with* $\bar{b} < \tilde{b} < \bar{\bar{b}}$, *then* $b_1 = \tilde{b}$ *is the optimal debt level (i.e. case d) holds), so there is sovereign default in the second period with probability* $1-\psi$.

i. *Higher* ψ *leads to an increase of* b_1 *if* $E(\lambda_2) > 1$.

ii. *Higher* ϕ *as well as lower* γ *lead to an increase of free future revenues.*

(c) *Residual revenues are used to finance transfers.*

(d) *There are positive investments in fiscal and legal capacity.*

(e) *Higher* ϕ *as well as lower* γ *increase investments in fiscal and legal capacity.*

(f) *Higher* ψ *increases investment in fiscal and legal capacity if* $E(\lambda_2) > 1$.

III. *If* $\lambda_1 > E(\lambda_2) + \frac{(1-\psi)}{\psi}\frac{\partial P(\Delta)}{\partial \Delta}\Big|_{b=\bar{\bar{b}}}$

(a) *Debt is raised maximally,* $b_1 = \bar{\bar{b}}$ *(case e) holds).*

(b) *Neither* ϕ *nor* γ *have an influence on the debt level, but it is increasing in* ψ.

(c) *Free future revenues are 0 and therefore they are constant with respect to* ϕ, γ, ψ *and* θ.

(d) *Residual revenues are used to finance transfers.*

(e) *There are positive investments in fiscal and legal capacity.*

(f) *Neither* ϕ *nor* γ *have an influence on the investment decision.*

(g) *Higher* ψ *increases investment in fiscal and legal capacity.*

As already mentioned, Part 1 of the proposition establishes the social planner solution, which coincides with the political equilibrium under the cohesiveness condition, $\alpha_L \geq 2(1-\theta)$. To understand the comparative static results, we can look at the respective first order conditions for fiscal and legal capacity in case a). Recall that the left-hand side of these conditions gives the marginal benefit of higher investments. Since no debt is raised and future tax resources are left in the future, investment incentives are driven by the expected value of future public funds, $E(\lambda_2) = \phi\alpha_H + (1-\phi)\alpha_L$. This explains the comparative static results (d). Furthermore, the benefit of future fiscal capacity depends on the expected income base to which it can be applied, $\{\psi\bar{\omega}(\pi_2) + (1-\psi)\underline{\omega}(\pi_2)\}$. Since this is increasing in ψ, the probability of a high income realization, investment incentives increase in ψ.

Part 2 of Proposition 2.4.1 illustrates the outcome of the political equilibrium when the cohesiveness condition fails. That is, cohesiveness θ is low enough such

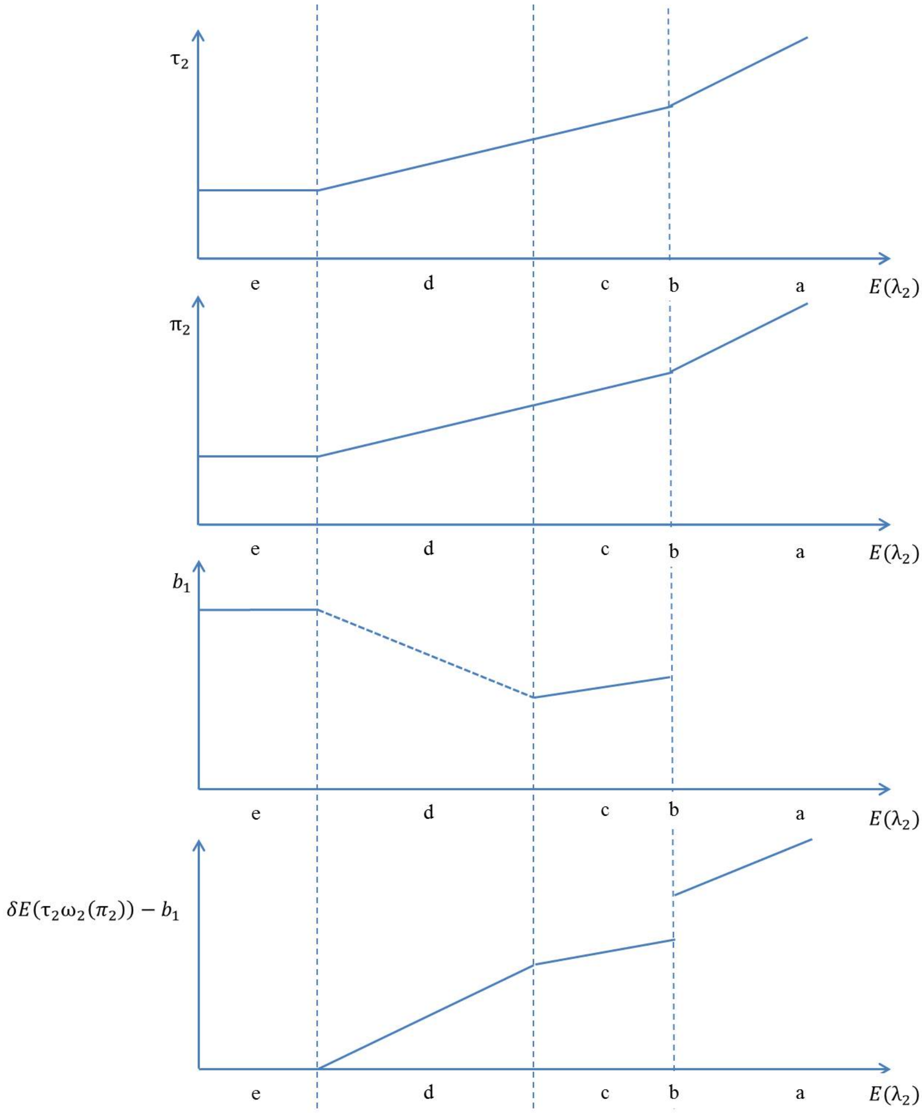


Figure 2.1: Equilibrium outcomes conditional on $E(\lambda_2)$ (holding cohesiveness θ fixed at a sufficiently low level)

that $\alpha_L < 2(1-\theta)$. The proposition contains the comparative static results that can be shown using the techniques of monotone comparative statics. It turns out that it is hard to get unambiguous comparative static results with respect to cohesiveness θ, as soon as debt is used. Therefore, we concentrate, for the following illustration, on parameter changes which do not alter cohesiveness θ. This implies that we keep the value of present public funds $\lambda_1 = 2(1-\theta)$ constant. Most of the remaining parameters enter $E(\lambda_2)$, the expected value of future public funds. Therefore, we can illustrate most comparative static results by considering the reactions to a change in $E(\lambda_2)$, keeping λ_1 constant.

For a fixed and sufficiently low value of cohesiveness (and $\alpha_1 = \alpha_L$ as before), Figure 2.1 illustrates the relation between $E(\lambda_2)$, future fiscal capacity τ_2, future legal capacity π_2, debt b_1 and free future revenues.[24,25]

The letters below the graphs refer to the different cases we identified above. Given an expected value of future public funds, $E(\lambda_2)$, higher than the present value λ_1, we start on the right of the figure in case a). The corresponding results are summarized in Part 2.I of Proposition 2.4.1. No debt is raised and the comparative static results correspond to a model without debt. In particular, all parameter changes that decrease $E(\lambda_2)$ will decrease investments in fiscal and legal capacity. One important possibility to lower $E(\lambda_2)$ is an increase in political instability.

Continuing to decrease $E(\lambda_2)$, at some point, we reach the knife-edge case b) with $E(\lambda_2) = \lambda_1$.[26] The debt level in this case is indeterminate in the range $[0, \bar{b}]$.

By lowering $E(\lambda_2)$ further, we move to case c). To understand the comparative static results for case c), it is helpful to consider the respective first order condition for fiscal capacity τ_2. Note that $\underline{\omega}(\pi_2)$ is the 'low income part' of the expected future tax base. This part will be available for sure in the future. In contrast, $\psi[\bar{\omega}(\pi_2) - \underline{\omega}(\pi_2)]$ describes the additional expected value of the (income) tax base since $\bar{\omega}(\pi_2) - \underline{\omega}(\pi_2)$ will be additionally available if the high income realizes. We call $\psi[\bar{\omega}(\pi_2) - \underline{\omega}(\pi_2)]$ the 'high income part'.

In case c), it is optimal to exactly raise a debt level of $\bar{b}(\tau_2, \pi_2) = \frac{\tau_2 \underline{\omega}(\pi_2)}{1+\rho}$. Because of the ensuing penalty, it would be too expensive to raise more debt. This means that the low income part of the future tax base is fully drawn to the present. For this part, the marginal benefit of making more of it available to the state through fiscal

[24] The underlying comparative statics within the different cases are established in proposition 2.4.1. So, we assume that $\tau_2 \geq \tau_1$ does not bind. However, letting it bind up to some $E(\lambda_2)$ would not change much. For the relevant values of $E(\lambda_2)$, τ_2 and π_2 then would be horizontal lines from the left, the dashed line for b_1 in case d) would be solid and both b_1 and free future revenues would be constant in case c) (as long as $\tau_2 \geq \tau_1$ binds).

The continuity at the border between two cases can be seen from the first order conditions. Free future revenues jump in case b) since debt jumps from $\bar{b}$ to 0. Depending on the functional forms of $F(\cdot)$, $L(\cdot)$ and $\omega(\cdot)$, the upward/downward sloping lines of the diagram are not necessarily linear.

[25] The corresponding figure derived from the model of Besley and Persson (2011) without debt is provided in Appendix A.2 (Figure A.8). They main difference is that there is a cutoff at $E(\lambda_2) = 1$ below which there is no investment in fiscal capacity and therefore τ_2 is constant at the level τ_1. In Figure 2.1, $E(\lambda_2) = 1$ is somewhere to the left of case b (for small ψ or a steep function $P(\cdot)$, $E(\lambda_2) = 1$ is close to b).

[26] This case is not included in the proposition because there are no comparative static results to derive.

capacity investments is thus proportional to $(\lambda_1 - 1)$. For case c), $E(\lambda_2) < \lambda_1$, so future public funds are more valuable when they can be used in the present through debt. Therefore, investment incentives are higher than in a world without debt through the influence of the low income part.[27]

In contrast, the high income part of expected future tax resources is not drawn to the present. For this part of the future tax base, the marginal benefit of making more of it available through fiscal capacity investments is thus proportional to $(E(\lambda_2) - 1)$. As far as this part is concerned, we therefore have the same effects as in a model without debt. For instance, given low cohesiveness, increasing political instability makes it more likely that the current government's group gets screwed over in the future by a rival government. This decreases $E(\lambda_2)$ and, through the influence of the high income part, decreases incentives to invest in fiscal capacity. By complementarity between the two forms of state capacity investment, we also get less investments in legal capacity π_2.[28] Lower levels of fiscal and legal capacity decrease $\bar{b}(\tau_2, \pi_2) = \frac{\tau_2 \underline{\omega}(\pi_2)}{1+\rho}$. The latter is just the present value of the low income part of future public funds. Since exactly this part is drawn to the present in case c), the debt level decreases when investments in state capacity decrease.[29] This is illustrated in the third panel of Figure 2.1. For case c), we thus have debt and state capacity moving in the same direction in response to exogenous parameter changes.

Continuing to decrease the value of future public funds, $E(\lambda_2)$, we enter case d). In this case, it is optimal to incur some penalty. The optimality condition for debt implies that the optimal debt level lies a certain amount db above $\bar{b}$. Since optimal debt b_1 is still lower than the maximal debt level $\bar{\bar{b}}$, there is still some proportion of expected future tax resources which is left in the future. In particular, for the *marginal* investment in fiscal capacity, the high income part of future tax resources is not drawn to the present. Therefore, as in case c), the marginal benefit of additional fiscal capacity contains a term proportional to $(E(\lambda_2)-1)$. Lowering $E(\lambda_2)$ will thus again decrease incentives to invest in fiscal and legal capacity. Since this decreases

[27] Note that the proposition does not contain results about this *level* comparison to a world without debt.

[28] These comparative static results are captured in Part 2.II (e) of Proposition 2.4.1. Note that $E(\lambda_2)$ does not enter the first order condition for legal capacity due to our assumption $\overline{\omega}'(\pi_2) = \underline{\omega}'(\pi_2)$. This implies that the high income part is not altered by investments in legal capacity.

[29] Part 2.II (a) i. of the proposition.

$\bar{b}(\tau_2, \pi_2) = \frac{\tau_2 \omega(\pi_2)}{1+\rho}$, we have one force that pulls debt down. Specifically, for a fixed level db of debt which is raised *above* $\bar{b}$, the total amount of debt, $\bar{b} + db$, will go down. The low income part of future public funds decreases and less debt is needed to draw it to the present. This effect was the only effect at work in case c) and it was responsible for debt and state capacity moving in the same direction. We call this effect the low income effect.

In case d), we get a second effect. Specifically, from the first order condition for debt in case d) we can see the following. If $E(\lambda_2)$ decreases, Δ will adjust upwards such that the first order condition holds again with equality. That is, the amount db of debt which is raised *above* $\bar{b}$ will increase and trigger a higher penalty. Given, for instance, an increasing level of political instability, the danger of getting screwed over by a rival government in the future gets bigger. Therefore, it becomes optimal to raise more debt and avoid the rival redistribution for a higher proportion of expected future tax resources. In particular, for a higher proportion of fiscal capacity, the high income part is now also drawn to the present.[30] The higher penalty implied by this is justified because the alternative of leaving money to the future also gets more expensive. We call this the high income effect.

The overall effect on the level of debt is therefore ambiguous. However, if the high income effect dominates the low income effect, we get an increase in debt if $E(\lambda_2)$ decreases, as indicated by the dashed line in the third panel of Figure 2.1. In region d), debt and state capacities can therefore start to move in opposite directions in response to exogenous parameter changes.[31]

Decreasing the value of future public funds, $E(\lambda_2)$, further, we finally enter case e). In this case, debt is raised maximally, so all future public funds are drawn to the present. However, this comes at the price of a high penalty. Despite the high penalty, these funds are drawn to the present due to the very low value of future public funds, since $E(\lambda_2) = \lambda_1 - \frac{(1-\psi)}{\psi} \left.\frac{\partial P(\Delta)}{\partial \Delta}\right|_{b=\bar{\bar{b}}}$ when we enter case e). If $E(\lambda_2)$ drops further,

[30]Note, however, that as long as we are in case d), the high income part is not drawn to the present for the *marginal* investment unit of fiscal capacity. That is why investment incentives are still driven partly by $E(\lambda_2)$.

[31]Note that in case d), the absolute level of debt could also decrease if $E(\lambda_2)$ decreases. However, this is rather an extreme scenario since this implies that $\bar{\bar{b}}$ in case e) would be lower than $\bar{b}$ at the border between case c) and d), which requires a very steep decrease of state capacities within case d). In any case, decreasing $E(\lambda_2)$ in case d) will always lead to a decrease in the level of free future revenues, that is of expected future public funds minus debt.

investment incentives stay constant at the level implied by $\lambda_1 - \frac{(1-\psi)}{\psi}\frac{\partial P(\Delta)}{\partial \Delta}\Big|_{b=\bar{\bar{b}}}$.

Even in case e), through the influence of the low income part, we still get higher investment incentives than in a world without debt under realistic restrictions on the income levels. Nevertheless, especially case d) and e) can reestablish a weak state situation similar to Besley and Persson (2011), where we get very low investments in fiscal and legal capacity.[32] These low investments arise from a low value of future public funds, $E(\lambda_2)$. Given the possibility to raise debt and letting $E(\lambda_2)$ be low enough that debt is chosen, $E(\lambda_2)$ influences investment incentives only through the high income part. Therefore, state capacity investments will be the lower, the higher the influence of the high income part, in the sense that the difference between the income levels, $\overline{\omega}(\cdot) - \underline{\omega}(\cdot)$, is bigger while holding the expected income, $\psi\bar{\omega}(\cdot) + (1 - \psi)\underline{\omega}(\cdot)$, constant.[33]

Furthermore, the situation of low investments in state capacity is now worsened by a high debt level. Debt is bad here because in the political equilibrium, $\lambda_1 = 2(1-\theta) > \alpha_L$ holds. Therefore, in case e), debt is used to fully tie down future public funds for clientele politics today. A social planner, on the other hand, would not draw future public funds to the present but would use them instead for public good expenditures in the future.

Note that the weak state situation in the preceding analysis arises for similar parameter values as in a model without debt. In particular, recall that the above analysis was done for countries with low enough cohesiveness. Furthermore, a low value of $E(\lambda_2)$ leading to case e) can be driven by high political instability γ. Low cohesiveness and high political instability constitute the parameter constellation that defines a weak state in the basic model without debt (Besley and Persson, 2011).[34] The mechanism at work has now already been highlighted several times: When the incumbent government is afraid that future public funds will be used against its interest, it will not invest in the additional creation of these public funds. We call

[32] Note that in Besley and Persson (2011), a weak state did not invest *at all* in fiscal capacity.

[33] The easiest way to see this is to look at the FOC for fiscal capacity in case e) (which equals the FOC of case d) for $E(\lambda_2) = \lambda_1 - \frac{(1-\psi)}{\psi}\frac{\partial P(\Delta)}{\partial \Delta}\Big|_{b=\bar{\bar{b}}}$). If $\overline{\omega}(\cdot) - \underline{\omega}(\cdot)$ increases while $\psi\bar{\omega}(\cdot) + (1-\psi)\underline{\omega}(\cdot)$ remains constant, the left-hand side clearly decreases (note that Δ increases). So, τ_2 decreases. For very high $\overline{\omega}(\cdot) - \underline{\omega}(\cdot)$, τ_2 decreases until $\tau_2 = \tau_1$ is reached, which corresponds to a state which does not invest at all in fiscal capacity like a weak state in Besley and Persson (2011).

[34] To be more precise, recall from the discussion of the stability condition in Section 2.3.3 that the probability ϕ for a high value of public good spending also has to be low enough.

this the low-investment-mechanism.

However, the preceding analysis also cautions that the low-investment-mechanism is only partly at work in the default setup. Specifically, we have just argued that the size of the difference between low and high income realizations plays a crucial role. Note in particular that, as this difference goes to zero, we move back to the debt model without default from Section 2.3. For this model, investment incentives were driven by the present value of public funds as soon as the future value dropped low enough. Therefore, the low-investment-mechanism was completely broken by the mechanism of using debt to bring future public funds at the disposal of the present. We call the latter the debt-mechanism.

The above analysis presents a first step in analyzing the relative strength of these two mechanisms. Specifically, we have highlighted how the two effects interact in a specific framework. The following conclusions and implications drawn from the above analysis depend on this framework. Therefore, we do not want to stretch them too far.

As can be seen in Figure 2.1, for countries with low cohesiveness, our model setup leads to a positive correlation between measures of state capacity and $E(\lambda_2)$, a negative correlation between debt and $E(\lambda_2)$ and therefore to a negative correlation of debt and state capacity. Moreover, 'crisis countries' with very high public debt and low fiscal and legal capacity can arise. Greece could be an example of such a country. In our model, these are countries with low cohesiveness θ and a low value of future public funds, $E(\lambda_2)$. The latter could be due, for instance, to high political instability γ.

Since $E(\lambda_2) < \lambda_1$ defines cases c)-e), only for sufficiently low cohesiveness we can ever end up in the high debt - low state capacity situation of case e). Therefore, the lower is cohesiveness, the more likely (i.e. for a larger range of parameter values) a country will end up in such a situation.

From this analysis, we can already draw some policy implications. A crucial factor that keeps a country from running into a debt trap, that is a situation with very high debt and low state capacity, seems to be a sufficient level of cohesiveness. High cohesiveness entails provisions in a country's constitution and other institutional features which prohibit clientele politics by the political group in power. In a politically unstable political environment, non-cohesive countries, in which it is easy to benefit your preferred clientele, will end up in the problematic situation of a debt trap. As the following quotation from Lyrintzis (2011) shows, Greece seems to have suffered from exactly such a lack of cohesiveness:

"Patronage and clientele networks have marked Greek politics since the creation of the modern Greek state [...] The alternation of the two major parties in power led to political polarization and after each governmental change to massive allocation of favours to the party's clientele." (p. 3 et seqq.)

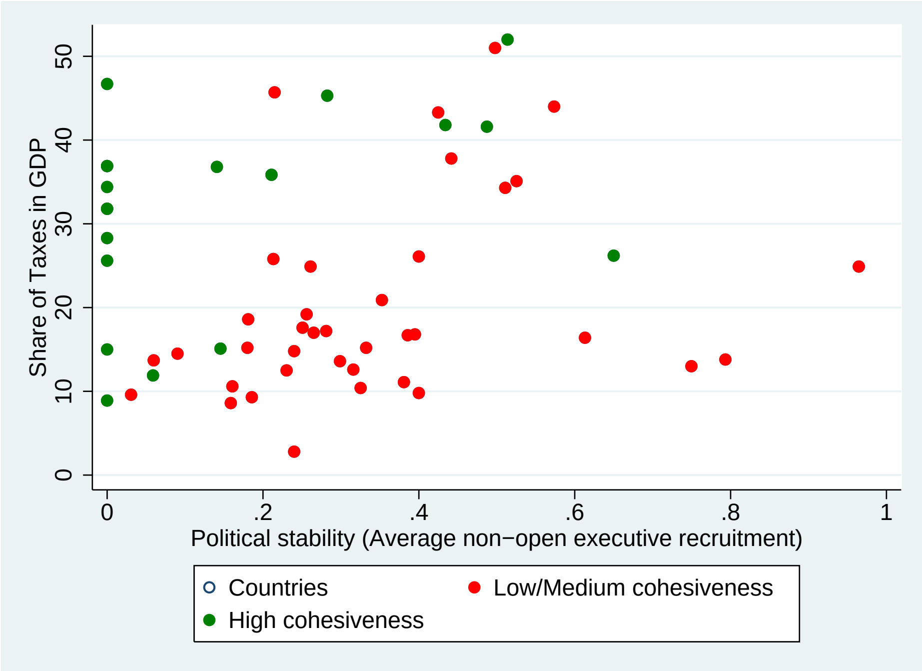
To avoid to get back in such a situation, a reform of cohesiveness seems to be beneficial. This necessitates deep reforms that go at the core of the functioning of the state. Examples of such reforms include implementing a functioning system of checks and balances, establishing an independent press that names and shames clientele politics, establishing provisions in the constitution that prevent clientele politics, or strengthening the constitutional court in its power to enforce such provisions.

2.4.2 Cross-country Correlations

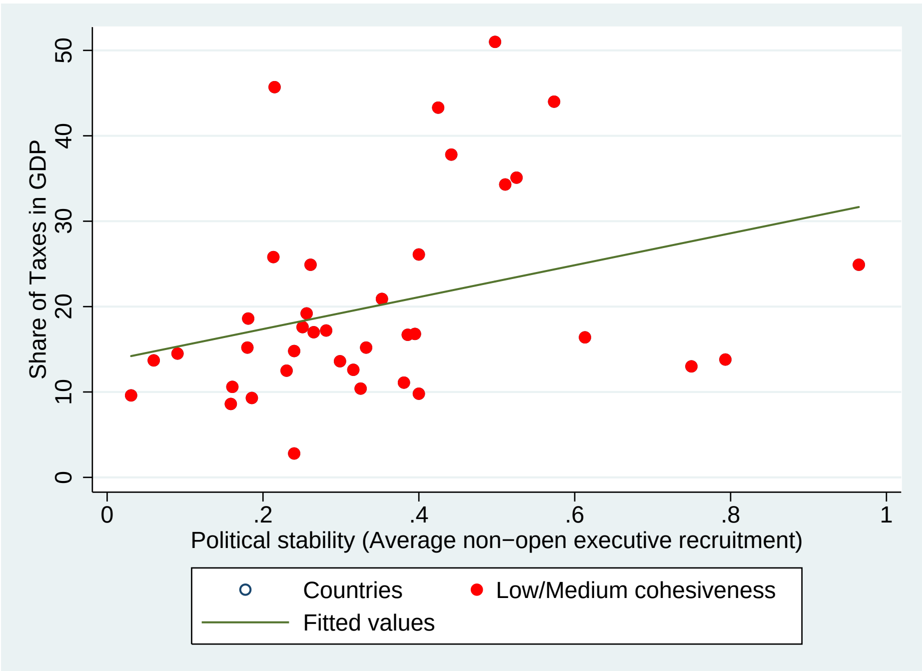
In the following, we take a short look at cross-country correlations. Thus, this subsection is not intended as a convincing test of the model's predictions. The aim is just to illustrate the theory and to see whether the presented cross-country correlations are somehow in line with the results from the model. In more detail, we like to mimic Figure 2.1 with real world data. Data for state capacities and estimates for model parameters are taken from Besley and Persson (2011) and debt data is taken from Reinhart and Rogoff (2009). Joining the two datasets results in a sample of 57 countries. In Figure 2.2 we plot fiscal capacity, measured as the share of taxes in GDP in 1999 against political stability, which is an index used by Besley and Persson (2011).[35,36] The color of the dots depends on the country's cohesiveness. High cohesive countries (green dots) are countries with a cohesiveness above the

[35] Detailed variable descriptions are provided in Appendix A.2.

[36] Even though Figure 2.2-2.4 use only data of Besley and Persson (2011), these figures are interesting since Besley and Persson (2011) do not plot the data in this dimension, i.e. state capacities conditional on political stability. Due to the theoretical results from our model with debt as summarized by Figure 2.1, these plots seem desirable.

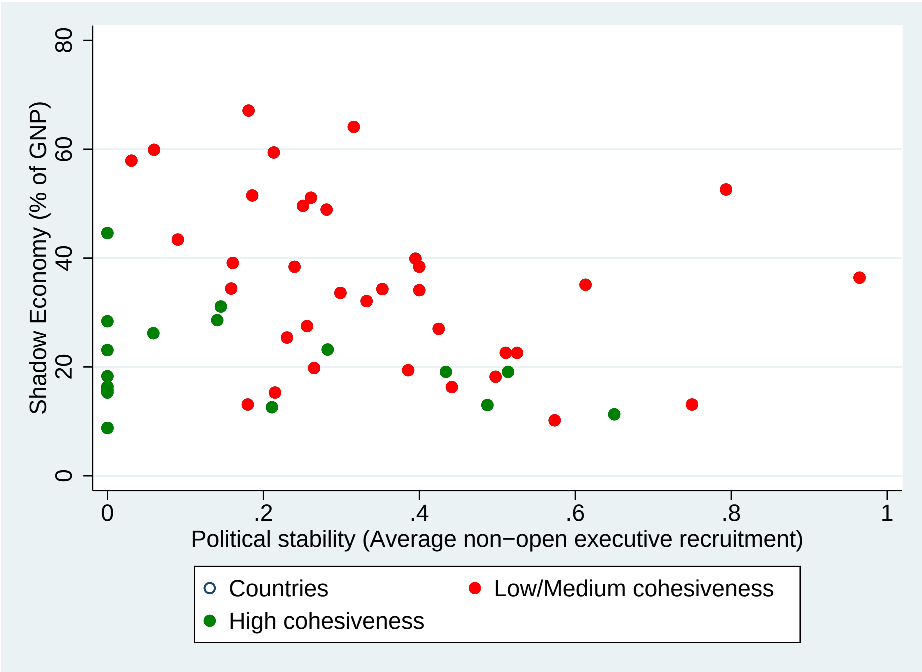


(a)

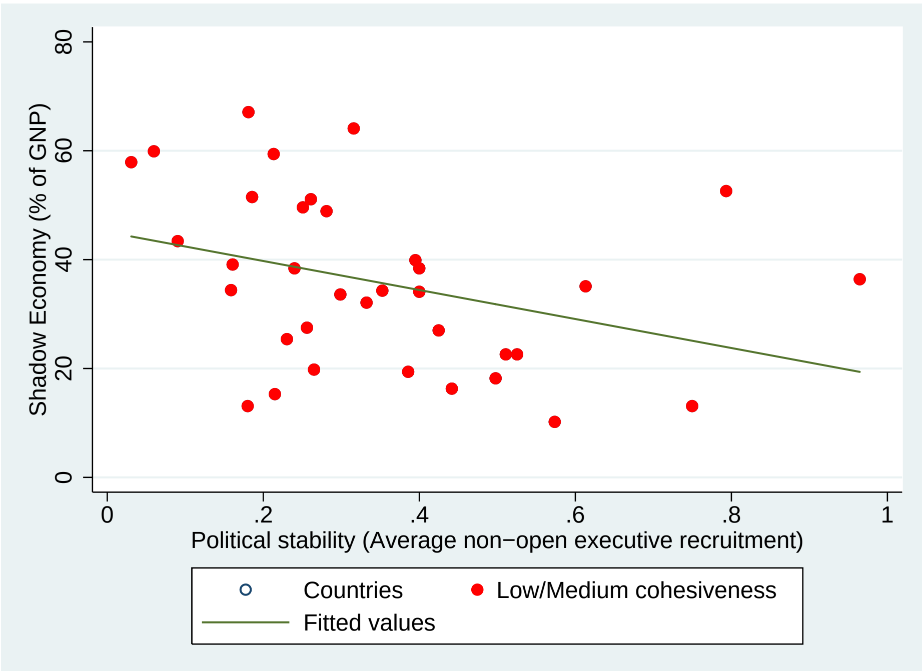


(b)

Figure 2.2: Cross-country correlations between fiscal capacity and political stability

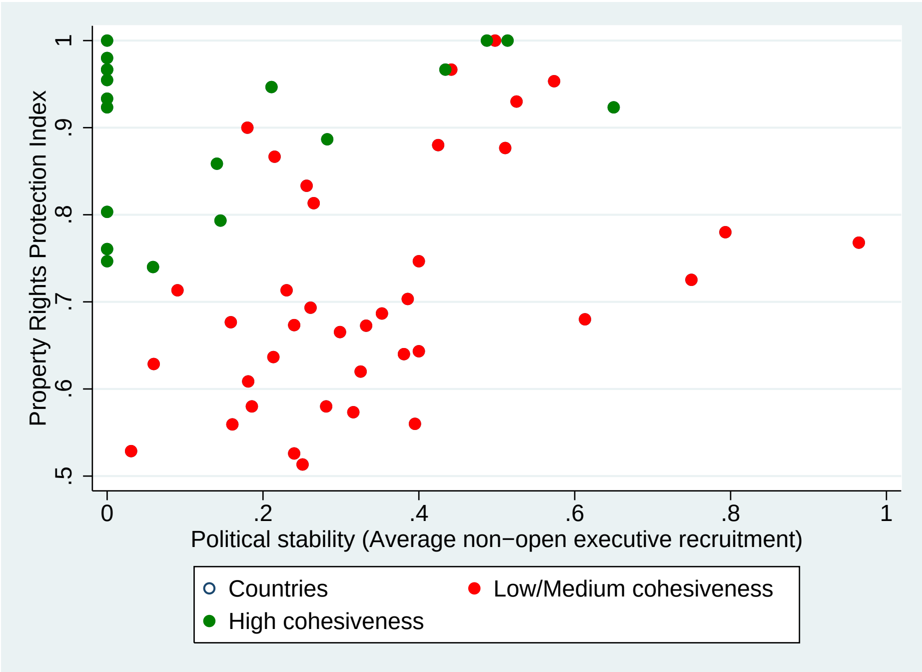


(a)

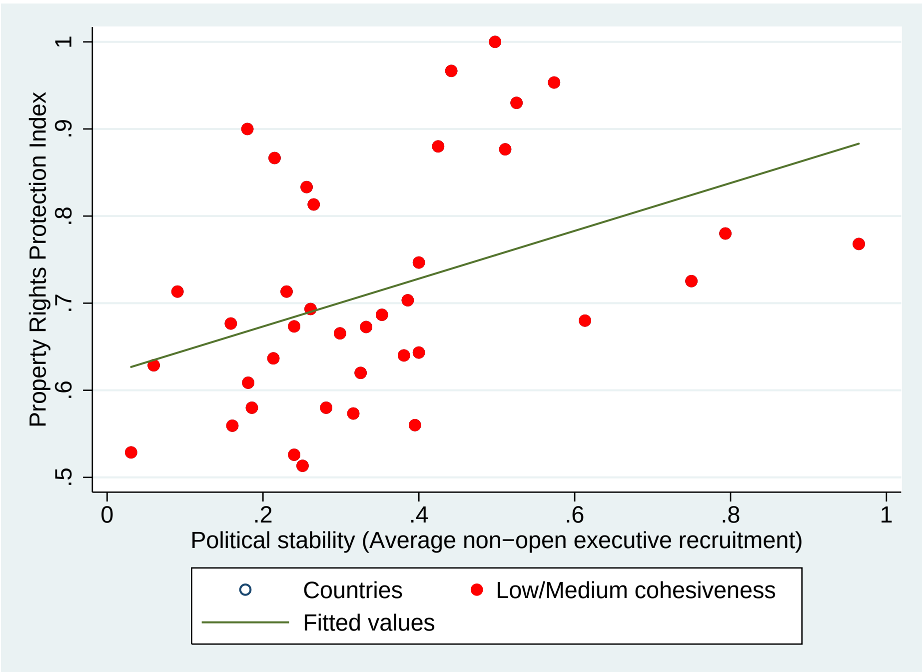


(b)

Figure 2.3: Cross-country correlations between fiscal capacity and political stability

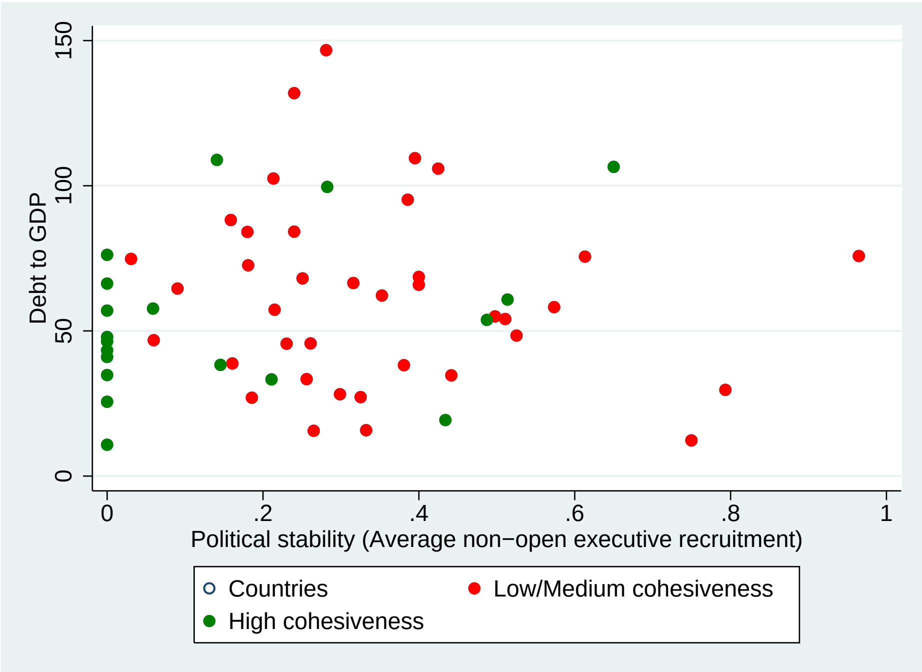


(a)

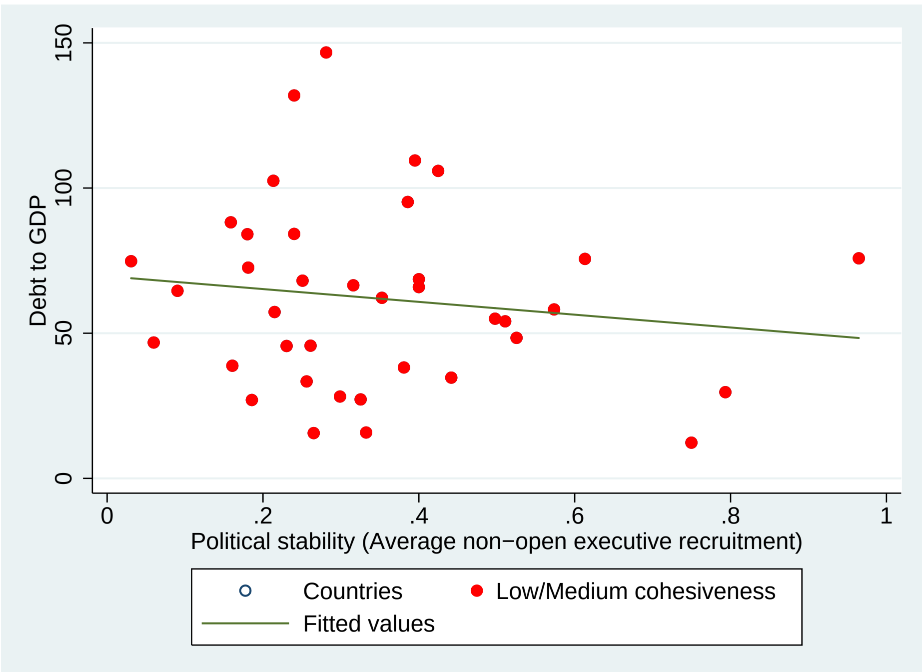


(b)

Figure 2.4: Cross-country correlations between legal capacity and political stability



(a)



(b)

Figure 2.5: Cross-country correlations between public debt and political stability

66th percentile. Cohesiveness is measured as the average executive constraints from 1800 to 2000. The theory predicts that fiscal capacity should increase with $E(\lambda_2)$ (cf. Figure 2.1). Since for non-cohesive countries, $E(\lambda_2)$ is increasing in political stability, the model predicts to observe a positive correlation between political stability and fiscal capacity for non-cohesive countries. Excluding highly cohesive countries, we find a positive correlation (+0.3200) as shown in Figure 2.2 b) which is statistically significant (p-value 0.0502).[37] Another measure for fiscal capacity suggested by Besley and Persson (2011) is the share of the non-shadow economy. Therefore, the theory predicts to observe a negative correlation between political stability and the share of the shadow economy for non-cohesive countries. Figure 2.3 provides cross-country evidence. The correlation shown in Figure 2.3 b) is -0.3488 and statistically significant (p-value 0.0400).

Turning to legal capacity and following the same reasoning as above, the model predicts to observe a positive correlation between political stability and legal capacity for non-cohesive countries. Figure 2.4 provides cross-country evidence, where we use the property rights protection index from Besley and Persson (2011) as a measure for legal capacity. Excluding highly cohesive countries, we find a positive correlation (+0.4115) which is statistically significant (p-value 0.0103).

Finally, the part of Figure 2.1 regarding debt suggests an overall negative correlation between stability and debt for non-cohesive countries. Figure 2.5 shows the corresponding cross-country data. For medium and low cohesive countries we observe a slight negative correlation (-0.1405), however, not statistically significant (p-value 0.4003). On the one hand, this might be due to the different effects working in opposite directions as explained above (cf. the explanations of case c) and d)). On the other hand, there are many further determinants of public debt for which we do not control and the high variation around the regression line strengthens the point that further variables are necessary to explain public debt more properly.

We also compute correlations between debt and state capacities. The correlations between debt and the property rights protection index as well as the correlation between debt and the share of the shadow economy point in the right direction,

[37] Plots which indicate the country names for this and the following graphs are provided in Appendix A.2.

however, they lack statistical significance.[38] However, regarding the relationship between debt and shadow economy there is an empirical study by Elgin and Uras (2013), who find a positive relation between these variables as well as positive relation between default risk and shadow economy, which is both in line with the results of our model.

The cross-country correlations presented here are just a first step of an empirical analysis and we do not claim to show causal patterns in the data. Nevertheless, at least these correlations indicate that the determinants of the model seem to be relevant for explaining some cross-country patterns of state capacities and debt. A comprehensive empirical analysis to test the theory convincingly and to establish causality, which would be an own project itself, remains a promising area of future research.

2.5 Quasi-linear Model

The extension to include *ability-to-pay* default added an important feature to the analysis. For a rising debt level, the risk of default makes it more and more expensive to use debt for drawing future public funds to the present. This can partly break the incentivizing effect which the possibility to raise debt can have on state capacity investments. Nevertheless, even with this extension, the linear modeling remains rather extreme in some of its predictions. For instance, it does not seem realistic that public good spending would go down to zero in some future instances. To see if the predictions from the linear model carry over to a more realistic preference specification, we modify the model from the last section to allow for quasi-linear preferences.

Specifically, utility of an individual of group J in period s changes from (2.2) to:

$$u_s^J = \alpha_s V(g_s) + (1 - t_s)\omega_s(p_s^J) + r_s^J \tag{2.33}$$

$V(\cdot)$ is increasing and concave and is assumed to fulfill the Inada conditions. The latter will make sure that there is preference for some positive public good spending

[38] Moreover, the correlation between debt and the share of taxes in GDP is insignificant and close to zero.
The corresponding figures and correlations are provided in Appendix A.2.

in each period. Within a period, a government will now provide public goods until the marginal benefit of doing so equals the marginal benefit of transfer spending:

$$\alpha_s V_g(\hat{g}) = 2(1-\theta) \tag{2.34}$$

If there is more money than $\hat{g}$ to spend, then this rest of the money will be spent on redistributive transfers.

Even this seemingly little modification of changing the public good sub-utility leads to quite some complications in the analytical solution of the model. In the analysis below, we therefore focus on a special case of the quasi-linear model environment. Furthermore, to reduce the number of cases to consider, we make the following assumption. The high income $\overline{\omega}(\pi_s)$ realizes exactly then when public good spending has a low value α_L. This can be justified by interpreting certain measures to avert an economic crisis as public good spending. Such a measure could be the nationalization of a system relevant bank in trouble. In a boom with high income, such public spending is not necessary and therefore public good spending can be seen as having a lower general benefit there. The complementary case that corresponds to an economic crisis has $\underline{\omega}(\pi_s)$ and α_H. The probability to end up in a boom time with a lower value α_L of public good spending is given by:

$$\text{Prob}(\overline{\omega}, \alpha_L) = (1-\phi) \tag{2.35}$$

The probability of a crisis with a high public good value α_H is given by:

$$\text{Prob}(\underline{\omega}, \alpha_H) = \phi \tag{2.36}$$

Everything else stays the same compared to the linear model with default, except for the specification of the penalty. We now assume that the penalty has the following form (where Δ is the amount not repaid):

$$P = \begin{cases} 0 & if \quad \Delta = 0 \quad (no\ default) \\ P(\Delta) & if \quad \Delta = (1+R(b_1))b_1 - (\tau_2 \underline{\omega}(\pi_2) - \bar{g}) \quad and\ (\alpha_2, \omega_2(\pi_2)) = (\alpha_H, \underline{\omega}(\pi_2)) \\ P_{max} & else. \end{cases} \tag{2.37}$$

In particular, there might be now an amount $\bar{g}$ which is left to the country even in case of default, without triggering the maximal penalty P_{max}. This acknowledges the fact that even the maximal penalty P_{max} that the international market can inflict might not be enough to keep the country from defaulting, if full repayment is required. Therefore, as long as the government repays $\tau_2\underline{\omega} - \bar{g}$, the international market acknowledges that the country does all that it can. When the government shows this kind of good will, the penalty depends on the amount of debt that is not repaid in the same way as before.

If the country repays less, that is the government defaults purposely, we assume the punishment to take its maximal value, P_{max}. Given P_{max}, the amount $\bar{g}$ of public good spending that is 'left' to the country is set such that the government does not want to default purposely. In particular, even with the maximally inflictable penalty, a country would prefer to default, if honoring the debt commitments to the demanded degree, $\tau_2\underline{\omega}(\pi_2) - \bar{g}$, would leave it with less welfare. To keep the analysis simple, we assume that $\bar{g}$ is such that the country would not want to default purposely even with the maximal debt $\bar{\bar{b}}$. For lower equilibrium levels of debt, $\bar{g}$ could be lower, but we neglect this subtlety here.[39,40]

Define $\Gamma \equiv (1-\gamma)2(1-\theta) + \gamma 2\theta$. We make the following **Assumptions**:[41]

$$\phi\alpha_H V_{g+}(\bar{g}) + (1-\phi)\Gamma < \frac{\phi}{1-\phi} \left.\frac{\partial P(\Delta)}{\partial \Delta}\right|_{b=\bar{b}} + \Gamma \tag{2.38}$$

$$\alpha_H V_{g-}(\bar{g}) > \left.\frac{\partial P(\Delta)}{\partial \Delta}\right|_{b=\bar{\bar{b}}} \tag{2.39}$$

Here V_{g+} denotes the derivative from the right and V_{g-} the derivative from the left.[42] Note also that $\frac{\partial P(\Delta)}{\partial \Delta}$ is evaluated at $\bar{b} = \frac{\tau_2\underline{\omega}(\pi_2)-\bar{g}}{1+\rho}$ in (2.38) and at $\bar{\bar{b}} = \frac{\tau_2[(1-\phi)\overline{\omega}(\pi_2)+\phi\underline{\omega}(\pi_2)]-\bar{g}}{1+\rho}$ in (2.39). Assumption (2.39) therefore says that public good spending below $\bar{g}$ is very valuable. Specifically, it is so valuable that even in the face of penalties the country will not reduce these penalties by lowering its public good consumption below $\bar{g}$, the level it is accorded by the international market in the case of default. Economically, this public good consumption can be interpreted as public

[39]Moreover, in order to derive the comparative statics results we assume that $\bar{g}$ is a fixed value which is constant with respect to changes in the parameters.

[40]Note that $\bar{g}$ can be 0 if $V(\cdot)$ is such that P_{max} is large enough to ensure that debt commitments are still honored. However, if some basic public good spending is necessary each period in the sense of being highly valuable, which seems rather realistic and could be captured for instance by $V(g) = ln(g)$, $\bar{g} > 0$ is necessary.

[41]Moreover, we assume $\alpha_H V_{g-}(\bar{g}) > 2(1-\theta)$ during the analysis, which just says that the resources which are left to the country in case of default without triggering P_{max} are actually spent on the public good.

[42]This allows for the theoretical possibility of a kink at $\bar{g}$.

expenditures for crucial projects. Examples include maintenance of basic medical care, security, infrastructure and schools. A reduction of public good spending below $\bar{g}$ would go at the core of these projects. Assumption (2.38) implies that the marginal penalty at $\bar{b}$ is high enough so that the optimal debt level b_1^* is a continuous function of the parameters.[43]

Intra-temporal policies

As in the analysis of the linear model, we first analyze the optimal intra-temporal policies while taking the inter-temporal policies b_s, τ_{s+1}, π_{s+1} (and so m_s and n_s) as given. Considering the intra-temporal maximization problem solved by the government, we now have to distinguish two scenarios.

Scenario 1: $\tau_s \omega_s(\pi_s) - m_s - n_s + b_s - (1 + R(b_{s-1}))b_{s-1} > \bar{g}$

That is, the residual public resources after taking care of the investment expenditures (m_s, n_s) and debt obligations are larger than the amount of public good spending which is 'left' to the country in any case. In this scenario, the intra-temporal maximization problem of the incumbent group is analogous to the linear case:

$$max_{\{g_s\}} u_s^I = \alpha_s V(g_s) + (1-\tau_s)\omega_s(\pi_s) + 2(1-\theta)[\tau_s\omega_s(\pi_s) - m_s - n_s + b_s - (1+R(b_{s-1}))b_{s-1} - g_s] \tag{2.40}$$

Given a public good provision of g_s by the incumbent government, the utility of the opposition group will be:

$$u_s^O = \alpha_s V(g_s) + (1-\tau_s)\omega_s(\pi_s) + 2\theta[\tau_s\omega_s(\pi_s) - m_s - n_s + b_s - (1+R(b_{s-1}))b_{s-1} - g_s] \tag{2.41}$$

In the following, denote the residual resources left after investment expenditures and debt obligations as:

$$T \equiv \tau_s \omega_s(\pi_s) - m_s - n_s + b_s - (1 + R(b_{s-1}))b_{s-1}$$

[43]Otherwise, the optimal debt level might jump from $b_1^* \leq \bar{b}$ to $b_1^* > \bar{b}$ at some point. We make this assumption just for convenience, it is not crucial for our results. If it is violated, the results stated in proposition 2.5.1 still hold (parts 1-4 and 7 hold without restrictions while parts 5-6 and 8 hold within $b_1^* \leq \bar{b}$ and $b_1^* > \bar{b}$ but not necessarily at the jump).

The policy function for public good provision then becomes:

$$G(\alpha_s, \tau_s, \pi_s, m_s, n_s, b_s, b_{s-1}) = \begin{cases} T & \text{if } \alpha_s V'(T) \geq 2(1-\theta) \\ \hat{g} & \text{otherwise.} \end{cases} \tag{2.42}$$

Plugging (2.42) into (2.40) and (2.41), yields the following 'indirect' payoff function for group $J \in \{I, O\}$ in period s:

$$\begin{aligned} W(\alpha_s, \tau_s, \pi_s, m_s, n_s, b_{s-1}, b_s, \beta^J) &= \alpha_s V(G) + (1-\tau_s)\omega_s(\pi_s) \\ &\quad + \beta^J[\tau_s \omega_s(\pi_s) - m_s - n_s + b_s - (1 + R(b_{s-1}))b_{s-1} - G] \end{aligned} \tag{2.43}$$

where $\beta^I = 2(1-\theta)$ and $\beta^O = 2\theta$.

Scenario 2: $\tau_s \omega_s(\pi_s) - m_s - n_s + b_s - (1 + R(b_{s-1}))b_{s-1} \leq \bar{g}$

In this case, the resources available after honoring the debt commitments and covering the investment expenditures (again we take the inter-temporal policies m_s, n_s and b_s as given) would be less than $\bar{g}$, the spending on public goods which is allowed without triggering the maximal penalty.

By assumption (2.39) and the convexity of the penalty function, we have $\alpha_H V_{g-}(\bar{g}) > \frac{\partial P(\Delta)}{\partial \Delta}\Big|_b$ for all $b \in [\bar{b}, \bar{\bar{b}}]$. This implies that for Scenario 2 and with $\alpha_s = \alpha_H$, the government will provide the public good level $\bar{g}$ and incur the resulting penalty from not being able to fully honor its debt commitments. With $\alpha_s = \alpha_L$ we would need to make additional assumptions in order to analyze Scenario 2. However, it turns out that for the situation we want to focus on below, the government will never end up in Scenario 2 for $\alpha_s = \alpha_L$. This is, we analyze an economy which starts in the first period with $\alpha_1 = \alpha_L$ and in which there are enough resources to provide transfers. In such an environment, Scenario 2 might only be the case for period 2 and $\alpha_2 = \alpha_H$ and if so, the corresponding 'indirect' payoff function for group $J \in \{I, O\}$ becomes:

$$\begin{aligned} W(\alpha_H, \tau_2, \pi_2, 0, 0, b_1, 0, \beta^J) =& \alpha_H V(\bar{g}) + (1-\tau_2)\underline{\omega}(\pi_2) \\ & - P[(1 + R(b_1))b_1 - (\tau_2 \underline{\omega}(\pi_2) - \bar{g})] \end{aligned} \tag{2.44}$$

Inter-temporal policies

The inter-temporal maximization problem of the incumbent group of period s=1 is:

$$\begin{aligned} max_{\{\tau_2,\pi_2,b_1\}}\; & W(\alpha_1,\tau_1,\pi_1,m_1,n_1,b_0,b_1,2(1-\theta)) + EV^{I_1}(\tau_2,\pi_2,b_1) \\ s.t.\; & \tau_2 \geq \tau_1, \\ & \pi_2 \geq \pi_1, \\ & b_1 \leq \bar{\bar{b}}(\tau_2,\pi_2), \end{aligned} \tag{2.45}$$

In the following, replace $W(\alpha_s,\tau_s,\pi_s,m_s,n_s,b_{s-1},b_s,\beta^J)$ by $W(\alpha_s,\beta^J)$. Then we get:

$$\begin{aligned} EV^{I_1}(\tau_2,\pi_2,b_1) =& \delta(1-\gamma)[\phi W(\alpha_H,2(1-\theta)) + (1-\phi)W(\alpha_L,2(1-\theta))] \\ & + \delta\gamma[\phi W(\alpha_H,2\theta) + (1-\phi)W(\alpha_L,2\theta)] \end{aligned} \tag{2.46}$$

In Appendix A.1, we derive comparative static results for this setup, summarized in the following proposition.

Proposition 2.5.1. *Suppose an economy in the quasi-linear model with sovereign default starts in the first period with $\alpha_1 = \alpha_L$. Moreover, suppose that there are enough resources to provide transfers in period 1 and that the constraint $\tau_2 \geq \tau_1$ does not bind.*[44] *Furthermore, assume that the public good subutility function and the values of α_H and α_L are such that the first order condition for debt holds with equality for $b_1^* \neq \bar{b}$. For such $b_1^* \neq \bar{b}$, we get:*[45]

1. *If $\alpha_2 = \alpha_L$ ($\alpha_2 = \alpha_H$), transfers (no transfers) will be provided in the second period.*
2. *There are positive investments in fiscal and legal capacity.*
3. *Higher ϕ increases(decreases) investments in fiscal and legal capacity if $\Gamma < 1$ ($\Gamma > 1$).*
4. *Lower γ increases investments in fiscal and legal capacity.*

[44] A sufficient but not necessary condition that $\tau_2 \geq \tau_1$ never binds is $\Gamma > 1$. The results when $\tau_2 \geq \tau_1$ binds are established in proposition A.1.1 in Appendix A.1.

[45] The results for $b_1^* = \bar{b}$ will be shortly discussed in Appendix A.1. They are analogous to the linear case.

5. *Lower γ leads to an increase of free future revenues.*

6. *Higher ϕ leads to a decrease of debt if $\Gamma > 1$.*

7. *For $\theta \to 1/2$, the probability that a country will end up in a situation with sovereign default approaches 0.*

Under some further technical assumptions spelled out in Appendix A.1, we get:

8. *The higher γ, the more likely it is that debt and state capacity investments move in opposite rather than the same direction in response to a change in γ.*

Regarding Part 1 to Part 7, the analogy to the findings from the linear case is clear.[46] Part 8 is worth an explanation. In order to have debt and state capacity investments change from moving in the same to moving in opposite directions, we actually need ambiguity in the way that debt and state capacity investments react to exogenous parameter changes. This ambiguity shows up clearly for the comparative statics with respect to political instability γ. In particular, both state capacities τ_2^* and π_2^* decrease with a higher value of political instability. The reaction of debt b_1^*, however, is ambiguous. In Appendix A.1, we show that the marginal effect of an increase of γ on both state capacities τ_2^* and π_2^* becomes stronger for higher γ. We then argue that for higher γ, it becomes more likely that debt and state capacity investments move in opposite rather than the same direction in response to a change in γ. Recall that in the linear case, we found that they move in the same direction for $b_1^* = \bar{b}$ but are likely to move in opposite directions for $b_1^* > \bar{b}$. The latter was the case for low $E(\lambda_2)$, which can be caused by high γ. In that sense, Part 8 points in the same direction as our findings in the linear case.

2.6 Conclusion

This chapter presented an integrated analytical framework for analyzing the interaction between public debt and state capacity, the power of a state to raise taxes and to provide market supporting policies. We showed that the possibility to raise

[46]However, the comparative statics with respect to ϕ now depend on Γ. The reason for this difference compared to the comparative statics in the model of Section 2.4 is that a change in ϕ captures now also a change in ψ.

debt can provide a novel incentive to invest in state capacity, because debt allows to bring future state capacity at the disposal of the current government. As long as debt can be used to protect the current government from an adverse use of future public funds, it is no longer necessary to use low investments in state capacity as a protection device.

However, we also showed how this novel mechanism can be weakened in a world with income fluctuations and the possibility of default. When high costs of raising debt make it very expensive to draw all relevant future public funds to the present, the mechanism of lowering investments resurfaces. Specifically, this mechanism is more prominent for high income fluctuations, because they increase the proportion of public funds that can only be drawn to the present at high costs. For such an environment, we get results that are closest to the original no-debt model by Besley and Persson (2011). In particular, an unstable political environment combined with insufficient institutional provisions to prevent clientele politics can then lead to a situation of low state capacity. Furthermore, this weak state situation is now worsened by a high built up of debt, increasing the probability of sovereign default.

The results of our model are in principle testable. In cross-country data, we predict to observe for countries with non-cohesive institutions a positive correlation between political stability and measures of state capacity, a negative correlation between political stability and public debt and therefore a negative correlation between public debt and measures of state capacity. For instance, countries with high political instability are expected to show high public debt and low fiscal and legal capacity. There is anecdotal evidence that Greece might be an example of such a country. Taking a brief look at cross country data, we find positive correlations between political stability and measures of state capacity but insignificant correlations regarding debt. However, a comprehensive empirical analysis, which would be necessary in order to convincingly test our theory, is left for future research.

Our model leaves room for several generalizations which should be investigated by future research. First, to qualify the model results in light of the tax smoothing literature, it would be interesting to allow for distortionary taxation. Second, the modeling of default could be extended to a full-fledged model of willingness-to-pay default. This would certainly allow to uncover additional interesting channels that shape the interaction between debt and state capacity. Third, in light of this, it could make sense to extend the model to more than two periods.

Chapter 3

Permanent Tax Amnesties, Audit Information Provision and Compliance Behavior: An Experimental Study

3.1 Introduction

Tax amnesties are a popular instrument for governments around the world which aim to increase both short- and medium-term tax revenue. For instance, in the US, more than 110 amnesty programs have taken place since 1980. Despite many different features, all of these amnesties had in common that they lasted less than one year, they did not forgive the tax owed and they waived criminal prosecution (Mikesell and Ross, 2012).[1]

However, several countries have policies in place which resemble a tax amnesty but are of unlimited duration, which is why they can be seen as a 'permanent' tax amnesty.[2] For instance, the German tax law allows for the possibility of a voluntary

[1] Baer and Le Borgne (2008) provide a more general review of tax amnesties around the world and define a tax amnesty as a "limited-time offer by the government to a specific group of taxpayers to pay a defined amount, in exchange for forgiveness of a tax liability (including interest and penalties), relating to a previous tax period, as well as freedom from legal prosecution." (p. 5)

[2] Examples for countries with such permanent programs which cover all or particular cases of tax evasion are inter alia Denmark, Germany, Mexico, the Netherlands, Norway, Sweden, and the US (Baer and Le Borgne, 2008).

disclosure which grants exemption from criminal prosecution regarding all kinds of tax evasion. While several empirical studies about the effects of tax amnesties exist,[3] so far, very little is known about such permanent tax amnesties, especially when it comes to experimental or other empirical investigations. However, studying permanent tax amnesties seems desirable since its effects on tax compliance are likely to be different from those of a one-time or repeated tax amnesty. The reason is that a permanent tax amnesty might reduce tax compliance if people anticipate that they can choose a voluntary disclosure at any time in the future. This might lead to an increase in tax evasion since the permanent possibility of a voluntary disclosure creates a kind of 'insurance', for instance against a rise in the audit rate or the punishment. This chapter is intended to fill this gap in the literature by examining the effects of a permanent tax amnesty on compliance behavior in an experimental setting.

In this experiment, all participants earn and declare income in an environment with a fluctuating audit rate, which mirrors that during the last years, the risk of getting caught has been subject to exogenous shocks, in particular caused by data leaks about foreign bank accounts. However, the provided amount of information about the audit rate differs among three treatments. In one treatment, the current audit rate is announced (currInf treatment), in a second treatment, the participants are informed about the audit rate of the previous round (pastInf treatment) while in a third treatment, the audit rates are completely unknown to the participants (noInf treatment). Within these treatments, a permanent tax amnesty is introduced which allows for voluntary disclosures to repay evaded taxes in order to go unpunished in case of future audits.

Varying audit rate information across treatments has not only been shown to be an interesting tool in tax compliance experiments (Alm et al., 2009) but it is especially interesting in light of a permanent tax amnesty. In particular, these treatments allow exploring three questions. First, they enable me to analyze whether a permanent tax amnesty lowers compliance by creating an insurance as explained above. Second, the experimental design allows examining whether this insurance effect decreases with less information about the audit rate. Third, the treatment without information

[3] See Baer and Le Borgne (2008) for a review.

enables me to investigate whether or not a permanent tax amnesty has an impact on tax compliance even beyond the insurance effect, for example by influencing social norms.

I find that, if the audit rates are announced (currInf treatment), the permanent tax amnesty lowers compliance by around 9% but that there is no effect on tax compliance in the absence of information (noInf treatment).[4] So, the experimental results suggest that a permanent tax amnesty lowers tax compliance if the informational setting allows using a permanent tax amnesty as an 'insurance' against an increase in the detection probability. Furthermore, I investigate when people decide for a voluntary disclosure and find that, as expected, most voluntary disclosures take place after a jump in the audit rate becomes public. However, surprisingly, I also find a large number of time-inconsistent voluntary disclosures in the treatment without information about the audit rate (noInf treatment).

During the last decades, many tax compliance experiments have been carried out.[5] Regarding the experimental setup, my study is related to the study of Alm et al. (2009) who investigate the effects of different forms of official and unofficial information about the audit rate on tax compliance, finding that the information setting plays an important role. I build on their setup by also allowing for different forms of information concerning the audit rate but modify it in order to investigate the effects of a permanent tax amnesty. To my knowledge, there are three tax compliance experiments that deal with tax amnesties, however all with non-permanent amnesties which take place between two rounds of an experiment. Moreover, they yielded inconclusive results. Alm et al. (1990) find that the overall level of compliance falls after an amnesty, while Torgler and Schaltegger (2005) and Rechberger et al. (2010) find that compliance tends to increase after an amnesty.[6] In contrast to these studies, I investigate the effects of a permanent tax amnesty on tax compliance

[4]The effect of a permanent tax amnesty in the pastInf treatment lies in between.

[5]Fonseca and Myles (2011) provide a detailed survey.

[6]There are also a few non-experimental attempts to examine the effects of (non-permanent) tax amnesties on tax compliance. Luitel and Sobel (2007) analyze tax amnesties from 1980 to 2004 in 37 states of the US and find evidence that a tax amnesty comes along with a decrease in future revenue and that this effect is even larger for a repeated tax amnesty. However, such studies with macro data have difficulties to establish causality. There is also a study with individual taxpayer-level data by Christian et al. (2002) who evaluate subsequent filing behavior of tax amnesty participants from Michigan, finding little if any positive impact on revenues. However, due to data availability, their results are conditional on amnesty participation and no inference is possible regarding overall compliance after the tax amnesty.

which has not been done so far.

On the theory side, as all tax compliance experiments, this chapter is related to the seminal tax compliance model of Allingham and Sandmo (1972), as discussed in more detail in Section 3.3. Concerning tax amnesties, there is a theoretical paper by Andreoni (1991) which discusses the desirability of a permanent tax amnesty. In his model, a permanent tax amnesty increases tax evasion but still might increase total revenue since the reason for additional tax evasion lies in agents expecting to potentially participate in the amnesty, in which case the government recaptures both the new and the pre-existing tax evasion. The model of Andreoni (1991), however, only mirrors my experiment to some extent since, in his model, the audit rate is fixed and the uncertainty arises from consumption shocks while in my experiment, the fluctuating audit rate is the main driving force which is intended to reflect reality more closely.

The rest of the chapter is organized as follows. The next section briefly discusses a current example of a permanent tax amnesty which is in force in Germany. Section 3.3 gives some theoretical background while section 3.4 explains the experimental design. In Section 3.5, I derive some hypotheses which will be examined in Section 3.6 in which the results are discussed. Section 3.7 concludes.

3.2 Example: The Voluntary Disclosure in Germany

The German tax law allows for the possibility of a voluntary disclosure regarding tax evasion which grants exemption from criminal prosecution under certain conditions.[7] This rule can be seen as some kind of permanent tax amnesty, as argued in the introduction. After 8079 voluntary disclosures occured in 2012 (Handelsblatt, 2013), there have been more than 26000 voluntary disclosures in 2013 (Süddeutsche Zeitung, 2014).[8] Moreover, the revenue due to voluntary disclosures since 2010 is

[7]In particular, the voluntary disclosure has to be complete, i.e. it has to cover all tax evasion which has not yet lapsed (5 to 10 years), the evaded tax including interest have to be paid (plus 5% of evaded taxes if tax evasion is greater than 50000 Euro) and the subject must not be informed about an ongoing investigation. Cf. Abgabenordung §371 and §398a

[8]The explanations for this jump are manifold (Handelsblatt (2013)): First, many tax evaders might have speculated on a bilateral tax treaty with Switzerland, however, the proposal failed

estimated to be greater than or equal to 3 billion Euro (Handelsblatt, 2013). Since the voluntary disclosure of the president of FC Bayern München, Uli Hoeneß, has become public in spring 2013, there is an ongoing political debate in Germany whether this rule should be abolished.

However, except from mentioning the revenue due to voluntary disclosures, the arguments in this debate are mainly driven by justice considerations, i.e. whether the possibility of a voluntary disclosure is a fair appreciation of active repentance or whether it is unjust to let tax evaders off the hook because they should get what they deserve.

For example, the spokesman on financial policy of SPD-Bundestagsfraktion, Lothar Binding, states in a newspaper interview: "In all other fields of law, this easy possibility to evade punishment does not exist. If our sensitivity against the theft of a yoghurt is higher than against tax evasion of 100000 Euro, something got mixed up. [...] Under the aspect of justice, there is only one possible answer: abolition."[9]

By contrast, the spokeswoman on financial policy of CDU/CSU-Bundestagsfraktion, Antje Tillmann, answers the question whether the principle of the voluntary disclosure regarding tax evasion is just compared to other offenses in the following way: "This is comparable to the case that someone starts a little fire to harm someone. But then, when he goes away, he is beset by his conscience, goes back and extinguishes the flame. So, he backs out of his deed. [...] I regard it as useful to allow for the possibility to come back to tax honesty here and now."[10]

One issue, which is neglected in the current debate in my eyes, are the potential effects of a permanent tax amnesty on compliance behavior, i.e. whether people increase or decrease their compliance if they anticipate that they will be able to go for a voluntary disclosure at any time in the future. In particular, a permanent tax amnesty might decrease tax compliance if it can be used as an 'insurance' against an increase in the audit rate, as explained in further detail in the next section. Therefore, this study contributes to this debate by experimentally investigating

in January 2013 in the Federal Council of Germany. Second, Swiss banks increased pressure on German clients in order to ensure they pay taxes. Third, the voluntary disclosure of Uli Hoeneß which became public might have caused copycats. Fourth, new CDs with data regarding foreign banking accounts have been bought by German tax authorities.

[9] Quote translated from Mannheimer Morgen (2014).

[10] Quote translated from Thüringer Allgemeine (2014).

whether and under what circumstances this concern is justified.

3.3 Theoretical Background

In the following, I want to use some simple theoretical framework to formulate two ideas how a permanent tax amnesty might influence compliance behavior. The first idea builds on the basic tax evasion model of Allingham and Sandmo (1972). Consider an individual with true income I in each round and who declares income D to the tax authorities in a given round. If the individual is not audited, her net income of this round will be $I_{NA} = I - \tau D$. However, if the individual is audited, the true income is detected and therefore her net income will be $I_A = (1-\tau)I - f\tau(I-D)$ where τ is the tax rate and f is the penalty rate on evaded taxes. Let the probability of an audit fluctuate between p_H and p_L with $p_H > p_L$ and $Prob(p = p_H) = \gamma$ in each round. Without a permanent tax amnesty, each round consists of three stages: In the first stage, the individuals declare their income. In the second stage, the audit rate is drawn and publicly announced and in the last stage, the potential audits take place and the payoffs are determined. Therefore, an individual in the first stage solves the following problem:

$$max_D \; E(p)U(I_A) + (1 - E(p))U(I_{NA}) \tag{3.1}$$

with:

$$E(p) = \gamma p_H + (1 - \gamma)p_L \tag{3.2}$$

Denote the solution to this maximization problem D^*_{noAmn}. With a permanent tax amnesty, there will be an additional stage compared to the previous setup: In the first stage, the individuals declare their income and in the second stage, the audit rate is drawn and publicly announced as before. Now introduce a new stage in which the individual has the possibility of a voluntary disclosure. If the individual decides to voluntarily disclose her income, she has to pay taxes on her true income, but no penalty. So, the net income after a voluntary disclosure is $I_V = (1-\tau)I$. In the last stage, the potential audits take place and the payoffs are determined. In this setup, an individual in the first stage solves the following problem:

$$max_D\ \gamma max\{U(I_V),\ p_H U(I_A) + (1 - p_H)U(I_{NA})\} \\ + (1 - \gamma)max\{U(I_V),\ p_L U(I_A) + (1 - p_L)U(I_{NA})\} \tag{3.3}$$

Generally, for people who never use the voluntary disclosure, either because they are completely honest or because they prefer cheating in both situations p_L and p_H, nothing changes. Moreover, for individuals who use a voluntary disclosure conditional on both audit probabilities, p_L and p_H, nothing changes since this is equivalent to being honest from the beginning on. However, for individuals who prefer a voluntary disclosure conditional on p_H but who prefer cheating conditional on p_L, I get

$$max_D\ \gamma U(I_V) + (1 - \gamma)(p_L U(I_A) + (1 - p_L)U(I_{NA})) \tag{3.4}$$

which is equivalent to:

$$max_D\ p_L U(I_A) + (1 - p_L)U(I_{NA}) \tag{3.5}$$

Denote the solution to this maximization problem D^*_{Amn}. Since $p_L < E(p)$, I get $D^*_{Amn} < D^*_{noAmn}$. This is, declared income is lower with a permanent tax amnesty since, in this case, the lower audit rate p_L and not the expected audit rate $E(p)$ is relevant for the tax evasion decision. The intuition is straightforward: tax compliance is lower under a permanent tax amnesty since it can be used as an 'insurance' against a surprisingly high audit rate.

The second and less obvious idea how a permanent tax amnesty might influence tax compliance comes from a different perspective and incorporates social norms. Alm et al. (2009) define social norms as follows: "A social norm represents a pattern of behavior that is judged in a similar way by others and that is sustained in part by social approval or disapproval. This suggests an individual will comply as long as he or she believes that compliance is the social norm." (p. 394) Moreover, this suggests that a policy such as a permanent tax amnesty might influence the believes about the social norm. One way to introduce a social norm is via a reference point, which means that an individual incurs a loss in utility if she does not achieve her reference point.[11] Following Alm et al. (2009), the reference point might be full compliance. If this is the case, an individual incurs a cognitive cost (or psychic cost) $\beta(\tau(I-D))$ proportional to tax evasion which reduces I_{NA}. The stronger the social norm of tax compliance, the higher is β. So, the question is whether the existence of a permanent tax amnesty influences the social norm of tax compliance, and if so, in which direction. On the one hand, a permanent tax amnesty could reduce tax compliance since tax evasion might become regarded as a trivial offense since it offers the possibility to return to legality without punishment. On the other hand, a permanent tax amnesty could increase tax compliance since getting caught might become less socially acceptable because it reveals that the tax evader wanted to evade until the point of getting caught and she cannot persuade others (and herself) that she wanted to become legal but there was no way. So, from a theoretical perspective, the effect of a permanent tax amnesty on social norms is unclear. After explaining the experimental design in the next section, I will come back to these considerations by formulating hypotheses in Section 3.5.

3.4 Experimental Design

120 subjects participated in the experiment which took place at the mLab at Mannheim University in Fall 2013. The experiment consisted of 60 rounds which were predetermined but unknown to the subjects.[12] In one half (round 1-30 or round 31-60), subjects faced a permanent tax amnesty while in the other half, the game was a standard tax compliance game. An AB/BA-design was used to control for order effects. The sequence of actions within a round with and without a permanent tax amnesty is summarized by Figure 3.1 and 3.2, respectively. At the beginning of each round, the round income is displayed to the subjects. The income is randomly drawn from the values 60, 70, 80, 90 and 100 which are all equally likely.[13] In the

[11] Reference points have become very important in the recent literature in behavioral economics. See Hart and Moore (2008) for an overview of applications in behavioral economics (p. 7, Footnote 12) and for an application of reference points to contract theory.

[12] The instructions say that "the number of rounds of the experiment is unknown to you, the duration of the experiment is, however, at most 1.5 hours" (cf. the instructions in Appendix B.2).

[13] Income is random for several reasons: First, voluntary disclosures are mostly used regarding tax evasion in the context of capital income, which fluctuate over time and which shall be mirrored in this experiment. Second, playing sixty rounds with a constant income might bore the subjects. Third, fluctuating income is also common in the experimental tax compliance literature, e.g. Alm et al. (2009).

rounds without a permanent tax amnesty (i.e. without the possibility of a voluntary disclosure), the subjects are then asked to fill in their tax declaration,[14] i.e. to state their income of the current round which is then taxed at the rate of 25% (which mirrors capital income taxation in Germany).[15] Thereafter, the computer randomly determines who is audited. If there is an audit, the subject has to pay taxes on the declared income, the evaded taxes of the current and the previous three rounds plus an additional penalty on top which is 100% of the evaded taxes (in other words, the subject has to pay evaded taxes of the current and the previous three rounds twice). If there is no audit, the subject pays only taxes on the declared income. The last stage of the round is the profit display in which the subjects are informed about whether or not they have been selected for an audit and which includes a round summary.

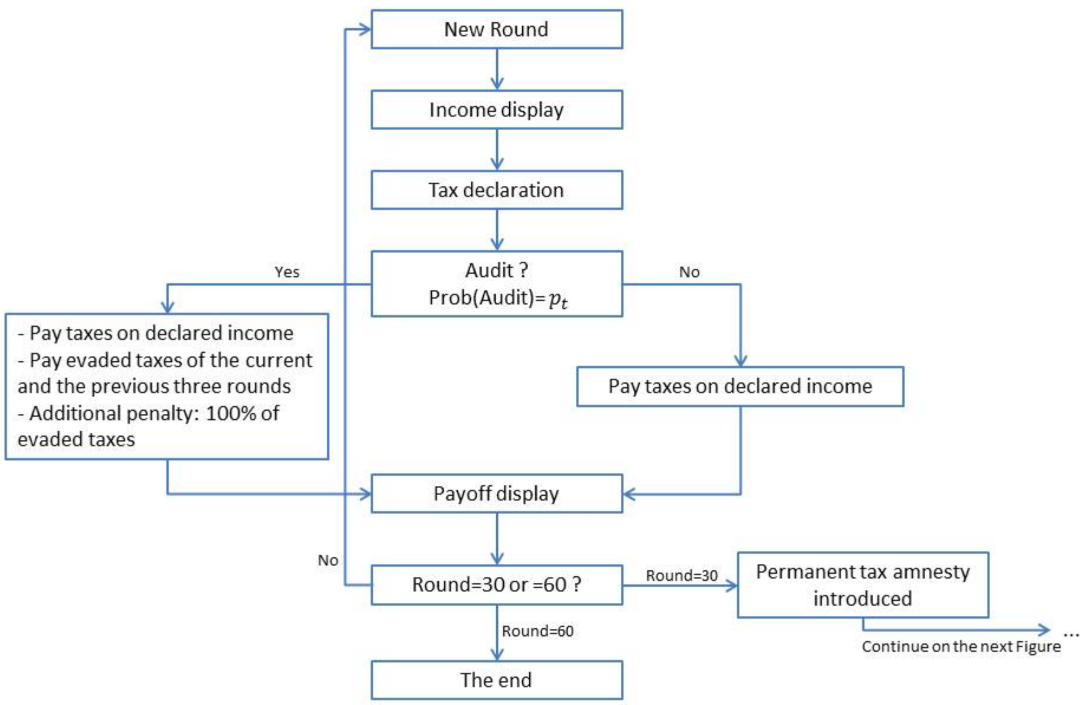


Figure 3.1: Experimental design: Rounds without permanent tax amnesty

In the rounds with a permanent tax amnesty, subjects can choose at the beginning

[14]Screenshots are provided in Appendix B.3.
[15]In Germany, the capital income tax rate is 25%. However, due to the "Solidaritätszuschlag", the true rate is 26.375% plus church tax if applicable.

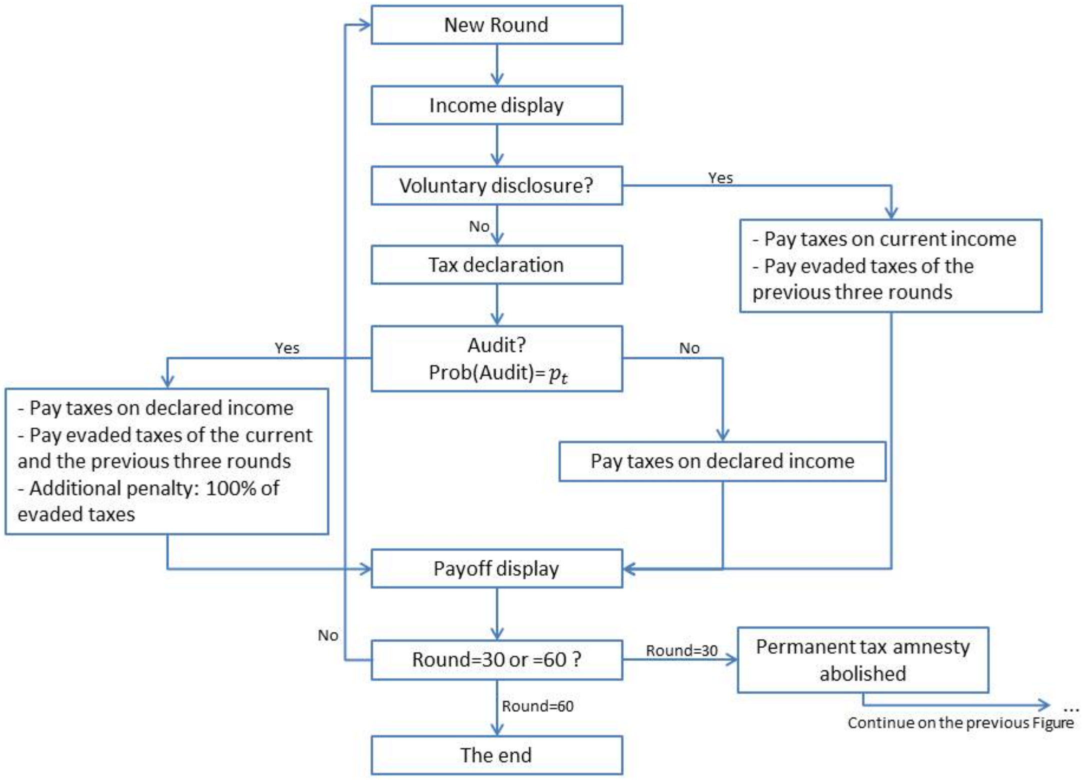


Figure 3.2: Experimental design: Rounds with permanent tax amnesty

of each round, after they have learned their current income, whether or not they want to undertake a voluntary disclosure. If they do so, they have to pay taxes on their current income plus the evaded taxes of the previous three rounds, however, no penalty. In case of a future audit, these evaded taxes will be treated as if they were regularly paid, i.e. there is no future penalty.[16] The audit rate fluctuates between 2.5%, to which I will refer to in the following as the 'low' level, and 25% (the 'high' level) which is independent of the subjects' decisions. In a round in which the audit rate is at the low level, the probability of an upward jump at the beginning of the next round is 15%. In case of a jump, the audit rate remains at the high level for 1 to 5 rounds (each equally likely, i.e. on average 3 rounds) and then falls back to

[16]The decision regarding the voluntary disclosure is modeled as a binary choice (complete disclosure or no disclosure) since partial disclosures in real life are void and therefore even counterproductive. In reality, partial disclosures also exist (e.g. the case of Uli Hoeneß), most likely done by accident due to the complexity of a comprehensive voluntary disclosure, which is ruled out in this experiment.

the low level.[17,18] The information regarding the random process of the audit rate is known to the subjects, however the information regarding the actual audit rate differs among the three treatments. In the noInf treatment, the subjects have no information regarding the level of the audit rate.[19] On the other extreme, in the currInf treatment, the subjects are informed about the value of the audit rate in the current round. The third treatment, pastInf, is in between these two extreme information settings and provides the subjects with the value of the audit rate of the previous round.

Each treatment comprises 40 subjects, with 20 subjects facing the permanent tax amnesty in the first half and 20 subjects facing the permanent tax amnesty in the second half of the experiment. After the experiment, measures of risk aversion have been collected as in Holt and Laury (2002)[20]. The entire experiment was programmed with zTree (Fischbacher, 2007) and recruitment was done with ORSEE (Greiner, 2004). The 120 subjects split up into 12 laboratory sessions with 8-12 participants each. The average duration is 75 minutes and the participants earned 11.85 Euro on average, ranging from 10.00 to 16.00 Euro.[21] All tax revenue and penalties have been converted into Euro using the same exchange rate as the profits[22] and were transferred to Bundeskasse, flowing into the German federal budget. All subjects were informed about this in the instructions, and, to ensure credibility, they were provided with a copy of the proof of payment by email after the experiment.[23]

[17] During the last years, from time to time tax authorities around the world gained access to information about tax evaders, for instance through the offshore leaks scandal in 2013 which revealed data about 130000 offshore accounts of people from 170 countries, or through CDs with stolen data about Swiss banking accounts of German citizens, which were sold to German tax authorities a couple of times since 2006. The fluctuating audit rate in the experiment is intended to mimic such shocks in the detection probability which last for some time until the data is exploited. Regarding the overall audit rate, a tenfold increase seems somewhat unrealistic, however, conditional on evading taxes (i.e. for the detection probability) a tenfold increase might be realistic.

[18] Note that my experimental design differs mainly in two ways from the theoretical framework introduced in Section 3.3. The draws of the audit rates are not i.i.d. and the voluntary disclosure takes place at the beginning of each round. However, the explained 'insurance' mechanism is qualitatively the same in my setup for the following two reasons. First, in my experimental design, in which the audit rate is not i.i.d. drawn in each round but depends on the previous round's audit rate, the mentioned "surprisingly high audit rate" corresponds to an upward jump of the audit rate. Second, although the voluntary disclosure takes place at the beginning of each round, the 'insurance' effect is present because the previous rounds' tax declarations are examined in case of an audit in the experiment. These two details are deliberately omitted in the theoretical considerations of Section 3.3 to keep the reasoning as simple as possible.

[19] Note that the instructions do not state the values of the two levels.

[20] After the tax evasion game, the subjects had to choose from a series of two lotteries with one of them being played by the computer. The lottery payoff, ranging from 0.05 to 1.90 Euro, was added to the final payoff

[21] All subjects have been paid individually and confidentially.

[22] 3.5 points = 1 eurocent.

[23] In the experimental literature, there is no consent about what to do with tax revenue. Some

An English translation of the instructions of all treatments, which were originally written in German, is provided in Appendix B.2.

An objection against my experiment and tax compliance experiments in general is that students might behave differently than actual taxpayers. However, there is little evidence for this argument. Alm et al. (2011) compare reporting behavior of students and non-students in tax compliance experiments and find that compliance *levels* might differ (however without a clear sign[24]), but that *changes* in the compliance rates due to treatment effects are similar. Moreover, in my experiment, a substantial part of the subject pool (34 out of 120 subjects, i.e. 28.3%) stated in a post-experimental survey to have already prepared their own tax return in real life at least once.[25] I control for this by including a corresponding dummy in my estimations later on, without finding a significant effect, which suggests that it is appropriate to have students included in the subject pool.

3.5 Hypotheses

As argued in Section 3.3, tax compliance should fall under a permanent tax amnesty if the permanent tax amnesty can be used as an 'insurance' against a jump in the audit rate. In the currInf treatment, the current audit rate is announced and therefore the 'insurance' mechanism is expected to reduce compliance:

> **Hypothesis 1:** In the currInf treatment, a permanent tax amnesty lowers tax compliance.

In the pastInf treatment, there is only information about the previous round's audit rate. Therefore, the permanent tax amnesty is not a perfect insurance against a jump in the audit rate and therefore tax compliance should fall less than in the currInf treatment, if at all:

studies implement a public good structure (e.g. Gerxhani and Schram (2006)), in some studies the money goes back to the experimenter (e.g. Alm et al. (2009)) and a few studies donate the money e.g. to the red cross (Doerrenberg and Duncan (2013)). However, in my eyes, the most realistic thing is to do the same with the money that is being done in reality with tax revenue, i.e. that it goes to the government budget. To my knowledge, this is the first study which implements this feature.

[24] Depending on the information treatment, Alm et al. (2011) find differences in either direction.

[25] Moreover, 62 out of 120 subjects stated that they have already paid taxes on income.

Hypothesis 2: In the pastInf treatment, if there is a negative effect of a permanent tax amnesty on tax compliance, its magnitude is smaller than in the currInf treatment.

In the noInf treatment, the 'insurance' effect is completely eliminated. If there is still an effect, this would be evidence for the impact of a permanent tax amnesty on social norms. As argued in Section 3.3, this impact might go in either direction, therefore leading to the following open question:

Open Question 1:
In the noInf treatment, is there an effect of a permanent tax amnesty on tax compliance and if so, in which direction?

An additional way to examine the theoretical considerations is to analyze the decisions whether to participate in the permanent tax amnesty, i.e. whether to decide for a voluntary disclosure. Following the 'insurance' reasoning as above, I expect to observe the following patterns in the data:

Hypothesis 3: In the currInf treatment, there is a positive number of voluntary disclosures and they are triggered by an upward jump of the audit rate.

Hypothesis 4: In the pastInf treatment, there are less voluntary disclosures than in the currInf treatment and they are triggered by an upward jump of the previous round's audit rate.

Moreover, in the noInf treatment, there is no information about current or past audit rates and therefore I expect to observe no voluntary disclosures:

Hypothesis 5: In the noInf treatment, there are no voluntary disclosures.

Lastly, an empirically interesting question is whether and how a permanent tax amnesty influences total government revenue, i.e. tax revenue including amnesty payments and penalties. Therefore, another open question arises:

Open Question 2: Does a permanent tax amnesty have an effect on total government revenue?

Since lower tax compliance reduces but amnesty payments increase total government revenue, the total effect is not clear.[26] Despite empirically important, I put this question at the end. The reason is, that the answer to this question is probably highly depending on the parameters (e.g. the frequency of jumps) and therefore my findings regarding this question cannot be generalized. Nevertheless, I will briefly discuss my experimental data in light of this question in Section 3.6.3.

3.6 Experimental Results

3.6.1 Tax Compliance

The focus of this analysis is on the compliance behavior of the subjects. Treatment averages are reported in Table 3.1. The mean compliance rate is declared income summed over the respective subjects and rounds divided by the sum of true income. It is important to note that due to the random process of the audit rate, the mean audit rates differ across treatments. Therefore, comparing compliance rates across treatments should be done with care. Since t-tests or nonparametric tests (e.g. Wilcoxon rank-sum test) do not control for the audit rate, we have to rely on the regression analysis presented in the following. Nevertheless, a brief look at the averages seems worthwhile. The mean compliance rate in the currInf treatment is 0.545 while 0.702 in the pastInf treatment under an almost identical mean audit rate. In the noInf treatment, the mean compliance rate is even higher (0.765) despite a slightly lower mean audit rate. This ranking of compliance rates seems intuitive: The more information about the particular audit rate in force is available, the better the rounds with low audit rate can be identified which lead to higher tax evasion and lower overall compliance. In the currInf and pastInf treatments, the mean of the perceived average audit rate by the individuals, collected in the survey after the experiment, is slightly above 0.1 and therefore close to the actual mean audit

[26] See Andreoni (1991) for a theoretical analysis.

rates which are slightly below 0.1. In the noInf treatment, the subjects somewhat overestimate the mean audit rate (0.126), however still within a reasonable range.

Table 3.1: Summary statistics by treatment

Treat-ment	Design	Total (60 rounds)	With amnesty (30 rounds)	Without amnesty (30 rounds)
currInf	show current audit rate	Subjects = 40 Mean compliance rate = 0.545 Mean audit rate = 0.094 Mean perceived audit rate = 0.103 (median =0.1)	Subjects = 40 Mean compliance rate = 0.530 Mean audit rate = 0.101 Voluntary disclosures = 65	Subjects = 40 Mean compliance rate = 0.560 Mean audit rate = 0.087
pastInf	show previous round's audit rate	Subjects=40 Mean compliance rate = 0.702 Mean audit rate = 0.095 Mean perceived audit rate = 0.109 (median =0.1)	Subjects=40 Mean compliance rate = 0.686 Mean audit rate = 0.096 Voluntary disclosures = 36	Subjects=40 Mean compliance rate = 0.718 Mean audit rate = 0.094
noInf	audit rates unknown	Subjects=40 Mean compliance rate = 0.765 Mean audit rate = 0.088 Mean perceived audit rate = 0.126 (median =0.1)	Subjects=40 Mean compliance rate = 0.769 Mean audit rate = 0.084 Voluntary disclosures = 45	Subjects=40 Mean compliance rate = 0.761 Mean audit rate = 0.092

The main question, whether and in which information treatments a permanent tax amnesty lowers compliance cannot be clearly answered based on this table due to the differences in the mean audit rates. In both, the pastInf and the currInf treatment the mean compliance rate is slightly higher without a permanent tax amnesty, while there is almost no difference in the noInf treatment. However, in the currInf treatment, the rounds without amnesty show a lower audit rate and therefore the difference in the compliance rate is expected to be larger when controlling for the audit rate. In order to do so and to check for statistical significance, I move on to a regression analysis.

The data constitutes a panel since the subjects make compliance decisions in every round, amounting to 7200 observations (120 subjects * 60 rounds). The distribution of values for *Compliance rate*, which is the declared income divided by the true income per subject and round, is shown in Figure 3.3. A large fraction of observations are 0 (22.8 %) or 1 (52.6 %). Moreover, a few observations (7, i.e. less than

0.1 %) are above 1 which corresponds to overreporting of income.[27,28] The pattern of high proportions of 0 and 1 in the data is a common finding in tax compliance experiments. However, there is no consensus in the literature how to deal with it when using the compliance rate as the dependent variable in regressions. As the benchmark, I use a generalized least squares panel random effects estimator as e.g. Alm et al. (2009), leading to the estimates of Table 3.3, and discuss alternative estimation approaches thereafter.

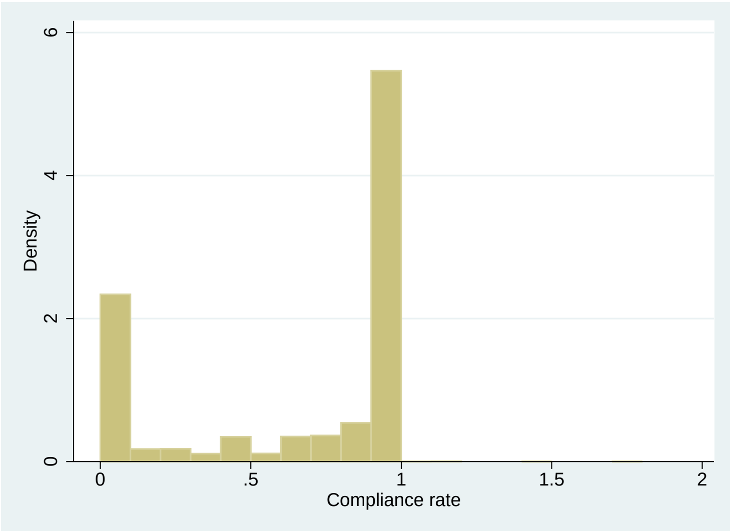


Figure 3.3: Histogram of *Compliance rate*

In all regressions, I include a set of explanatory variables. Tax compliance is expected to depend on the variables which vary over the rounds, i.e. round income and the audit rate, at least if known. Therefore, *Income* and treatment specific variables for the current and past audit rate are included. My main variables of interest are *Amnesty*, which is 1 if the respective round falls into the half of the experiment in which the permanent tax amnesty takes place, and the corresponding dummies $Amnesty{*}currInf$, $Amnesty{*}pastInf$ and $Amnesty{*}noInf$. $Amnesty\ first\ half$ is a dummy variable which indicates whether the permanent tax amnesty took place in the first half of the experiment. To control for subject characteristics, I include variables which control for age, gender and risk aversion. Since compliance behavior of subjects who already prepared their own tax return in real life at least once might

[27] These 7 observations lie between 1 and 2. Note that there is no rational reason for overreporting.

[28] The distribution of values for the overall compliance rate per subject, i.e. the average compliance rate across all rounds per subject, is shown in Figure B.1 in Appendix B.1. The values range from 0.013 (1 subject) to 1 (9 subjects), i.e. 9 subjects chose full compliance in every round.

differ from subjects who did not yet, I include a dummy which controls for this. In my sample, 34 out of 120 subjects stated that they have already prepared their own tax return at least once. I control for the experience of the previous round by including treatment-specific dummy variables which account for voluntary disclosures and audits in the previous round. Moreover, general learning over the rounds is captured by treatment specific *Round* variables. Treatment-specific intercepts completes the set of regressors. Summary statistics for the variables are provided in Table 3.2.

The benchmark estimation is Specification 1 in Table 3.3. Specification 3 is identical to Specification 1 except that they differ regarding which Amnesty*treatment dummy is left out.[29] *Income* is negatively correlated with compliance, in line with previous studies (e.g. Alm et al. (2009)). *High audit rate* has a significantly positive effect on compliance when being announced (currInf) while else being insignificant, both as expected. Similarly, a high audit rate in the previous round (*Lag high audit rate*) has a positive impact in the pastInf treatment, since the announcement of a high audit rate in the previous round is a signal that the audit rate might also be high in the current round. In the noInf treatment, there is no impact, as expected. However, in the currInf treatment, *Lag high audit rate* exhibits a negative coefficient which indicates that the large jump in tax compliance associated with an upward or downward jump in the audit rate is somewhat adjusted in the other direction one round later.

Regarding my primary variables of interest, I observe that the existence of a permanent tax amnesty has no effect (coefficient close to 0 and not significant) on compliance in the noInf treatment. This answers Open Question 1. So, at least in this experiment, there is no evidence for a unidirectional impact of a permanent tax amnesty on social norms.[30] In the currInf treatment, a permanent tax amnesty has a statistically significantly negative effect. On average, the compliance rate decreases under a permanent tax amnesty by about 5 percentage points (or even more when just exploring the between subjects dimension i.e. the first 30 rounds as

[29]The reason is to make the magnitude and significance of the effect of the permanent tax amnesty in the currInf treatment more easily visible (which is the sum of two coefficients in Spec.1).

[30]This might be due to the fact that either there is no such effect or there are several effects which go in different directions as discussed in Section 3.3.

Table 3.2: Summary statistics

Variable	Definition	Mean	Standard deviation
Compliance rate	Declared income over true income	0.6765	0.4209
Full compliance	Dummy variable equal to 1 if *Compliance rate* ≥ 1	0.5271	0.4993
Voluntary disclosure	Dummy variable equal to 1 for subjects who decided for a voluntary disclosure in the current round	0.0325	0.1773
Income	Income at the beginning of the round, ranging from 60 to 100	80.0806	14.1154
High audit rate	Dummy variable equal to 1 if the audit rate is at the high level in the current round	0.3013	0.4588
Lag high audit rate	Dummy variable equal to 1 if the audit rate was at the high level in the previous round	0.3006	0.4585
Amnesty	Dummy variable equal to 1 for rounds during the permanent tax amnesty	0.5000	0.5000
Amnesty first half	Dummy variable equal to 1 if the permanent tax amnesty takes place in the first half of the experiment	0.5000	0.5000
Age	Age of the subject	22.1083	4.5073
Male	Dummy variable equal to 1 if the subject is male	0.4583	0.4983
Prepared own tax return	Dummy variable equal to 1 for subjects who prepared already their own tax return in real life	0.2833	0.4506
Risk aversion	Measure of risk aversion, ranging from 0 to 10 and collected following Holt and Laury (2002)	5.7917	1.7838
Lag vol. disclosure	Dummy variable equal to 1 for subjects who decided for a voluntary disclosure in the previous round	0.0326	0.1777
Lag audit	Dummy variable equal to 1 for subjects who have been audited in the previous round	0.0888	0.2845
Tax debt	Evaded taxes of the previous three rounds	15.6065	19.6490
Round	Round of the experiment (1-60)	30.5000	17.3193
Amnesty round	Round of the permanent tax amnesty	15.5000	8.6560
currInf	Dummy variable equal to 1 for subjects in the currInf treatment	0.3333	0.4714
pastInf	Dummy variable equal to 1 for subjects in the pastInf treatment	0.3333	0.4714
noInf	Dummy variable equal to 1 for subjects in the noInf treatment	0.3333	0.4714
For all variables, N=7200 (120 subjects * 60 rounds)			

Table 3.3: Estimation results for *Compliance rate*

	Spec. 1 GLS	Spec. 2 OLS-FE	Spec. 3 GLS	Spec. 4 GLS 1-30
Income	-0.0026***	-0.0026***	-0.0026***	-0.0023***
	(0.0005)	(0.0005)	(0.0005)	(0.0006)
High audit rate	-0.0160	-0.0160	-0.0160	-0.0287*
	(0.0120)	(0.0120)	(0.0120)	(0.0170)
High audit rate * currInf	0.4149***	0.4146***	0.4149***	0.4333***
	(0.0429)	(0.0430)	(0.0429)	(0.0463)
Lag high audit rate	-0.0240	-0.0241	-0.0240	-0.0182
	(0.0194)	(0.0194)	(0.0194)	(0.0309)
Lag high audit rate * pastInf	0.2382***	0.2385***	0.2382***	0.1725***
	(0.0470)	(0.0470)	(0.0470)	(0.0572)
Lag high audit rate * currInf	-0.0727***	-0.0729***	-0.0727***	-0.0728*
	(0.0275)	(0.0275)	(0.0275)	(0.0421)
Amnesty	0.0132	0.0133	-0.0498**	-0.1583**
	(0.0183)	(0.0183)	(0.0249)	(0.0737)
Amnesty * currInf	-0.0630**	-0.0632**		
	(0.0309)	(0.0309)		
Amnesty * pastInf	-0.0470	-0.0469	0.0160	0.1143
	(0.0309)	(0.0308)	(0.0352)	(0.1035)
Amnesty * noInf			0.0630**	0.1007
			(0.0309)	(0.0916)
Amnesty first half	-0.0761*		-0.0761*	
	(0.0417)		(0.0417)	
Age	0.0070		0.0070	0.0072
	(0.0052)		(0.0052)	(0.0050)
Male	-0.0874**		-0.0874**	-0.0821**
	(0.0440)		(0.0440)	(0.0405)
Prepared own tax return	-0.0157		-0.0157	-0.0068
	(0.0537)		(0.0537)	(0.0523)
Risk aversion	0.0354***		0.0354***	0.0239**
	(0.0113)		(0.0113)	(0.0110)
Lag vol. disclosure	-0.1576**	-0.1599**	-0.1576**	-0.2252**
	(0.0792)	(0.0792)	(0.0792)	(0.1102)
Lag vol. disclosure * currInf	0.1664*	0.1695*	0.1664*	0.2087
	(0.0963)	(0.0961)	(0.0963)	(0.1381)
Lag vol. disclosure * pastInf	0.1665	0.1650	0.1665	0.0555
	(0.1024)	(0.1032)	(0.1024)	(0.1794)
Lag audit	-0.1379***	-0.1387***	-0.1379***	-0.0839*
	(0.0452)	(0.0451)	(0.0452)	(0.0460)
Lag audit * currInf	0.0925*	0.0931*	0.0925*	0.0508
	(0.0550)	(0.0549)	(0.0550)	(0.0608)
Lag audit * pastInf	0.0258	0.0264	0.0258	0.0149
	(0.0548)	(0.0547)	(0.0548)	(0.0545)
Round	-0.0006	-0.0006	-0.0006	-0.0045**
	(0.0006)	(0.0006)	(0.0006)	(0.0019)
Round * currInf	0.0008	0.0008	0.0008	0.0018
	(0.0009)	(0.0009)	(0.0009)	(0.0024)
Round * pastInf	-0.0021**	-0.0021**	-0.0021**	0.0012
	(0.0010)	(0.0010)	(0.0010)	(0.0026)
currInf	-0.3474***		-0.3474***	-0.3435***
	(0.0551)		(0.0551)	(0.0595)
pastInf	-0.0717		-0.0717	-0.1234*
	(0.0564)		(0.0564)	(0.0682)
Constant	0.7499***	0.8886***	0.7499***	0.8395***
	(0.1333)	(0.0393)	(0.1333)	(0.1232)
N	7080	7080	7080	3480
Subjects	120	120	120	120
R^2 overall (FE: within)	0.1889	0.1355	0.1889	0.1844

The dependent variable is the compliance rate (declared income over true income) per subject and round. Cluster-robust standard errors (subject level) are provided in parentheses. ***,** and * indicate significance at the 1%, 5% and 10% level.

in Spec. 4[31]). In relation to the mean compliance rate in the currInf treatment of 0.545, this corresponds to a decrease in compliance of about 9%. So, there is strong evidence in favor of Hypothesis 1. Regarding the pastInf treatment, we see that the effect of the permanent tax amnesty is neither statistically different from the effect in the currInf treatment (see Spec.3) nor from the effect in the noInf treatment (see Spec.1). In terms of its magnitude, it lies in between the two other treatments and is negative (-0.0338) but not significantly different from zero.[32] This finding is in line with Hypothesis 2.

The coefficients and standard errors obtained from the GLS random effects estimation (Spec. 1) are almost identical to the ones obtained from the fixed effects estimation reported as Specification 2. Moreover, a Hausman test suggests that using a random effects estimator is appropriate. Concerning the individual characteristics, I find that high risk aversion increases tax compliance, as expected. Male subjects evade more taxes than female subjects, which is in line with previous studies (e.g. Alm et al. (2009)). Age and the preparation of own tax returns in real life do not exhibit statistically significant effects on tax compliance. I also conduct separate estimations for each treatment based on Specification 1 of Table 3.3. The results are qualitatively similar to Specification 1 and are provided in Appendix B.1 (Table B.6).

As already mentioned, due to the high proportions of 0 and 1 in tax compliance experiments, alternative estimation techniques might be of interest. For example, some authors also use a Tobit estimator (e.g. Alm et al. (2010)), treating the data on one or both sides as censored. However, it is questionable whether the strong assumptions of the Tobit model (e.g. normal distribution of the error terms) are fulfilled. Concerning my dataset, the observations might only be left-censored, i.e. censored at 0 (since subjects cannot declare negative income) but not right-censored, i.e. not censored at 1 (since subjects can declare more than their true income). How-

[31]Specification 4 is identical to Specification 3 but just includes the first 30 rounds of the experiment, i.e. explores just the between subjects dimension. However, due to very small sample sizes per treatment in this between subject analysis (6 treatments with 20 subjects each), this and all similar estimations (Spec. 4 in Table B.1 and Spec. 3 in Table B.2 to B.5) should be interpreted with care and conclusions had better be drawn from the estimations which employ the full data, i.e. the within and between subjects dimension as in Specification 1-3.

[32]I.e. in a specification in which Amnesty*pastInf is the dummy which is left out (not reported), the coefficient of *Amnesty* is not significantly different from zero.

ever, a Tobit model specified to allow for censoring at 0 seems unlikely to have normally distributed error terms (due to the spike at 1). Nevertheless, for the sake of completeness, I also conduct some Tobit estimations. The results are qualitatively similar to the ones of the benchmark estimations and are provided in Appendix B.1 (Table B.1).

Moreover, some authors (e.g. Gerxhani and Schram (2006)) do not use the compliance rate but the binary variable whether people fully comply with taxes or not as the dependent variable and estimate the effects of the variables of interest on the probability that people evade (at least some) taxes. I also do so by using probit, logit and linear probability models.[33] Since the results are qualitatively similar to each other and to the benchmark estimations, I provide them in Appendix B.1 (Table B.2 to B.4).

In addition to these commonly used approaches, I use an additional estimation technique to check for robustness. Since *Compliance rate* is a fraction, one could also think of using estimation methods for fractional data. However, a fractional logit regression (Wooldridge (2002), p.661 et seqq.) cannot handle 0 and 1 and is therefore inappropriate. Thus, following Baum (2008) it is better to use an adequate generalized linear model (e.g. glm in stata specified with the logit link function and a binomial distribution as argued by Baum (2008)). Again, the results are qualitatively similar to the benchmark estimations and are provided in Appendix B.1 (Table B.5).

3.6.2 Voluntary Disclosures

Next, I want to evaluate Hypotheses 3 and 4. Table 3.4 shows descriptive evidence. In the currInf treatment, I observe 65 voluntary disclosures among 40 subjects which is clearly above zero. Moreover, 46 out of 65 voluntary disclosures take place directly after an upward jump which is in line with Hypothesis 3.[34] Moreover, in the pastInf treatment, I observe 36 voluntary disclosures, among which 21 occurred if there was

[33] These estimations use the same independent variables as the benchmark estimations of Table 3.3 but the dependent variable is no longer *Compliance rate* but *Full compliance*, which is 0 for *Compliance rate* < 1 and 1 for *Compliance rate* ≥ 1.

[34] Among the remaining 19 voluntary disclosures, 11 take place in rounds with a high audit rate while 8 occur in rounds with a low audit rate.

Table 3.4: Voluntary disclosures by treatment

Treatment	Audit rate properties (amnesty rounds)	Voluntary disclosures
currInf	Mean audit rate = 0.101 Number of upward jumps = 143	Total = 65 At upward jump = 46 During high audit rate = 57 During low audit rate = 8 (= time-inconsistent)
pastInf	Mean audit rate = 0.096 Number of upward jumps = 131	Total = 36 At upward jump (t-1) = 21 During high audit rate (t-1) = 27 During low audit rate (t-1)= 9 (= time-inconsistent)
noInf	Mean audit rate = 0.084 Number of upward jumps = 119	Total = 45 (= time-inconsistent)

an upward jump in the previous round which is in line with Hypothesis 4.[35] However, due to the differences in the audit rate process (due to its randomness), one should control for these when comparing treatments and drawing conclusions. Therefore, a regression analysis is required in order to control for these differences. The results of logit, probit and linear probability estimations are presented in Table 3.5, where the dependent variable is 1 or 0, i.e. whether or not a subject decides for a voluntary disclosure in a given round. The coefficients indicate that in the currInf treatment, the probability of a voluntary disclosure increases by about 20 percentage points (according to Spec. 3)[36] when the audit rate jumps to the high level and slightly decreases afterwards. Regarding the pastInf treatment, the coefficients indicate that the probability of a voluntary disclosure increases by about 5 percentage points (according to Spec. 3 from Table 3.5)[37] after an upward jump in the audit rate in the previous round. These results provide evidence for the second parts of Hypotheses 3 and 4. Moreover, Table 3.5 indicates that the income level has no significant effect on the disclosure decision but that the amount of evaded taxes (*Tax debt*) is positively correlated with the likelihood of a diclosure.

Table 3.6 provides additional evidence in favor of the first part of Hypothesis 4, i.e. that there are fewer voluntary disclosures in the pastInf treatment than in the

[35] Among the remaining 15 voluntary disclosures, 6 take place in rounds which follow a round with a high audit rate while 9 occur in rounds which follow a round with a low audit rate.

[36] 0.0146+0.1836=0.1982

[37] -0.0207+0.0752=0.0545

Table 3.5: Estimation results for *Voluntary disclosure*

	Spec. 1 Logit	Spec. 2 Probit	Spec. 3 Linear probability
Income	-0.0097	-0.0043	-0.0005
	(0.0065)	(0.0034)	(0.0003)
Tax debt	0.0358***	0.0178***	0.0015***
	(0.0075)	(0.0037)	(0.0004)
High audit rate	0.3638	0.1737	0.0146
	(0.2792)	(0.1387)	(0.0124)
High audit rate * currInf	3.5864***	1.8085***	0.1836***
	(0.8245)	(0.3784)	(0.0399)
Lag high audit rate	-0.3806	-0.2377	-0.0207
	(0.3643)	(0.1860)	(0.0177)
Lag high audit rate * pastInf	2.0751***	1.0532***	0.0752***
	(0.6460)	(0.3023)	(0.0250)
Lag high audit rate * currInf	-1.1585*	-0.6333*	-0.0719**
	(0.6364)	(0.3353)	(0.0323)
Amnesty round	-0.0345**	-0.0211***	-0.0021***
	(0.0145)	(0.0076)	(0.0007)
Amnesty round * currInf	0.0260	0.0188	0.0022
	(0.0350)	(0.0177)	(0.0014)
Amnesty round * pastInf	0.0232	0.0121	0.0016*
	(0.0231)	(0.0117)	(0.0009)
Amnesty first half	-0.0956	-0.0486	0.0124
	(0.4390)	(0.2190)	(0.0203)
Age	-0.0154	-0.0055	0.0005
	(0.0689)	(0.0346)	(0.0027)
Male	0.0496	-0.0113	-0.0111
	(0.4581)	(0.2261)	(0.0220)
Prepared own tax return	-0.2849	-0.1791	-0.0216
	(0.4773)	(0.2371)	(0.0157)
Risk aversion	-0.0939	-0.0491	-0.0025
	(0.1104)	(0.0551)	(0.0044)
currInf	-2.5174**	-1.3010***	-0.1006***
	(1.0508)	(0.4849)	(0.0360)
pastInf	-1.9281**	-0.9548**	-0.0764**
	(0.8363)	(0.3923)	(0.0361)
Constant	-1.9931	-1.1010	0.1374**
	(1.6501)	(0.8339)	(0.0673)
N	3540	3540	3540
Subjects	120	120	120
R^2 overall			0.0492
Log-Likelihood	-590.4554	-591.9021	

The dependent variable is Voluntary disclosure (0 or 1) per subject and round. Cluster-robust standard errors (subject level) are provided in parentheses. ***,** and * indicate significance at the 1%, 5% and 10% level.

Table 3.6: Estimation results for *Number of voluntary disclosures*

	Spec. 1 Poisson	Spec. 2 Poisson	Spec. 3 Poisson
currInf	0.5423*	0.5279*	0.4994*
	(0.2963)	(0.2948)	(0.2916)
Mean auditrate	11.9649***		
	(4.2843)		
Log mean auditrate		1.2841***	
		(0.4512)	
Log jumps			1.0575***
			(0.4043)
Constant	-1.3174***	2.8820***	-1.3649**
	(0.4777)	(1.0925)	(0.5419)
N	80	80	79
Subjects	80	80	79
pseudo R^2	0.0666	0.0718	0.0784
Log-Likelihood	-128.676	-127.9486	-125.8682

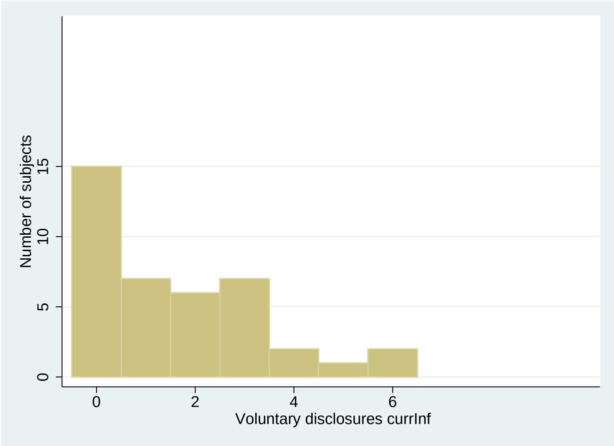
The dependent variable are the number of voluntary disclosures per subject. The sample comprises the treatments currInf and pastInf. Robust standard errors are provided in parentheses. ***,** and * indicate significance at the 1%, 5% and 10% level.

currInf treatment, while controlling for differences in the audit rate process.[38] The dependent variable is the number of voluntary disclosures by subject. In order to test the difference between pastInf and currInf appropriately, only these two treatments are included in the regressions. The interpretation of the coefficients is that when moving from the pastInf to the currInf treatment, the number of voluntary disclosures increases by 65 to 72 percent, ceteris paribus.[39]

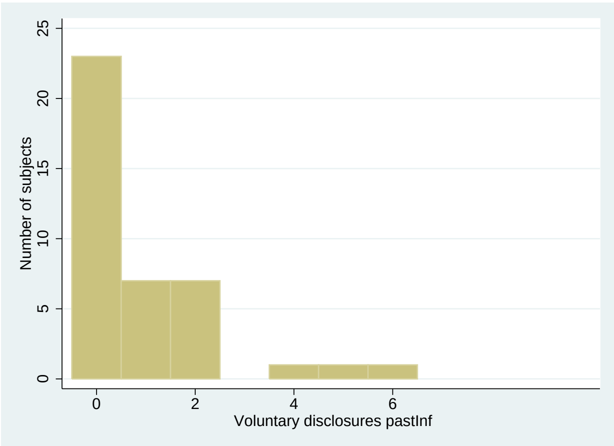
It remains to comment on Hypothesis 5, which states that in the noInf treatment, there should be no voluntary disclosures. Surprisingly, this is clearly not the case since 45 voluntary disclosures can be observed, as Table 3.4 shows. Figure 3.4 shows how the numbers of voluntary disclosures are distributed among the subjects. As shown in Figure 3.4 c), 16 out of 40 subjects in the noInf treatment decide at least once for a voluntary disclosure, including two outliers who exhibit 8 and 9 voluntary disclosures. This is surprising since people do not get any new information in any round which might trigger the voluntary disclosure. Moreover, if the decision for a future voluntary disclosure was made not in the current round but one or several rounds in advance, the subjects should not evade taxes in the meantime because

[38]Due to the small N in these estimations, I include as few regressors as possible. However, estimations including all usual controls lead to similar results and are provided in Table B.7 in Appendix B.1.

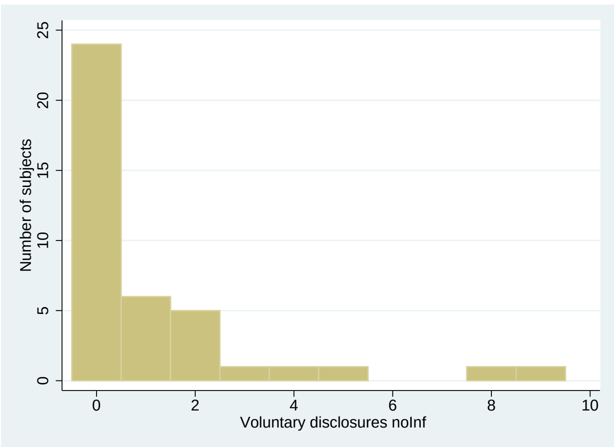
[39]$exp(0.5423) = 1.7200;\ exp(0.4994) = 1.6477$



(a) Number of voluntary disclosures per subject (currInf treatment)



(b) Number of voluntary disclosures per subject (pastInf treatment)



(c) Number of voluntary disclosures per subject (noInf treatment)

Figure 3.4: Voluntary disclosures by treatment

this means unnecessarily taking a risk. However, every voluntary disclosure follows previous tax evasion.[40] So, since I have no time-consistent explanation, I call these voluntary disclosures time-inconsistent.

One might think about whether subjects playing mixed strategies might provide an alternative explanation instead of time inconsistency. However, a mixed strategy as an explanation requires indifference between a voluntary disclosure and the alternatives, which are continuing with tax evasion or being honest from now on. But if I know that in the next round my expected future utility equals the utility from a voluntary disclosure (due to indifference), I will not evade taxes today because I otherwise could increase my expected utility by being honest (since the payoff from being honest is the same as the payoff from successfully evading taxes and choosing the voluntary disclosure one round later, however there is no risk of getting caught if being honest). Therefore, a mixed strategy cannot be an appropriate explanation.

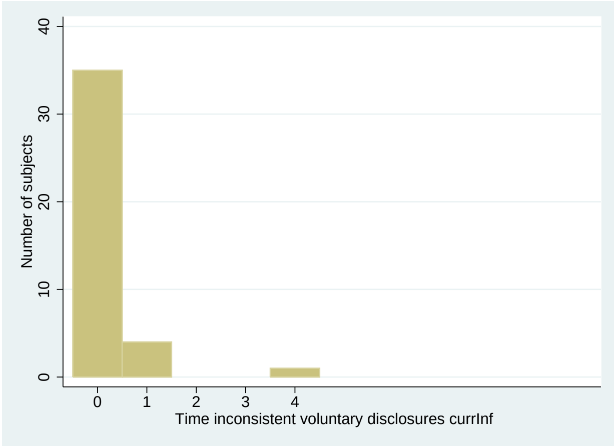
Another idea would be that the voluntary disclosures are driven by the shocks in the income. However, Table B.8 in Appendix B.1 shows the voluntary disclosures by income in the noInf treatment without suggesting any relationship.

So, these voluntary disclosures seem indeed to be time-inconsistent. Similar arguments can be applied to the voluntary disclosures during rounds with low audit rate in the currInf treatment (which amount to 8) and during rounds with past low audit rates in the pastInf treatment (which amount to 9). Figure 3.5 shows how the numbers of time-inconsistent voluntary disclosures in the currInf and pastInf treatment are distributed among the subjects.

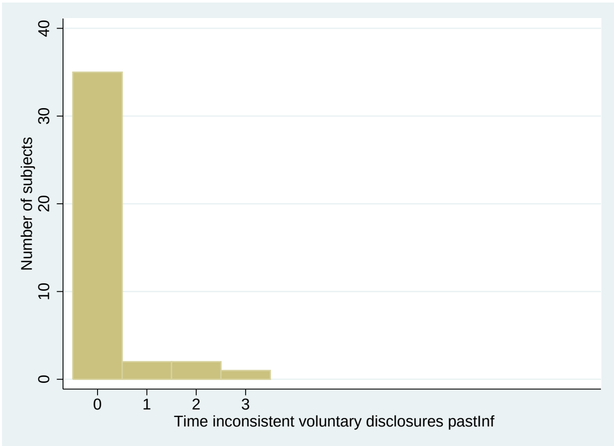
In the literature, there are two common explanations for time-inconsistent behavior. The first explanation is hyperbolic discounting, i.e. using different discount rates for the near and more distant future (e.g. Laibson (1997), Rabin and O'Donoghue (1999)). However, this cannot be the explanation in my case since there is only one payment at the end and therefore nothing to discount in the experiment.

The second explanation is formulated by Loewenstein et al. (2003) and is based on the idea of a projection bias. In their model, people's tastes change over time and so time-inconsistent behavior arises as a result of misprediction of future utilities. In

[40] Note that I count only 'real' voluntary disclosures, i.e. voluntary disclosures which include a repayment of evaded taxes.



(a) Number of time-inconsistent voluntary disclosures per subject (currInf treatment)



(b) Number of time-inconsistent voluntary disclosures per subject (pastInf treatment)

Figure 3.5: Time-inconsistent voluntary disclosures (currInf and pastInf)

my eyes, this cannot be an explanation for my findings for two reasons. First, utility functions might change over a human life cycle but it does not seem very likely that they change within seconds as the behavior in the experiment does. Second, in the experiment, most subjects who exhibit time-inconsistent voluntary disclosures do so more than once (14 out of 26), i.e. many subjects go back and forth between evading taxes and deciding for a voluntary disclosure. In my eyes, it is quite unrealistic that utility functions change so often. Therefore, it seems unlikely that the argument of Loewenstein et al. (2003) explains my results.

In conclusion, both common explanations for time inconsistency do not fit. Since the comparison of my treatments suggest that time-inconsistent behavior is strong if information is low and therefore uncertainty is high, my hunch is that the explanation for my results should be related to uncertainty.[41] As, to my knowledge, there is no theory about the connection between uncertainty and time inconsistency, this remains a topic for future research.[42]

3.6.3 Total Revenue

Finally, I want to address Open Question 2, i.e. to investigate the effect of the permanent tax amnesty on total government revenue. Table 3.7 shows some evidence. The dependent variable is the revenue share, i.e. the sum of total taxes, penalties and amnesty payments over total income, calculated separately for every subject and each half of the experiment. Table 3.7 shows treatment specific estimations which regress the dependent variable on the mean audit rate per subject and half, the amnesty dummy (which is 1 for the half with the permanent tax amnesty and 0 else) and a constant.[43,44]

As can be seen, I find no significant effect of the tax amnesty on total government revenue in any of the treatments. For the pastInf and noInf treatment, this is not surprising since there was no significant impact on the compliance rate. However, in the currInf treatment, there was a negative effect on the compliance rate. Therefore, the insignificant and even slightly positive coefficients in Specification 1 and 2 of Table 3.7 are the result of two countervailing effects. This is, the negative effect due to the fall in the compliance rate is compensated by a positive effect which arises from the high number of voluntary disclosures and the associated amnesty payments through which the government recaptures both the additional tax evasion due to the

[41]One potential explanation could be that the uncertainty of getting caught might create stress which increases over time while evading taxes and finally leads to a voluntary disclosure. This might not be correctly anticipated by the subjects. However, the question remains why several subjects do not seem to learn from their experience but go back and forth between evading taxes and deciding for a voluntary disclosure.

[42]There is one study by Grenadier and Wang (2007) which incorporates uncertainty and time inconsistency in the context of hyperbolic discounting. However, as argued, this cannot be an explanation for my results.

[43]Table B.9 in Appendix B.1 provides estimations analogously to Table 3.7 but which exclude round 30 to 33 for the computation of the variables. The reasons are, on the one hand, that in the treatments having the amnesty take place in the first half, the abolition is announced after round 29, so round 30 might be special. On the other hand, in round 31 to 33, amnesty payments and payments in case of an audit are influenced by actions of the first half (since the 3 previous rounds are relevant), so I exclude them to have the two halves clearly separated. However, the results do not change.

[44]Due to the small N in the estimations, I include as few regressors as possible. To check robustness when controlling for subject characteristics, I also show fixed effects estimates (FE).

Table 3.7: Estimation results for *Revenue share*

	Spec. 1 currInf (GLS)	Spec. 2 currInf (OLS-FE)	Spec. 3 pastInf (GLS)	Spec. 4 pastInf (OLS-FE)	Spec. 5 noInf (GLS)	Spec. 6 noInf (OLS-FE)
Mean auditrate	0.7781***	0.5754	0.5194***	0.5629***	0.2729*	0.1596
	(0.2774)	(0.3430)	(0.1551)	(0.1988)	(0.1576)	(0.1644)
Amnesty	0.0118	0.0147	-0.0020	-0.0020	0.0076	0.0066
	(0.0102)	(0.0103)	(0.0099)	(0.0099)	(0.0061)	(0.0060)
Constant	0.1235***	0.1412***	0.1743***	0.1702***	0.2038***	0.2143***
	(0.0281)	(0.0312)	(0.0134)	(0.0161)	(0.0168)	(0.0153)
N	80	80	80	80	80	80
Subjects	40	40	40	40	40	40
R^2 overall (FE: within)	0.1971	0.2085	0.0936	0.1493	0.0670	0.0440

The dependent variable is the revenue share (total taxes, penalties and amnesty payments over total income) per subject, separately calculated for rounds with and without permanent tax amnesty. Cluster-robust standard errors (subject level) are provided in parentheses. ***,** and * indicate significance at the 1%, 5% and 10% level.

permanent tax amnesty and the tax evasion which also occurs in the absence of a permanent tax amnesty. These two effects of a permanent tax amnesty are formally shown by Andreoni (1991) in a theoretical model. In his model, the total effect can be positive or negative, depending on the parameters. Since, in my experiment, the total effect is also very likely to depend on the parameters (e.g. the frequency of jumps probably plays an important role), my findings regarding Open Question 2 should not be generalized.

3.7 Conclusion

Does a permanent tax amnesty reduce tax compliance? And when do people decide for a voluntary disclosure? In my experiment, I investigate these questions using three different treatments. All participants earn and declare income in an environment with a fluctuating audit rate. In one treatment, the current audit rate is announced, in a second treatment, the participants are informed about the audit rate of the previous round while in a third treatment, the audit rates are completely unknown to the participants. Within these treatments, a permanent tax amnesty is introduced which allows for voluntary disclosures to repay evaded taxes in order to go unpunished in case of future audits.

My main findings are the following: In the treatment in which the current audit rate is announced, the permanent tax amnesty lowers tax compliance by around 9%. This suggests that if the informational setting allows using a permanent tax amnesty as an 'insurance' against an increase in the detection probability, a permanent tax amnesty lowers tax compliance. Otherwise (i.e. in the treatments with past or no information regarding the audit rate), I find no statistically significant effect on tax compliance. As expected, most voluntary disclosures take place after a jump in the audit rate becomes public. However, surprisingly, there is a large number of time-inconsistent voluntary disclosures in the treatment without information about the audit rate which cannot be explained by common explanations for time inconsistency.

One limitation of the experiment is that in reality, voluntary disclosures often take place in the context of tax evasion regarding capital income, which often comes along with an accumulated stock of capital that is hidden in a foreign country. To keep the experiment manageable, the accumulation of a capital stock and the decision to hide it in a foreign country is not included in this experiment. Instead, in every round the income is i.i.d. drawn and the subjects have to decide in every round how much they want to hide, i.e. to evade.[45]

There are several topics for future research. First, since my study is the only experiment so far which investigates a permanent tax amnesty, further studies should replicate my experiment and should moreover check whether my findings are robust to changes in the parameters and the experimental design. Second, I observe patterns of time-inconsistent behavior which I cannot explain so far. Therefore, the question of such an explanation remains open.

[45] Although it would be interesting, to my knowledge, there is no tax compliance experiment in the literature which incorporates the accumulation of a foreign capital stock in the experiment, probably due to its complexity.

Chapter 4

Tax Complexity and Foreign Direct Investment

4.1 Introduction

Foreign Direct Investment (FDI) is determined by numerous factors. In addition to economic factors such as market size, factor endowments or exchange rates, one could also argue that institutional aspects such as political stability, property rights or differences in tax systems matter. This chapter focuses on the latter aspect by paying particular attention to one specific characteristic of a tax system: Its complexity.

The complexity of a tax system, to be called tax complexity in the following, "is usually associated with the numbers of tax rates, tax bases and special provisions it includes" (p. 123, Warskett et al. (1998)). There are several potential reasons for the existence of tax complexity regarding corporate taxation. On the one hand, one could argue that it has no purpose and just constitutes a sort of transaction cost. Under this perspective, tax complexity differs across countries since the governments exhibit different technologies to collect taxes (or differ in the investment in the development of their technology). On the other hand, tax complexity could have a purpose in allowing for discrimination between firms or industries, which may have several reasons.[1] Lastly, one could argue that tax complexity is used as a tool to

[1] First, discrimination might be used to implement a fair tax system driven by the citizens'

blur the true effective tax rate.[2]

However, in this chapter we do not analyze the different sources of tax complexity but instead focus on its effect. In particular, tax complexity is costly since it creates a transaction cost for firms, also called compliance cost. The awareness that taxation creates compliance costs is quite old. Already Adam Smith observed that "by subjecting the people to the frequent visits and the odious examination of the tax-gatherers, it may expose them to much unnecessary trouble, vexation, and oppression; and though vexation is not, strictly speaking, expence, it is certainly equivalent to the expence at which every man would be willing to redeem himself from it"(p. 500, Smith (1776)).[3] Nowadays, compliance costs are primarily not anymore driven by "frequent visits and the odious examination of the tax-gatherers" but by all actions to fulfill the requirements which are necessary to remain in compliance (such as studying the tax law, "calculating tax liabilities, completing requisite forms, maintaining records and providing documentation" (p. 343, Edmiston et al. (2003))).

There is anecdotal evidence that the compliance cost due to tax complexity is not negligible. For instance, in 2010, the tax return of General Electric in the US amounted to 57000 pages (Weekly Standard, 2011). There is also literature that estimates the compliance cost of taxation and relates it to the total tax revenue. For example, Slemrod and Blumenthal (1996) investigate corporations in the US and find that the compliance costs for the US federal and state corporate income

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preferences for fairness. Second, discrimination might be motivated by the desire to achieve a system of optimal taxation (or considered to be optimal by the government) that requires a different treatment of firms with respect to size, mobility, labor intensity, multinational structure or R&D activities. Different treatments, however, need some sorting, which can be done by exemptions and special regulations in the tax law, which in turn increase its complexity. (A similar argument is developed by Davies (2013) for the case of subsidies. He shows in a theoretical model that if the benefits of targeting subsidies outweigh the associated cost of bureaucracy, bureaucracy will be used as a sorting mechanism.) Third, discrimination in the tax system might be driven by political economy considerations. Analogous to political economy models that describe the political outcome in other policy fields as the result of a lobbying game between governments and industries (e.g. as in the *Protection for Sale* model in Grossman and Helpman (1994) for trade policy), one could also think of the structure of a tax system as being governed by lobbying activities of firms or industries.

[2] This argument requires the assumption that tax complexity is not due to special provisions and tax reliefs that reduce the taxation for some firms or industries. Instead, it might be caused by hidden additional taxes in order to create some kind of illusion by blurring the effective level of taxation that is higher than the corporate tax rate.

[3] Moreover, Adam Smith was already aware of further inefficiencies which come along with taxation such as distortions or administrative costs for the state. His general advice is: "Every tax ought to be so contrived as both to take out and to keep out of the pockets of the people as little as possible, over and above what it brings into the public treasury of the state."(p. 499, Smith (1776))

tax come to more than 3 percent of the tax revenues. Evans (2003) provides an detailed overview of studies which measure compliance costs and finds that such estimates typically range from 2% to 10% of tax revenue.[4] The National Taxpayers Union (NTU) even estimates that in 2009 the compliance costs of US firms sum up to 159.4 billion US Dollar which corresponds to 54 percent of corporate income tax revenue (National Review, 2010).

These numbers strongly indicate that tax complexity is indeed an important issue. The existence of high compliance costs suggests that tax complexity suppresses economic activity.[5] However, on the firm or industry level this is not that clear. It might foster the activities of those firms or industries privileged by special regulations that cause the complexity. However, since the increase of tax complexity due to privileges places a sort of externality on all other firms and industries, it appears likely that the negative effect is dominant.

It might also be the case that the magnitude of the effect of tax complexity depends on the level of the corporate income tax rate. Dividing the effect of tax complexity for the firms into a negative effect (compliance cost) and a positive effect that lies in the possibility of tax optimization,[6] one could argue that the latter effect becomes more important if the statutory tax rate increases, resulting in the negative effect of tax complexity becoming weaker if taxation is high.

The question whether tax complexity indeed suppresses economic activity and, if so, to what extent, is highly relevant for policy making. If it is the case that a complex tax system suppresses economic activity in terms of inward FDI,[7] simplifying the

[4] Moreover he finds that in contrast to compliance costs, the administrative costs for the state are typically estimated to lie below 1% of tax revenue.

[5] Apart from the compliance cost, there is an additional issue related to why tax complexity might suppress investment, namely an informational problem. High tax complexity might lead to incomplete information in terms of a misperception of the effective level of taxation (or uncertainty about it) which might reduce investments.

[6] For instance, General Electric paid no taxes after having filed the 57,000-page federal tax return despite $14 billions in profits (Weekly Standard, 2011).

[7] Existing economic models can be used to argue that high compliance costs will reduce FDI. For example, treating the compliance cost due to tax complexity partly as a fixed cost allows us to think in the spirit of heterogeneous firms models. In such models like the one of Helpman et al. (2004), firms face fixed costs when they want to invest in a foreign country. In a setting where firms differ in their productivities, Helpman et al. (2004) show that there is a productivity cutoff such that only firms with a productivity above this level invest abroad while firms with a productivity below this level do not. Increasing fixed costs of investing in a specific foreign country lead to an increase of the productivity cutoff beyond that firms start to invest abroad and therefore result in less FDI-projects in that country. Treating tax complexity partly as a fixed cost the argument is straightforward.

tax system will be a source for stimulating economic activity without decreasing the tax revenue. In other words, if firms take into account their total costs of taxation consisting of the tax that is actually paid plus the compliance cost that is increasing in the complexity of a tax system, simplifying the tax system will be an alternative measure to reducing tax rates in order to increase a country's international competitiveness. Moreover, viewing tax complexity as a property of the government's technology to generate tax revenue, it is desirable for governments to know the benefits of reducing tax complexity to know whether and how much it is worth investing in technology improvement.

It is obvious that the effect of tax complexity is not restricted to FDI but affects an economy as a whole. However, it is reasonable to analyze its influence on economic activity by using FDI data since, if there is a suppressing effect at all, one should see it in FDI data more strongly. This is because these investment decisions are more or less subject to a worldwide choice set whereas big parts of the domestic economy are not, as many firms are immobile.

We use the Microdatabase Direct Investment (MiDi) of Deutsche Bundesbank and analyze the location choice of 4474 new German FDI projects in OECD countries from 2005 to 2009. In order to measure tax complexity, we use the Doing Business data published by the World Bank. The topic Paying Taxes of this database includes variables which have been constructed by defining a fictive, standardized firm for which tax experts calculated taxes and answered some survey questions for a large set of countries. We use the variable which captures the time it takes to comply with taxes, i.e. to prepare, file and pay taxes in the respective country, as a measure for tax complexity.

The contribution of this chapter to the existing literature is twofold. First, we evaluate the impact of tax complexity on FDI using firm-level data to analyze the issue on the economic level where the decision process regarding FDI actually takes place. This allows us to test a wide range of firm-level hypotheses. Second, we analyze the effects of tax complexity on FDI employing a panel dataset. This allows us to estimate the effect of within-country changes in tax complexity on FDI. This is more appropriate than purely cross sectional studies for evaluating the potential gains from reforms that lead to a cut-back of tax complexity.

Our main findings are the following: First, our estimates suggest that a higher level of tax complexity significantly decreases the probability to locate an FDI project in that country. Second, we find a positive coefficient of the interaction term of the corporate tax rate and tax complexity. This indicates that the negative effect of tax complexity is weaker the higher the corporate tax rate is. This finding is in line with the argument that there might also be a positive effect of tax complexity that lies in the possibility of tax optimization which becomes more important if the tax rates are high.

The rest of the chapter is organized as follows: In the next section we discuss how this chapter is related to the existing literature. Section 4.3 presents the data. Section 4.4 explains the econometric specification, estimates the impact of tax complexity on the location choice of FDI projects and calculates country-specific elasticities. The last section concludes.

4.2 Relation to the Literature

There is a large branch of literature examining the potential determinants of FDI,[8] starting in the early 1960s.[9] Since then, empirical studies have focused on many different aspects that influence FDI, especially economic but also institutional and political factors. A large strand of literature examines the effect of taxation on FDI.[10] To get an overview regarding the magnitude of the effect the different studies find, it is good to look at De Mooij and Ederveen (2003). They analyze 25 studies comprising 371 elasticities of FDI with respect to corporate taxation and find a median tax-elasticity of FDI of -3.2. But their sample of 371 elasticities is highly dispersed, exhibiting a standard deviation of 9.0 and just 300 of the 371 elasticities having a negative sign.[11]

[8] Blonigen (2005) and Faeth (2009) provide comprehensive reviews.

[9] This early work has been done by Robinson (1961), Behrman (1962), Basi (1966) and Kolde (1968).

[10] Reviews of the literature on taxation and FDI can be found by Hines (1999) and Devereux and Griffith (2002).

[11] The standard deviation of their sample after excluding outliers (resulting in 351 elasticities) unfortunately is not given in this paper. However, De Mooij and Ederveen (2008) add 76 elasticities from six further studies to their previous sample excluding outliers, obtaining a total number of

A subpart of the literature on taxation and FDI focuses on the location choice of multinational firms and their affiliates. Among these studies, Devereux and Griffith (1998) investigate the effect of taxation on the decisions of US multinationals regarding the question whether to serve the European market and how, i.e. through export or FDI, in three European countries. Buettner and Ruf (2007) analyze the role of tax incentives with regard to German FDI, also using Deutsche Bundesbank data. Arulampalam et al. (2012) study the location of M&As and explore whether taxation has an impact on the decision in which country to acquire a target firm. Barrios et al. (2012) examine the impact of host and parent country taxation on the location choice of both foreign affiliates and parent firms, and Voget (2011) analyzes the relocation of headquarters of multinational firms in the context of corporate taxation.

Contrasting this comprehensive literature on the relation between tax rates and FDI, very little research has examined the effect of tax complexity on FDI. Edmiston et al. (2003) look at the effect of tax complexity and tax uncertainty on FDI for 25 transition countries in the former Soviet Union and Eastern Europe, finding a negative correlation of both with total FDI inflow. They use the Central and East European Tax Directory, an annual publication of the International Bureau of Fiscal Documentation (IBFD), to calculate their own tax complexity measures, which are the number of tax rates and number of lines that are used for describing the tax base therein. Since this publication was issued only from 1993-1998, Edmiston et al. (2003) restrict their analysis to this time period. Though having panel-like data, they focus on the effect of tax complexity across countries by just using a random effects model for their estimation.

A more recent study has been done by Djankov et al. (2010). They examine the effect of corporate taxation on investment and entrepreneurship and, among other things, they lightly touch on the relationship between tax complexity and FDI. They use data that has been generated by defining a notional business and asking PricewaterhouseCoopers (PwC) accountants and tax lawyers to fill out its tax return and to answer questions related to the procedure, corresponding to the fiscal year 2004. Parts of this data are published in the World Bank Doing Business database

427 elasticities that exhibit a standard deviation of 4.4 (a mean of -3.3 and a median of -2.9).

that we will use, too.[12] Besides other questions, they ask for the time to comply with taxes which can be interpreted as a proxy for the complexity of the tax system. Using this variable as a control in regressions of total FDI inflow (averaged from 2002-2004) on the corporate income tax rate and some additional controls in a cross section of 85 countries, they do not find any significant effect of tax complexity on FDI.

Lawless (2013) uses the World Bank Doing Business data and analyzes the effect of tax complexity on bilateral FDI flows from 16 OECD countries to 57 host countries. In this cross-sectional study (using FDI data from 2002), she distinguishes between the extensive and intensive margin, that is the probability of the existence and the magnitude of bilateral FDI flows, finding a significantly negative effect of tax complexity on FDI through the extensive but not through the intensive margin. In some regressions, she also includes the interaction term of tax complexity and the corporate income tax rate, however without finding a significant interaction effect.

As already mentioned, we contribute to this existing literature in two ways. First, we examine the effect of tax complexity on FDI using firm-level data. This is a useful investigation as this is the level where FDI decisions are actually made. So, a better understanding of how tax systems influence individual firms' decisions, especially the effect of tax complexity on the probability of investing in a specific country, can be gained.

Second, we analyze the effect of tax complexity on FDI employing not a cross section but a panel dataset. This allows us to examine the effect of tax complexity not only across countries – as previous work does – but also changes within countries. Examining the effect of tax complexity within countries is desirable since the motivation for estimating the effect of tax complexity on FDI is to provide some policy recommendation and to predict the potential effect of reforms that change tax complexity. To be able to address this point properly, it is necessary to evaluate existing changes in tax complexity within countries.

[12]For a more detailed description of the Doing Business data, see Section 4.3.

4.3 Data

In this study, we use a database governed by Deutsche Bundesbank that provides FDI data on firm level.[13] This database, the Microdatabase Direct Investment (MiDi), is the result of the German Außenwirtschaftsgesetz (AWG) and the Außenwirtschaftsverordnung (AWV) that force all German firms to report all foreign affiliates on annual basis if the affiliate's balance sheet total exceeds 3 million Euro and the German parent firm holds at least 10% of the shares or voting rights.[14] The MiDi entails some basic data (such as balance sheet total, annual turnover and number of employees) about the parent firm that is reporting and the foreign affiliate as well as quite detailed information about the latter one, like balance sheet data, economic sector, country, the share of equity and the share of voting rights hold by the German parent firm. Moreover, since 2005, for every foreign affiliate it has to be stated whether it is reported the first time and if so, whether it is a new investment project or just an overshooting of the reporting threshold (i.e. the foreign affiliate existed already in the previous year but this year is the first time that the reporting requirements are met).[15] We will use this information to filter out only new FDI projects. Moreover, we restrict our sample to investments with a participation rate of the German mother above or equal 50%.

The firm-level FDI data is collected by the Deutsche Bundesbank since 1976. The MiDi comprises all data after 1989, available as a panel for observations after 1996. However, the reporting requirements and the variables collected changed from time to time so that the data reported before 2005 is useless for our needs.[16] In the relevant time period (2005-2009) 4577 new investments (with German participation above or equal 50%) have been reported in OECD countries.[17] Table 4.1 lists the number of new investments by country. The highest portion of new investments took place in the US (17%) followed by UK (11%) and France (9%). Our estimation

[13] For detailed information about the database see Lipponer (2009) or Hügelschäffer et al. (2009).

[14] The MiDi comprises also data of FDI in Germany hold by foreign firms since there is a reporting duty as well. However this data will not be used in this study.

[15] For a complete listing of the requested information see the reporting forms for the firms (reporting form K3), available at `http://www.bundesbank.de/Redaktion/EN/Standardartikel/Service/Reporting_systems/reports_k3_and_k4.html?nn=6520`.

[16] I.e. the current reporting requirements are in force since 2002, but the variables that allow us to filter out new FDI projects are collected since 2005.

[17] Note that the data comprises both legally independent enterprises as well as branches and permanent establishments.

sample comprises 4474 investments in 27 countries.[18] These investments are hold by 1346 German parent firms.

We choose the Bundesbank database instead of other firm-level FDI databases for several reasons. First, as already mentioned, it allows to filter out new FDI projects. Second, it provides detailed information about both the FDI project (e.g. M&A vs. greenfield investment, the economic sector, etc.) and the German parent firm (e.g. the international firm structure) that we use in our analysis. Third, due to the reporting duty, the database is very comprehensive and of high quality.

The description of all variables used later on and their sources are reported in Table 4.2. Regarding the measures of tax complexity, we use the same data source as Djankov et al. (2010), i.e. the World Bank Doing Business data regarding the topic Paying Taxes. This data, annually published since 2006[19] has been constructed by defining a fictive, standardized business, called "TaxpayerCo". For this business, country specific balance sheets as well as profit and loss statements have been calculated (all financial data as a multiple of the country's income per capita). The financial statements have been handed to tax experts from a number of firms in each economy (mainly including PwC) who computed the taxes and mandatory contributions for the standardized business in their respective country and answered some survey questions. This results in the following variable that we use:

"Time" (results in our variable $Tax\ complex_j$) [20]

"*Time* is recorded in hours per year. The indicator measures the time taken to prepare, file and pay 3 major types of taxes and contributions: the corporate income tax, value added or sales tax and labor taxes, including payroll taxes and social contributions. Preparation time includes the time to collect all information necessary to compute the tax payable and to calculate the amount payable. If separate

[18] The difference to the number of 29 OECD countries at that time in addition to Germany is due to the fact that there are no investments in Iceland (so it drops out in a logit estimation) and missing data for Turkey. The number of 4474 investments is also due to this issue as well as to missing controls for investments in Luxembourg in 2005 and 2006.

[19] However, the data published in 2006 has to be dated back to 2004 since it corresponds to that year. The same is the case for all other years, resulting in a time span of 2004-2009 obtained from the Doing Business reports 2006-2011. For a detailed description of the methodology, see `http://www.doingbusiness.org/methodology/paying-taxes` and Djankov et al. (2010).

[20] Using survey data regarding time which taxpayers need to comply with taxes in order to measure tax complexity is quite common in the literature. See Gale and Holtzblatt (2002) for a review of past surveys.

Table 4.1: Foreign direct investment of German multinationals by country

Country	New Investments 2005-2009	Total Investments reported 2009	*Tax complex.*$_j$	*Corp. tax*$_j$
Australia	75 (1.64%)	333 (1.80%)	4.67	30.00
Austria	281 (6.14%)	1213 (6.54%)	5.14	26.80
Belgium	149 (3.26%)	624 (3.37%)	4.67	33.99
Canada	130 (2.84%)	377 (2.03%)	4.78	33.98
Czech Republic	163 (3.56%)	855 (4.61%)	6.70	24.60
Denmark	48 (1.05%)	285 (1.54%)	4.91	27.20
Finland	70 (1.53%)	207 (1.12%)	5.57	26.60
France	408 (8.91%)	1776 (9.58%)	4.88	33.62
Greece	25 (0.55%)	124 (0.67%)	5.51	29.20
Hungary	93 (2.03%)	554 (2.99%)	5.82	16.00
Iceland	0 (0%)	0 (0%)	-	-
Ireland	56 (1.22%)	203 (1.09%)	4.33	12.50
Italy	222 (4.85%)	1092 (5.89%)	5.80	36.12
Japan	85 (1.86%)	349 (1.88%)	5.84	41.32
Korea (South)	38 (0.83%)	162 (0.87%)	5.61	27.50
Luxembourg	141 (3.08%)	322 (1.74%)	4.07	29.63
Mexico	83 (1.81%)	315 (1.70%)	6.27	30.00
Netherlands	307 (6.71%)	1167 (6.29%)	5.31	29.32
New Zealand	9 (0.20%)	58 (0.31%)	5.26	32.40
Norway	52 (1.14%)	170 (0.92%)	4.47	28.00
Poland	182 (3.98%)	1004 (5.41%)	6.02	19.00
Portugal	44 (0.96%)	250 (1.35%)	5.79	27.10
Slovakia	48 (1.05%)	271 (1.46%)	5.74	19.00
Spain	203 (4.44%)	1022 (5.51%)	5.58	33.50
Sweden	125 (2.73%)	481 (2.59%)	4.80	28.00
Switzerland	183 (4.00%)	1,037 (5.59%)	4.14	21.90
Turkey	63 (1.38%)	264 (1.42%)	-	-
United Kingdom	503 (10.99%)	1,510 (8.14%)	4.66	29.60
United States	791 (17.28%)	2,518 (13.58%)	5.56	39.40
Total	4577 (100.00%)	18543 (100.00%)	5.27	28.36

Source: Deutsche Bundesbank: MiDi. Only investments included with German participation above or equal 50%. Variable descriptions and data sources for *Tax complex.*$_j$ and *Corp. tax*$_j$ are provided in Table 4.2. The reported numbers for these variables are mean values over the years 2004-2008 accounting books must be kept for tax purposes -or separate calculations made- the time associated with these processes is included. This extra time is included only if the regular accounting work is not enough to fulfill the tax accounting requirements. Filing time includes the time to complete all necessary tax return forms and file the relevant returns at the tax authority. Payment time considers the hours needed to make the payment online or at the tax authorities."[21]

In our sample of 27 countries, we observe a decrease in tax complexity within 12 countries and an increase within 4 countries (in 11 countries tax complexity remains constant). In absolute values, the within country variation from 2004 to 2008 amounts to 14.8% on average. Examples of reforms leading to a decrease in tax complexity are simplifications of reporting and payment requirements and the introduction of electronic filing systems.[22] Figure 4.1 shows the values of the variable $Tax\ complex._j$ within the 27 countries for the first and the last year of our estimation sample.[23] In our estimations, we use a large set of control variables, all described in Table 4.2. Descriptive statistics and correlations of these variables are shown in Table C.4 in Appendix C.2.

[21] The description of this variable is taken from `http://www.doingbusiness.org/methodology/paying-taxes`.

[22] A detailed list of reforms which have influenced the Doing Business Indicators is available at `http://www.doingbusiness.org/reforms/overview/topic/paying-taxes`

[23] Note that the variable $Tax\ complex._j$ is the logarithm of the variable *Time* of the Doing Business data.

Country labels are 3 digit ISO codes. For Luxembourg, data for 2005 and 2008 is taken due to missing data in 2004.

Table 4.2: Variable descriptions and data sources

Variable	Data Source	Description
y_{kj}	Deutsche Bundesbank: MiDi	Takes the value 1 if an investment k takes place in country j. For all other countries the value is 0. This is the dependent variable for all estimations except of Specification 5 in Table 4.3.
$Total\ assets_j$	Deutsche Bundesbank: MiDi	Sum of total assets of all new investments (of German parent firms) in country j in year t. This is the dependent variable for Specification 5 in Table 4.3.
$Prev.\ presence_{kj}$	Deutsche Bundesbank: MiDi	Previous Presence; Dummy variable which takes the value 1 if the parent firm holds already an affiliate in country j in the year before the investment k takes place. Otherwise the value is 0.
$Small\ parent_k$	Deutsche Bundesbank: MiDi	Dummy variable which takes the value 1 if the investment k belongs to a parent firm with total assets below the median. Otherwise the value is 0.
$Small\ affiliate_k$	Deutsche Bundesbank: MiDi	Dummy variable which takes the value 1 if the total assets of the investment k are below the median. Otherwise the value is 0.
$M\&A_k$	Deutsche Bundesbank: MiDi	Dummy variable which takes the value 1 if the investment k is an M&A project. Otherwise (i.e. for greenfield investments) the value is 0.
$Manuf_k$	Deutsche Bundesbank: MiDi	Manufacturing; Dummy variable which takes the value 1 if the investment k belongs to the manufacturing sector. Otherwise the value is 0.
$Holding_k$	Deutsche Bundesbank: MiDi	Holding company; Dummy variable which takes the value 1 if the investment k is a holding company. Otherwise the value is 0.
HT_k	Deutsche Bundesbank: MiDi	High-tech; Dummy variable which takes the value 1 if the investment k belongs to the high-technology industry. Otherwise the value is 0.
$Tax\ complex_j$	World Bank: Doing Business data	"The time it takes to prepare, file and pay (or withhold) the corporate income tax, the value added tax and social security contributions (in hours per year)."[a] *
$Corp\ tax_j$	IBFD	Statutory corporate income tax rate in %.
VAT_j	OECD, own search	Value added tax rate in %.
$EATR_j$	Oxford University Center for Business Taxation	Effective average tax rate in %.
GDP_j	World Bank: World Development Indicators	GDP in (current year) US $.*
$Bureaucracy_j$	World Bank: Doing Business data	"The total number of days required to register a firm. The measure captures the median duration that incorporation lawyers indicate is necessary to complete a procedure with minimum follow-up with government agencies and no extra payments."[a] *
$Labor\ costs_j$	Bureau of Labor Statistics, Eurostat	Hourly wages in the manufacturing sector in US $.*
$Corruption_j$	Transparency International	Corruption Perceptions Index 2010. A low value means high corruption.
$Inflation_j$	World Bank: World Development Indicators	Inflation (consumer prices) in %.
$Exch.\ rate_j$	IMF: International Financial Statistics	Real effective exchange rate (Index, 2005=100).
$Country\ risk_j$	OECD	Country risk classification.
$Lending\ rate_j$	IMF: International Financial Statistics, OECD	Lending rate in %.
$Trade\ freedom_j$, $Invest.\ freedom_j$	Heritage Foundation: Index of economic freedom	Indices measuring economic freedom regarding foreign trade and investments, respectively.

All Data is for the years 2004-2009.
[a] Description taken from `http://www.doingbusiness.org/methodology`.
* For these variables the natural logarithm of the data is used, $ln(...)$.

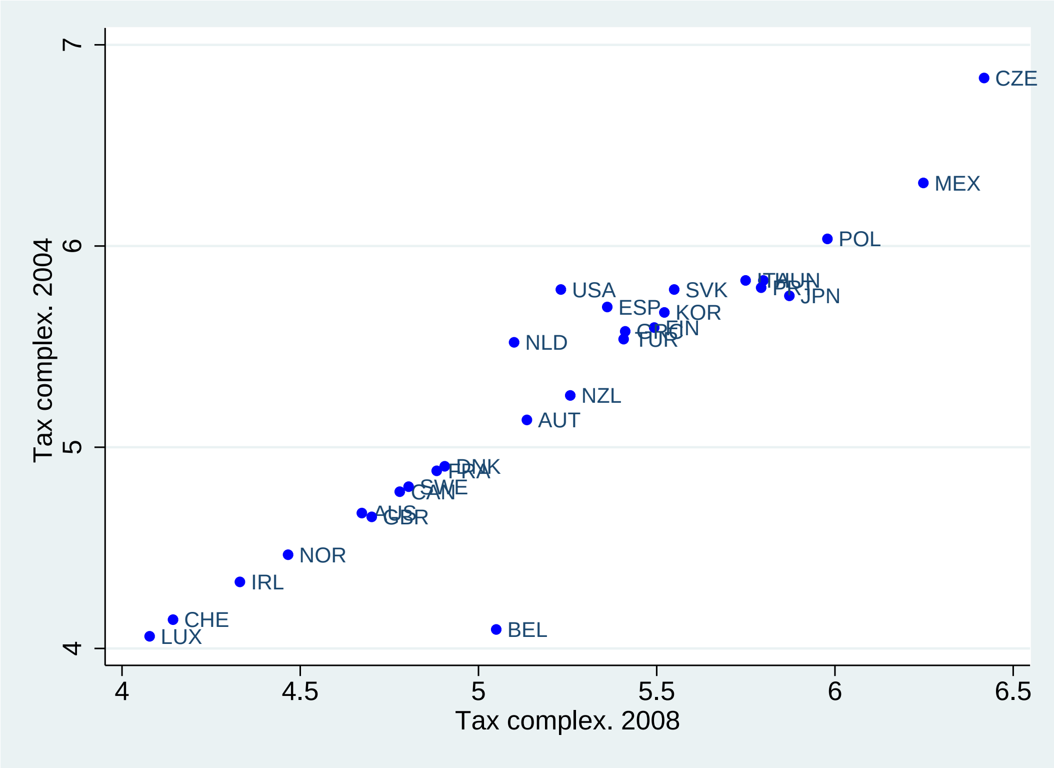

Figure 4.1: $Tax\ complex._j$ in 2004 and 2008

4.4 Empirical Analysis

4.4.1 Econometric Specification

FDI decisions are made by individual firms. Therefore, it is desirable to analyze the effect of properties of the tax system on the attractiveness of FDI with firm-level data. The approach we pursue in this section is related to multinomial location choice problems of FDI projects as considered in Arulampalam et al. (2012), Buettner and Ruf (2007), Hebous et al. (2011) and Herger et al. (2010).[24]

Let the latent surplus of an FDI project k in a potential host country j be

$$\Pi^*_{kj} = \Pi(Tax\ complex._j, Corp.\ tax_j, ...; z_{kj}), \tag{4.1}$$

where z_{kj} are variables that are specific not only to the country j but also to the affiliate k.

[24]In more detail, we employ a mixed logit model similar to Arulampalam et al. (2012) and use partially some notation similar to Herger et al. (2010), Buettner and Ruf (2007) and Hebous et al. (2011).

We assume the latent surplus to follow the linearized equation[25]

$$\Pi^*_{kj} = \underbrace{X_{kj}\beta_k + a_j + a_{t(k)}}_{\equiv \Pi_{kj}} + e_{kj} \ , \tag{4.2}$$

where a_j and $a_{t(k)}$ are unobserved effects depending on the host country j and the year $t(k)$ in which the investment took place. e_{kj} is the error term that is assumed to be an independent and identically distributed (i.i.d.) draw from a Gumbel distribution (i.e. a type-1 extreme value distribution).[26] We will treat the unobserved effects as fixed effects to account for correlation between the unobserved effects and the regressors.[27] X_{kj} includes variables listed in Table 4.2.[28]

In addition, X_{kj} includes the interaction term between tax complexity and the corporate income tax rate as a regressor. The reason is that the effect of tax complexity on firms might consist of two effects, a negative effect due to compliance costs and a positive effect that lies in the possibility of tax optimization (due to loopholes, special rules and exemptions), the value of which depends on the tax rate. If the tax rate is low, gains from tax optimization will only be small meaning the positive effect of tax complexity is expected to be minimal so that the negative effect is dominant. If the tax rate increases, the possibility of tax optimization becomes more and more important, which is expected to partly offset the negative effect of tax complexity. In order to capture these two potential effects appropriately, the inclusion of the interaction term between tax complexity and the corporate income tax rate is required.

To focus ideas, we briefly want to theoretically formulate this argument. Let us rewrite the net profits of an investment k in country j as $\Pi^*_{kj} = P_{kj} - T(t_j, tc_j, ...)$ where P_{kj} would be the profits in the absence of taxation and $T(t_j, tc_j, ...)$ are the cost associated with taxation, i.e. tax payments plus compliance cost, which depends amongst others on the tax rate t_j and tax complexity tc_j. In more detail, let $T(\cdot)$ have the following form: $T(t_j, tc_j, ...) = g(tc_j, firm\ size_k, ...) + t_j P_{kj}(1 - h(tc_j))$

[25] Actually, since the latent surplus is not observed and therefore not included as a variable in the estimations, it does not make a difference whether we assume the latent surplus Π^*_{kj} or its logarithm $\pi^*_{kj} = ln(\Pi^*_{kj})$ to follow the linearized equation.

[26] Later on, we allow for correlated errors via cluster-robust standard errors.

[27] As one will see later on, the time-depending unobserved effect $a_{t(k)}$ will cancel out in the estimation procedure (cf. equation (4.4)). So, only a_j are left as fixed effects to be estimated.

[28] For all country variables, we use data for the year $t(k) - 1$, the year before the investment k took place. This captures the fact that investment decisions are based on past information.

where the first term is the compliance cost (which is a function of tax complexity, firm size, etc. and which is assumed to be increasing in tax complexity, i.e. $\frac{\partial g(\cdot)}{\partial tc_j} > 0$) while the second term is the actual tax payment.[29] The function $h(\cdot)$ shall capture the extent to which tax payments can be avoided due to loopholes, special rules and exemptions associated with a complex tax system. We make the following assumptions regarding the function $h(\cdot)$: $0 \leq h(\cdot) < 1$, $h(0) = 0$ and $\frac{\partial h(tc_j)}{\partial tc_j} > 0$. So, if tax complexity is 0, $(1 - h(tc_j)) = 1$, i.e. in the absence of tax complexity, the actual tax payment is simply profits times tax rate. If tax complexity increases, $h(\cdot)$ increases and constitutes the share of profits which can be prevented from being taxed due to tax complexity. Taking the derivative with respect to tax complexity, we obtain $\frac{\partial \Pi^*_{kj}}{\partial tc_j} = \underbrace{-\frac{\partial g(\cdot)}{\partial tc_j}}_{<0} + t_j P_{kj} \frac{\partial h(tc_j)}{\partial tc_j}$ and $\frac{\partial^2 \Pi^*_{kj}}{\partial tc_j \partial t_j} = P_{kj} \frac{\partial h(tc_j)}{\partial tc_j} > 0$.

From this considerations, we can derive the following hypotheses for our estimations in which we include tax complexity, the corporate income tax rate and their interaction:

1. The coefficient of tax complexity is negative (this corresponds to $-\frac{\partial g(\cdot)}{\partial tc_j} < 0$).
2. The coefficient of the interaction term between tax complexity and the corporate income tax rate is positive (this corresponds to $P_{kj} \frac{\partial h(tc_j)}{\partial tc_j} > 0$).

In some specifications, we allow the vector of coefficients β_k to vary across the investment projects k with a density $f(\beta)$, the mixing distribution. In order to make this possible, we have to use a mixed logit estimation in addition to a conditional logit estimation. The latter one, formulated by McFadden (1974), assumes that $\beta_k = \overline{\beta}$ for all k, i.e. the estimated coefficients are the same for all investment projects.[30] However, due to limited computational power, we only estimate selected equations with the mixed logit model and rely on the conditional logit model otherwise.[31] In the following, we still explain the mixed logit approach since everything holds also

[29] Assume that the actual tax payment consists of the tax rate t_j times (gross) profits P_{kj} times $(1 - h(tc_j))$. In reality, compliance costs might often be at least partially deductible from the tax base, however, we neglect this here for the sake of convenience.

[30] The mixed logit model improves upon the conditional logit model not only by allowing for random variation in the coefficients but also by not exhibiting independence of irrelevant alternatives and its restrictive substitution patterns (Train, 2009). Another model with such properties would be a multinomial probit model with random coefficients (Train, 2009). However, the estimation of such a multinomial probit model is not feasible with our large dataset due to limited computational power.

[31] Note that all estimations have to be run inside the research center of Deutsche Bundesbank.

for the conditional logit model, which can be regarded as a special case.[32]

By using the mixed logit model, we allow β_k not only to depend on the multinational firm that makes the investment, but also on the individual investment itself. This is desirable since it mirrors the fact that the importance of factors that influence the attractiveness of a location depends on the specific investment. The value of the own β_k and the e_{kj} for all j are known by the decision maker. So, the investment k takes place in country j if the latent surplus of investment k in country j is higher than in all other countries.[33] This is

$$y_{kj} = \begin{cases} 1 & if \quad \Pi^*_{kj} > \Pi^*_{kl} \quad \forall\, l \neq j \quad and \\ 0 & else \ , \end{cases} \tag{4.3}$$

where y_{kj} is observed, but Π^*_{kj} cannot be observed. Conditional on β_k, the probability that a given investment k takes place in country j can be written as:

$$P(\underbrace{Investment_k \ in \ country_j}_{y_{kj}=1} | \beta_k) = \frac{exp(\Pi_{kj})}{\sum_l exp(\Pi_{kl})} \tag{4.4}$$

However, one only observes X_{kj} but neither β_k nor e_{kj}. So, one cannot condition on β_k and hence the unconditional choice probability

$$P(y_{kj} = 1) = \int \frac{exp(\Pi_{kj})}{\sum_l exp(\Pi_{kl})} f(\beta) d\beta \ , \tag{4.5}$$

that is the mixed logit probability, has to be used. The mixing distribution $f(\beta)$ is the probability density function of a normal distribution for the coefficients that we allow to be random. The mixed logit estimator estimates the parameters of $f(\beta)$, in particular the means μ_m and standard deviations σ_m of the coefficients β_k^m that we allow to be random. The conditional logit model equals the case in which the mixing distribution is degenerate at a fixed value $\overline{\beta}$, i.e. the vector of coefficients β_k is assumed to be the same for all investments k, say $\overline{\beta}$ with $f(\overline{\beta}) = 1$ and 0 else.

[32]The following explanation of the mixed logit approach is based on Chapter 6 of Train (2009).
[33]Note that this setup is adequate in our study since we only look on new FDI projects.

We allow clustered error terms e_{kj} with regard to the economic sector of the investment k.[34] This captures the fact that, for some sectors, certain countries might be particularly attractive or unattractive, and so the errors are not i.i.d. for investments within the same sector.

4.4.2 Estimation Results

The estimation results are shown in Table 4.3. Specification 1 is the benchmark specification and shows that the coefficient of $Tax\ Complex_j$ is significantly negative while the coefficient of the interaction term between $Corp.\ tax_j$ and $Tax\ Complex_j$ is significantly positive. Both findings confirm the hypotheses derived in Section 4.4.1. So, we find evidence which is in line with the argument that the effect of tax complexity on firms consists of a negative effect due to compliance costs and a positive effect that lies in the possibility of tax optimization, the value of which depends on the tax rate. However, in order to be able to draw conclusions about the 'total' effect of a marginal increase of tax complexity, we have to compute the 'total' coefficient of tax complexity, i.e. the coefficient of tax complexity conditional on the level of the statutory corporate income tax rate,[35] which is shown in Figure 4.2. The lines for the coefficient and confidence intervals are plotted within the range of corporate income tax rates in our sample, ranging from 12.5% to 42.1%. The median tax rate is 28% and the first and third quartile is 25% and 33.33%, respectively. Our key findings are twofold. First, the 'total' coefficient of tax complexity is negative in the range of our sample, which suggests that a higher level of tax complexity decreases the probability to locate an FDI project in the respective country. Second, however, the repressive effect of tax complexity becomes weaker when the tax rate increases. Following the theoretical considerations behind the interaction effect in Section 4.4.1, this is evidence that there is also a positive effect of tax complexity but that the negative effect outweighs the positive effect for all tax rates in the range of our sample.

In addition to the explanation with the two effects working in opposite directions,

[34] Sectoral coding follows the NACE Rev.1 categories (3/4 digit) and results in 71 clusters in our estimation sample.

[35] I.e. -2.3448+ $Corp.\ tax_j$*0.0547, according to Spec. 1 of Table 4.3

Table 4.3: Estimation results

	Spec. 1	Spec. 2	Spec. 3	Spec. 4	Spec. 5
$Tax\ complex._j$	-2.3448**	-2.5917**	-2.4493***	-1.6866*	-10.9158***
	(0.9442)	(1.1069)	(0.8048)	(0.9686)	(3.4993)
$Corp.\ tax_j$	-0.2855**	-0.3319**		-0.2115*	-1.5418***
	(0.1270)	(0.1658)		(0.1186)	(0.4889)
$Corp.\ tax * Tax\ complex._j$	0.0547**	0.0623*		0.0414*	0.2955***
	(0.0247)	(0.0318)		(0.0232)	(0.0963)
VAT_j	-0.0632*	-0.1366**	-0.0576	0.0336	0.0232
	(0.0383)	(0.0560)	(0.0394)	(0.1484)	(0.2725)
$VAT * Tax\ complex._j$				-0.0150	
				(0.0194)	
$EATR_j$			-0.3428***		
			(0.1283)		
$EATR * Tax\ complex._j$			0.0666***		
			(0.0247)		
GDP_j	2.8965**	3.1151**	3.1247**	2.7121**	12.5072**
	(1.3902)	(1.5006)	(1.4687)	(1.3692)	(5.0858)
$Bureaucracy_j$	-0.1031*	-0.1638**	-0.1052*	-0.1089*	-0.2450
	(0.0617)	(0.0827)	(0.0591)	(0.0661)	(0.4566)
$Labor\ costs_j$	-1.2877	1.3692	-1.5860	-1.2740	-0.1716
	(1.7375)	(2.6673)	(1.7171)	(1.7399)	(5.7967)
$Trade\ freedom_j$	-0.0109	-0.0074	-0.0139	-0.0108	-0.0101
	(0.0089)	(0.0094)	(0.0092)	(0.0089)	(0.0479)
$Corruption_j$	-0.0088	-0.0308	-0.0226	-0.0067	-0.3363
	(0.0730)	(0.0827)	(0.0744)	(0.0736)	(0.4143)
$Inflation_j$	-0.0092	-0.0003	-0.0172	-0.0142	-0.0696
	(0.0505)	(0.0575)	(0.0506)	(0.0534)	(0.2288)
$Exch.\ rate_j$	-0.0123	-0.0354	-0.0121	-0.0122	-0.1170*
	(0.0239)	(0.0313)	(0.0236)	(0.0239)	(0.0648)
$Country\ risk_j$	-0.2077	-0.3467	-0.2429	-0.1877	-0.0413
	(0.2245)	(0.2579)	(0.2408)	(0.2377)	(0.3580)
$Lending\ rate_j$	0.0245	0.0137	0.0243	0.0236	-0.0592
	(0.0180)	(0.0186)	(0.0177)	(0.0183)	(0.0510)
$Invest.\ freedom_j$	-0.0017	-0.0036	-0.0018	-0.0009	0.0431
	(0.0044)	(0.0056)	(0.0044)	(0.0043)	(0.0301)
N	118992	118992	118992	118992	133
Affiliates	4474	4474	4474	4474	
Countries	27	27	27	27	27
pseudo R^2	0.1223		0.1224	0.1223	
Log-Likelihood	-12882.42	-12879.41	-12881.47	-12881.87	-1.22e+08
Clusters	71	71	71	71	27
Country FE	✓	✓	✓	✓	✓

The dependent variable is y_{kj} (i.e. 0 or 1) except for Specification 5. All independent variables correspond to the year $t(k)-1$ before the investment k takes place. Cluster-robust standard errors (regarding affiliate sector except for Specification 5) are provided in parentheses. ***,** and * indicate significance at the 1%, 5% and 10% level. All specifications except of Spec. 2 and 5 are conditional logit estimations. Spec. 2 is a mixed logit estimation (using 200 Halton draws) with random coefficients for $Tax\ complex._j$, $Corp.\ tax_j$, VAT_j and GDP_j (the reported parameters are the μ of their distributions). The σ are -0.5895 (0.3842), 0.1171*** (0.0405), 0.1678*** (0.0518) and 1.4833** (0.5752), respectively (standard errors in parantheses). Specification 5 is a Poisson estimation inlcuding year dummies, with $Total\ assets_j$ as the dependent variable and cluster-robust standard errors regarding country.

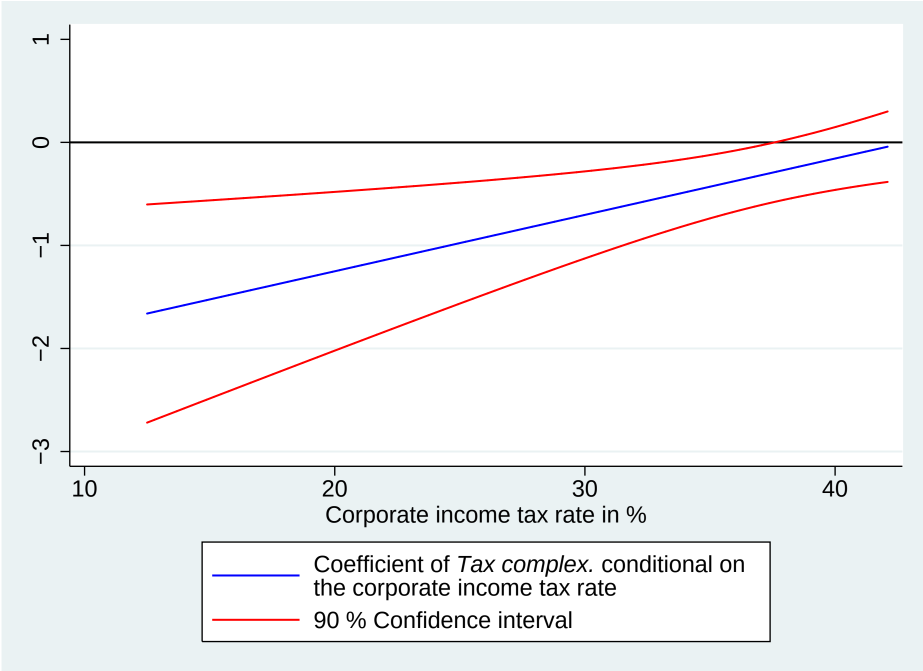

Figure 4.2: The coefficient of tax complexity conditional on the corporate income tax rate (based on Table 4.3, Spec. 1)

there might also be another explanation for our results. This second explanation concerns the mobility of FDI projects, i.e. whether a foreign affiliate could be in any country (e.g. a holding company) or whether it is tied to a specific host country (e.g. a mining company due to local mineral resources). It seems reasonable that the higher the corporate income tax rate in a country, the lower is the share of investments which are mobile, i.e. not tied to the specific country. Combined with the argument that the cost associated with a complex tax system should be more deterrent for mobile investments than for immobile ones, this reasoning provides an additional explanation for the positive coefficient of the interaction term.[36]

Concerning the further variables in the estimation, $Corp.\ tax_j$ shows a negative sign while the coefficient of GDP_j is positive, both as expected. Moreover, an increase in VAT_j exhibits a negative effect on the location choice, which can be explained by tax incidence considerations.[37] Moreover, we include a number of further controls, which are commonly used in the empirical literature on FDI, to prevent omitted

[36] As we will show later (Table 4.5, Spec. 2), holding companies indeed react stronger to higher tax complexity than other firms.

[37] This is in line with the findings of Desai et al. (2004) who investigate the effect of direct and indirect taxes on FDI. They find that higher local indirect tax rates have a negative effect on affiliate assets of American multinational firms.

variable bias. Interestingly, most coefficients are statistically insignificant which is probably due to little within-country variation.

So far, we have just interpreted the sign of the coefficients, but not yet their magnitude. We will do this in Section 4.4.3 in which country-specific elasticities are computed based on the benchmark estimation (Spec. 1).

As mentioned previously, the conditional logit estimation requires the IIA assumption. A Hausman test does not reject this assumption. Nevertheless, in order to see whether the results remain the same when we relax this assumption, we run a mixed logit estimation (Spec. 2). The results are very similar, both qualitatively and quantitatively.[38] This validates our findings from the conditional logit estimations (Spec. 1). Therefore, following Occam's razor we stick to conditional logit estimations for further specifications.[39]

In Specification 3 we use effective average tax rates instead of statutory tax rates.[40] The results are almost identical which is not surprising since due to the country fixed effects, only changes in the effective average tax rate matter and these are mainly driven by changes in the statutory tax rate.[41,42]

Specification 4 examines the interaction between the value added tax rate (VAT) and tax complexity. This seems interesting since our tax complexity measure also includes the time to deal with VAT. However, as Specification 4 shows, there is no significant interaction effect regarding VAT. Specification 5 corresponds to the benchmark estimation (Spec. 1), however, we use an alternative measure of FDI as the dependent variable and employ another estimation technique in this specification. The dependent variable is no longer the binary variable y_{kj} which indicates the location choice but the sum of total assets of the new investments, aggregated per year and country. The estimation is done with a Poisson panel estimator which

[38]The estimated μ of our variables of interest are very close to the coefficients of Specification 1. Only the negative effect of VAT_j is on average about twice as large as in Specification 1. The kernel density estimates for the random coefficients are provided in Appendix C.2 (Figure C.5 and C.6).

[39]Moreover, this is necessary due to limited computational capacity since all estimations have to be run inside the research center of Deutsche Bundesbank and the mixed logit estimations are very time-consuming.

[40]A specification which employs effective marginal tax rates instead is provided in Appendix C.1, Table C.1

[41]The correlation between these variables demeaned by country is 0.93, as shown in Table C.4 in Appendix C.2.

[42]The analogous figure to Figure 4.2 for the 'total' coefficient of tax complexity conditional on the level of the effective average tax rate is provided in Appendix C.2, Figure C.4.

includes country fixed effects and year dummies. Regarding our variables of interest, the estimates qualitatively confirm our findings so far, i.e. the negative coefficient of $Corp.\ tax_j$ and $Tax\ Complex_j$ as well as the positive coefficient of their interaction term, and show even stronger significance. We conduct several further robustness checks which confirm our findings and which are provided and explained in Appendix C.1 (Table C.1-C.3). In order to be able to investigate firm-specific variables in our estimations, we stick to conditional logit estimations at the firm level in the following.

Table 4.4 shows estimations which include firm-specific characteristics. In Specification 1, we test whether the probability of an (additional) investment in a specific country increases if the parent firm already holds an affiliate there. Moreover, if the burden due to tax complexity is a fixed cost per country and not a cost per affiliate, the negative impact of tax complexity should be smaller in this case. Regarding our estimation equation, this means that in this case the coefficient of $Tax\ complex. * Prev.\ Pres._{kj}$ should be positive. The results from Specification 1 suggest that German parent firms indeed prefer to invest in countries in which they have already been before, but that the effect of tax complexity is not significantly different in such cases. This suggests that the burden due to tax complexity cannot be seen as a cost paid by the parent firm only once per host country but has to be paid for every single investment project.

Specification 2-4 of Table 4.4 include the interactions of dummies for firm-specific characteristics with $Corp.\ tax_j$, $Tax\ Complex_j$ and the interaction term of the latter two variables. In Specification 2, this dummy is $Small\ parent_k$ which is 1 if an investment belongs to a parent firm with total assets below the median and 0 else. In Specification 3, this dummy is $Small\ affiliate_k$ which is 1 if the total assets of an investment are below the median and 0 else. The interactions of our tax variables with these dummies lead to significant coefficients. However, regarding the interpretation, we have to be careful and should rely on figures which indicate the 'total' coefficient of $Tax\ Complex_j$ and its confidence intervals conditional on $Corp.\ tax_j$, as in Figure 4.2. These figures are provided in Appendix C.2 (Figure C.1 and C.2). They show that, despite the significant coefficients of the dummy interactions in our regression, the 'total' coefficient of tax complexity conditional

Table 4.4: Estimation results

	Spec. 1	Spec. 2	Spec. 3	Spec. 4
$Tax\ complex._j$	-2.8849***	-2.6581***	-2.7756***	-2.3641**
	(1.0563)	(0.9456)	(1.0077)	(0.9646)
$Corp.\ tax_j$	-0.3578**	-0.3304**	-0.3427**	-0.3214**
	(0.1436)	(0.1307)	(0.1399)	(0.1338)
$Corp.\ tax * Tax\ complex._j$	0.0692**	0.0637**	0.0683**	0.0633**
	(0.0281)	(0.0252)	(0.0269)	(0.0257)
$Prev.\ Presence_{kj}$	1.2400***			
	(0.3550)			
$Tax\ complex. * Prev.\ Pres._{kj}$	0.0327			
	(0.0610)			
$Tax\ complex._j*$		0.8988***		
$Small\ parent_k$		(0.3274)		
$Corp.\ tax_j*$		0.1292**		
$Small\ parent_k$		(0.0625)		
$Corp.\ tax * Tax\ complex._j*$		-0.0260**		
$Small\ parent_k$		(0.0122)		
$Tax\ complex._j*$			0.8807**	
$Small\ affiliate_k$			(0.4149)	
$Corp.\ tax_j*$			0.1192*	
$Small\ affiliate_k$			(0.0684)	
$Corp.\ tax * Tax\ complex._j*$			-0.0280**	
$Small\ affiliate_k$			(0.0131)	
$Tax\ complex._j * M\&A_k$				0.1586
				(0.3587)
$Corp.\ tax_j * M\&A_k$				0.0746
				(0.0538)
$Corp.\ tax * Tax\ complex._j*$				-0.0168
$M\&A_k$				(0.0110)
VAT_j	-0.0489	-0.0591	-0.0629	-0.0634
	(0.0397)	(0.0383)	(0.0385)	(0.0386)
GDP_j	2.5128**	2.8706**	2.8688**	2.8825**
	(1.2625)	(1.3780)	(1.3831)	(1.3818)
N	118992	118992	118992	118992
Affiliates	4474	4474	4474	4474
Countries	27	27	27	27
pseudo R^2	0.1549	0.1232	0.1246	0.1244
Log-Likelihood	-12403.96	-12868.98	-12848.64	-12852.07
Clusters	71	71	71	71
Country FE	✓	✓	✓	✓
Country controls	✓	✓	✓	✓

The dependent variable is y_{kj} (i.e. 0 or 1). All independent variables correspond to the year $t(k) - 1$ before the investment k takes place. Cluster-robust standard errors (regarding affiliate sector) are provided in parentheses. ***,** and * indicate significance at the 1%, 5% and 10% level. All specifications are conditional logit estimations. Country controls are the variables $Bureaucracy_j$, $Labor\ costs_j$, $Trade\ freedom_j$, $Corruption_j$, $Inflation_j$, $Exch.\ rate_j$, $Country\ risk_j$, $Lending\ rate_j$ and $Invest.\ freedom_j$.

on the corporate income tax rate is neither statistically different between large and small investments nor between investments of large or small parent firms (the 'total' coefficient for one lies always within the 90% confidence interval of the other). Consequently, our results indicate that the location choice of large and small firms is similarly affected by tax complexity. This suggests that the 'cost' of tax complexity is not solely a fixed cost but entails a substantial variable component which depends on firm size, because otherwise, the location choice of large investments should have been observed to be less affected.

FDI can either be an M&A project or a greenfield investment. In our sample, almost 65% of all investments are due to M&A (cf. Table 4.6). One might expect that the investment decision for these two forms of FDI are differently affected by tax complexity. Specification 4 investigates whether this is the case by including interactions of an M&A-dummy with our tax variables. Interestingly, we find no significant difference between M&As and greenfield investments. This suggests that the 'cost' of tax complexity is not a one-time cost either because otherwise this cost would have already been carried (at least partially) by an existing firm and therefore, M&As should have been observed to be less affected.

Both findings, i.e. that the cost of tax complexity is neither solely a fixed cost regarding firm size nor a one-time cost, are intuitive. As argued before, the compliance cost due to tax complexity comprises all tasks that are necessary in order to understand the tax law and to fulfill the requirements. The cost associated with understanding the tax law might be seen as a fixed cost with respect to firm size and time (i.e. paid only once). The cost associated with fulfilling the requirements occurs annually and can be divided into two parts, one that is variable and another one that is fixed with respect to firm size. So, our findings suggest that the recurring cost (e.g. cost associated with annually fulfilling the requirements) is crucial and that its variable part is dominant.

Table 4.5 provides estimations with dummy interactions regarding the industry of foreign investments. The absolute and relative share of these industries is shown in Table 4.6. For manufacturing firms (Spec. 1), we find no differences. For high-tech firms (Spec. 3), we estimate significantly different coefficients, however, a graph

Table 4.5: Estimation results

	Spec. 1	Spec. 2	Spec. 3
$Tax\ complex._j$	-2.6386**	-2.1985**	-2.2666**
	(1.0985)	(0.9518)	(0.9566)
$Corp.\ tax_j$	-0.3174**	-0.2745**	-0.2733**
	(0.1486)	(0.1280)	(0.1295)
$Corp.\ tax * Tax\ complex._j$	0.0610**	0.0522**	0.0522**
	(0.0289)	(0.0248)	(0.0252)
$Tax\ complex._j * Manuf_k$	0.7430		
	(0.6306)		
$Corp.\ tax_j * Manuf_k$	0.0648		
	(0.0971)		
$Corp.\ tax * Tax\ complex._j * Manuf_k$	-0.0126		
	(0.0190)		
$Tax\ complex._j * Holding_k$		-1.1134***	
		(0.3143)	
$Corp.\ tax_j * Holding_k$		-0.0834*	
		(0.0486)	
$Corp.\ tax * Tax\ complex._j * Holding_k$		0.0201**	
		(0.0097)	
$Tax\ complex._j * HT_k$			-1.7935***
			(0.4201)
$Corp.\ tax_j * HT_k$			-0.2767***
			(0.0820)
$Corp.\ tax * Tax\ complex._j * HT_k$			0.0595***
			(0.0144)
VAT_j	-0.0618	-0.0649*	-0.0637*
	(0.0386)	(0.0380)	(0.0383)
GDP_j	2.8581**	2.9357**	2.8785**
	(1.3891)	(1.3825)	(1.3879)
N	118992	118992	118992
Affiliates	4474	4474	4474
Countries	27	27	27
pseudo R^2	0.1242	0.1242	0.1229
Log-Likelihood	-12854.84	-12854.94	-12873.22
Clusters	71	71	71
Country FE	✓	✓	✓
Country controls	✓	✓	✓

The dependent variable is y_{kj} (i.e. 0 or 1). All independent variables correspond to the year $t(k) - 1$ before the investment k takes place. Cluster-robust standard errors (regarding affiliate sector) are provided in parentheses. ***,** and * indicate significance at the 1%, 5% and 10% level. All specifications are conditional logit estimations. Country controls are the variables $Bureaucracy_j$, $Labor\ costs_j$, $Trade\ freedom_j$, $Corruption_j$, $Inflation_j$, $Exch.\ rate_j$, $Country\ risk_j$, $Lending\ rate_j$ and $Invest.\ freedom_j$.

Table 4.6: Foreign direct investment of German multinationals 2005-2009

	Number of new investments	in %
Total	4577	100.00
Greenfield	1620	35.39
M&A	2957	64.61
Holding Companies	579	12.65
Manufacturing	1241	27.11
High-Tech (HT)	148	3.23

Source: Deutsche Bundesbank: MiDi. Only investments included with German participation above or equal 50%.

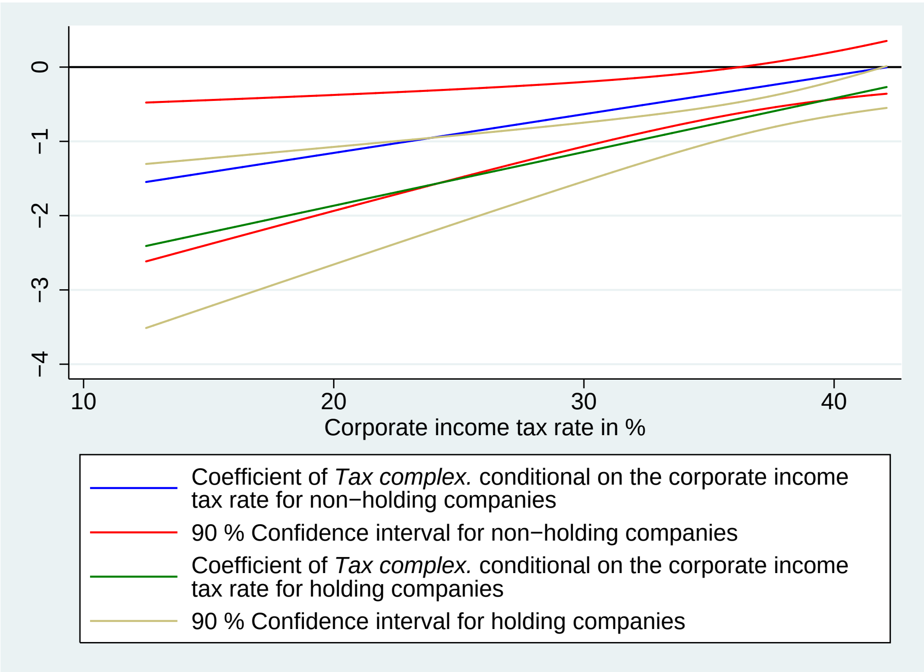

Figure 4.3: The coefficient of tax complexity conditional on the corporate income tax rate (based on Table 4.5, Spec. 2)

which shows the 'total' coefficient of tax complexity conditional on the corporate income tax rate shows that they do not differ, except for extremely high tax rates (cf. Figure C.3 in Appendix C.2). By contrast, for holding companies (Spec. 2), we estimate significantly different coefficients which lead to different 'total' coefficients for tax complexity conditional on the corporate income tax rate, at least for a substantial range of corporate income tax rates as shown in Figure 4.3.[43] For corporate tax rates approximately between 25% and 40%, the total coeffient of tax complexity for non-holding companies lies above the 90% confidence interval of the 'total' coefficient for holding companies. This means that within this interval, the deterrent effect of tax complexity is stronger for holding companies. Since holding companies are very mobile and might be placed in any country, it seems intuitive that the location choice of such investments is stronger influenced by the 'cost' of tax complexity.

4.4.3 Elasticities

So far, we have just interpreted the signs of coefficients and their relation to each other but not yet their magnitude. The best way to get a sense of the magnitude of the effect a marginal change in tax complexity has is to compute elasticities regarding the number of new investments in a country. In the following, we do so by relying on the estimates of the benchmark specification (Table 4.3, Spec. 1). However, in order to compute elasticities, one has to make an assumption whether the total number of investments is fixed or not. In other words, one has to make an assumption whether reducing tax complexity is a zero-sum game (the reducing country wins while all others lose ('fixed pie' scenario)) or not (there is no externality on other countries, additional investments arise in the reducing country ('no externality' scenario)). Following Schmidheiny and Brülhart (2011), it is best practice to compute both types of elasticities as the truth will probably lie in between. Since we estimate country-specific elasticities, we cannot use investment-specific variables and we can rewrite equation (4.4) as

$$P(Investment_k \ in \ country_j) = \frac{exp(\Pi_{kj})}{\sum_l exp(\Pi_{kl})} = \frac{exp(X_{t-1,j}\beta + a_j)}{\sum_l exp(X_{t-1,l}\beta + a_l)} = P_{t,j} \ , \quad (4.6)$$

43 Recall that the median tax rate is 28% and the first and third quartile is 25% and 33.33%, respectively.

where $t-1 = t(k)-1$ is the year before investment k takes place (cf. the notes on Table 4.3). Since k drops out, $P_{t,j}$ is the probability that an arbitrary investment takes place in country j in year t.[44]

With $n_{t,j}$ being the total number of new investments in country j in year t and

$$X_{t-1,j}\beta = x_{1,t-1,j} \cdot \beta_1 + x_{2,t-1,j} \cdot \beta_2 + x_{1,t-1,j} \cdot x_{2,t-1,j} \cdot \beta_3 + ... \quad , \tag{4.7}$$

we obtain, under the assumption that the total number of investments per year n_t is fixed ('fixed pie' scenario), the own-elasticity

$$\frac{\partial lnE(n_{t,j})}{\partial x_{1,t-1,j}} = (\beta_1 + x_{2,t-1,j} \cdot \beta_3) \cdot (1 - P_{t,j}) \tag{4.8}$$

and the cross-elasticity

$$\frac{\partial lnE(n_{t,i})}{\partial x_{1,t-1,j}} = -(\beta_1 + x_{2,t-1,j} \cdot \beta_3) \cdot P_{t,j} \tag{4.9}$$

which is the expected percentage change in the number of new investments in a country i due to a marginal change in the variable x_1 in country j.

Under the assumption that the total number of investments is not fixed, we obtain the own-elasticity

$$\frac{\partial lnE(n_{t,j})}{\partial x_{1,t-1,j}} = (\beta_1 + x_{2,t-1,j} \cdot \beta_3) \tag{4.10}$$

and the cross-elasticity

$$\frac{\partial lnE(n_{t,i})}{\partial x_{1,t-1,j}} = 0 \ , \tag{4.11}$$

i.e. there is no externality on other countries in this scenario ('no externality' scenario). Table 4.7 shows the elasticities of tax complexity (using the above formulas with $x_{1,j} = Tax\ complex._j$ and $x_{2,j} = Corp.\ tax_j$) for the year t=2009, computed using Specification 1 of Table 4.3.

[44]Note that this is the probability of a conditional logit model. We rely on the conditional logit estimations instead of mixed logit estimations for the calculation of the elasticities due to limited computational power since the standard errors of the elasticities are calculated via bootstrapping.

Table 4.7: Estimated elasticities

Country	Own-elasticities 'fixed pie' scenario	Cross-elasticities 'fixed pie' scenario	Own-elasticities 'no externality' scenario	Cross-elasticities 'no externality' scenario
Australia	-0.6896**	0.0139**	-0.7035 ***	0
	(0.2773)	(0.0063)	(0.2567)	
Austria	-0.9145**	0.0626**	-0.9771 ***	0
	(0.3622)	(0.0247)	(0.3569)	
Belgium	-0.4716**	0.0136**	-0.4852 **	0
	(0.2142)	(0.0056)	(0.1968)	
Canada	-0.4980**	0.0140**	-0.512 **	0
	(0.2199)	(0.0068)	(0.2025)	
Czech Republic	-1.1354**	0.0605**	-1.1959 ***	0
	(0.4639)	(0.0262)	(0.4455)	
Denmark	-0.9684**	0.0087**	-0.9771 ***	0
	(0.3824)	(0.0037)	(0.3569)	
Finland	-0.9091**	0.0133***	-0.9224 ***	0
	(0.3615)	(0.0042)	(0.3356)	
France	-0.4704**	0.0509**	-0.5213 **	0
	(0.2065)	(0.0236)	(0.2046)	
Greece	-0.9709**	0.0062	-0.9771 ***	0
	(0.3831)	(0.0042)	(0.3569)	
Hungary	-1.4387**	0.0307*	-1.4695 ***	0
	(0.5771)	(0.0177)	(0.561)	
Ireland	-1.6447**	0.0162*	-1.6609 ***	0
	(0.6699)	(0.0085)	(0.6436)	
Italy	-0.6020**	0.0249**	-0.6269 ***	0
	(0.2499)	(0.0097)	(0.2327)	
Japan	-0.1111	0.0016	-0.1126	0
	(0.1977)	(0.0027)	(0.1925)	
Korea (South)	-0.8335**	0.0068**	-0.8403 ***	0
	(0.3295)	(0.0033)	(0.3047)	
Luxembourg	-0.6934**	0.0304**	-0.7238 ***	0
	(0.2792)	(0.0134)	(0.2635)	
Mexico	-0.8000**	0.0130**	-0.8129 ***	0
	(0.3174)	(0.0053)	(0.2947)	
Netherlands	-0.8725***	0.0772*	-0.9497 ***	0
	(0.3369)	(0.0397)	(0.3462)	
New Zealand	-0.7024**	0.0011	-0.7035 ***	0
	(0.2827)	(0.0007)	(0.2567)	
Norway	-0.8017**	0.0112**	-0.8129 ***	0
	(0.3179)	(0.0051)	(0.2947)	
Poland	-1.2434**	0.0619**	-1.3053 ***	0
	(0.4953)	(0.0313)	(0.4913)	
Portugal	-0.8864**	0.0086**	-0.895 ***	0
	(0.3496)	(0.0039)	(0.3252)	
Slovakia	-1.2887**	0.0166*	-1.3053 ***	0
	(0.5145)	(0.0085)	(0.4913)	
Spain	-0.6692**	0.0344*	-0.7035 ***	0
	(0.2653)	(0.0189)	(0.2567)	
Sweden	-0.7913**	0.0217***	-0.8129 ***	0
	(0.3155)	(0.0079)	(0.2947)	
Switzerland	-1.1346**	0.0520**	-1.1866 ***	0
	(0.4500)	(0.0227)	(0.4417)	
United Kingdom	-0.7362**	0.0767**	-0.8129 ***	0
	(0.2883)	(0.0355)	(0.2947)	
United States	-0.1604	0.0288	-0.1892	0
	(0.1615)	(0.0316)	(0.1811)	

The reported elasticities show the expected effect of a change in $Tax\ complex._j$ on the number of new investments in a country, based on Spec. 1 in Table 4.3 and the year t=2009. Cluster-robust standard errors (regarding affiliate sector (71 clusters), estimated via bootstrapping (199 replications) in the fixed pie scenario) are provided in parentheses. ***,** and * indicate significance at the 1%, 5% and 10% level.

The own-elasticities are widely significantly negative with a mean elasticity of -0.7586 (median of -0.7344) in the 'fixed pie' scenario and -0.7844 (median of -0.7446) in the 'no externality' scenario. This means that, on average, reducing tax complexity by one percent leads to an increase of the expected number of new investments (at least new German investments) of 0.7586 percent and 0.7844 percent, respectively. The highest elasticities are found for Ireland, Hungary, Slovakia, Poland, Czech Republic and Switzerland, which are the countries with the lowest corporate income tax rates in our sample (cf. Table 4.1). In these countries, reducing tax complexity by one percent leads to an increase of the expected number of new investments (at least new German investments) of 1.1 to 1.6 percent.

4.5 Conclusion

The question whether and how much the complexity of tax systems has an impact on economic activity is highly relevant for policy-making. In this chapter, we investigate this question by focusing on one part of economic activity that is FDI. We use the Microdatabase Direct Investment (MiDi) of Deutsche Bundesbank and analyze the location choice of new German FDI projects in OECD countries from 2005 to 2009. As a measure for tax complexity, we us the time it takes for a standardized firm to comply with taxes, i.e. to prepare, file and pay taxes, published in the Doing Business data of the World Bank.

We find two main results. First, our estimates suggest that a higher level of tax complexity significantly decreases the probability to locate an FDI project in that country. Second, we find a positive coefficient of the interaction term of the corporate tax rate and tax complexity. This indicates that the negative effect of tax complexity is weaker, the higher the corporate tax rate is. Concerning policy implications, our results suggest that reducing tax complexity is a powerful instrument for increasing a country's attractiveness for new FDI projects. Moreover, the effect of a reduction of tax complexity will be particularly powerful for countries with a low statutory corporate income tax rate.

However, our results need to be validated by future research. In particular, further firm-level studies are desirable which use FDI data not restricted to German multinationals, alternative tax complexity measures and a larger time span.

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Appendix A

Appendix to Chapter 2

A.1 Proofs

Proof of proposition 2.3.1:

Part 1 a) follows from (2.17) and Part b) follows from (2.8). Part c) follows from the FOC for fiscal and legal capacity (i.e. (2.20) and (2.21)). Part 1 d): We first want to show that fiscal and legal capacity are both monotone nondecreasing in $E(\lambda_2)$. Since ϕ enters the model only through $E(\lambda_2)$ and $E(\lambda_2)$ is increasing in ϕ, this suffices. Let us rewrite equation (2.15):

$$f(b_1, \tau_2, \pi_2) = EV^{I_1}(\tau_2, \pi_2, b_1) - \lambda_1(F(\tau_2 - \tau_1) + L(\pi_2 - \pi_1) - b_1) \tag{A.1}$$

As stated in Part 1 a), $b_1 = 0$ is the debt level that maximizes (A.1). Define $g(\tau_2, \pi_2) \equiv f(0, \tau_2, \pi_2)$. Following Corollary 3 of Milgrom and Shannon (1994), it remains to show that $g(\tau_2, \pi_2)$ is quasisupermodular in (τ_2, π_2) and satisfies the single crossing property in $(\tau_2, \pi_2, E(\lambda_2))$. We have:

$$\frac{\partial^2 g(\tau_2, \pi_2)}{\partial \pi_2 \partial \tau_2} = \delta\omega'(\pi_2)(E(\lambda_2) - 1) > 0 \tag{A.2}$$

$$\frac{\partial^2 g(\tau_2, \pi_2)}{\partial \pi_2 \partial E(\lambda_2)} = \delta\omega'(\pi_2)\tau_2 > 0 \tag{A.3}$$

$$\frac{\partial^2 g(\tau_2, \pi_2)}{\partial \tau_2 \partial E(\lambda_2)} = \delta\omega(\pi_2) > 0 \tag{A.4}$$

By Theorem 6 of Milgrom and Shannon (1994), $g(\tau_2, \pi_2)$ has increasing differences in $(\tau_2, \pi_2, E(\lambda_2))$ and is supermodular in (τ_2, π_2). It follows that $g(\tau_2, \pi_2)$ satisfies the single crossing property in $(\tau_2, \pi_2, E(\lambda_2))$ and is quasisupermodular in (τ_2, π_2). So, fiscal and legal capacity are both monotone nondecreasing in $E(\lambda_2)$.

It remains to show that fiscal and legal capacity are both strictly increasing in $E(\lambda_2)$. Since we have shown that both are monotone nondecreasing, there are three other potential possibilities: Fiscal capacity is strictly increasing while legal capacity remains constant, legal capacity is strictly increasing while fiscal capacity remains constant, both are constant. However, all of them lead to a contradiction regarding the FOC (2.20) and (2.21), so they can be ruled out.

Part 2 a) follows from (2.17) and b) follows from (2.8). Part c): The positive investments follow from the FOC for fiscal and legal capacity (i.e. (2.20) and (2.21)). The comparison to the model without debt is due to the fact that when no debt can be raised, $max\{\lambda_1, E(\lambda_2)\}$ has to be replaced by $E(\lambda_2)$ which is smaller (the comparison can be shown rigorously using monotone comparative statics similar to the proof of Part 1 d) of proposition 2.3.1).

Proof of proposition 2.3.2:

If the cohesiveness condition holds, $\lambda_1 = \alpha_1$ and $E(\lambda_2) = \phi\alpha_H + (1-\phi)\alpha_L$. These are the same terms as for a social planner. Therefore, the results of proposition 2.3.1 hold.

Proof of proposition 2.3.3:

Part 1 a) follows from (2.17) and Part b) follows from (2.8). Part c) follows from the FOC for fiscal and legal capacity (i.e. (2.20) and (2.21)). For Part 1 d) and e) we apply again monotone comparative statics as in Part 1 d) of proposition 2.3.1. As stated in Part a), $b_1 = 0$ is the debt level that maximizes (2.15). Define $g(\tau_2, \pi_2) \equiv f(0, \tau_2, \pi_2)$, with $f(b_1, \tau_2, \pi_2)$ denoting the objective function of (2.15). We have:

$$\frac{\partial^2 g(\tau_2, \pi_2)}{\partial \pi_2 \partial \tau_2} = \delta\omega'(\pi_2)(E(\lambda_2) - 1) > 0 \tag{A.5}$$

since the stability condition holds.

$$\frac{\partial^2 g(\tau_2, \pi_2)}{\partial \pi_2 \partial E(\lambda_2)} = \delta\omega'(\pi_2)\tau_2 > 0 \tag{A.6}$$

$$\frac{\partial^2 g(\tau_2, \pi_2)}{\partial \tau_2 \partial E(\lambda_2)} = \delta\omega(\pi_2) > 0 \tag{A.7}$$

$$\frac{\partial^2 g(\tau_2, \pi_2)}{\partial \pi_2 \partial \theta} = \delta\omega'(\pi_2)\tau_2(1-\phi)2(2\gamma-1) + 2\frac{\partial L(\cdot)}{\partial \pi_2} > 0 \quad \text{for } \gamma > 1/2 \tag{A.8}$$

$$\frac{\partial^2 g(\tau_2, \pi_2)}{\partial \tau_2 \partial \theta} = \delta\omega(\pi_2)(1-\phi)2(2\gamma-1) + 2\frac{\partial F(\cdot)}{\partial \tau_2} > 0 \quad \text{for } \gamma > 1/2 \tag{A.9}$$

Following the same reasoning as in the proof of Part 1 d) of proposition 2.3.1, we are done.

Part 2 a) follows from (2.17). Part 2 b): The positive investments follow from the FOC for fiscal and legal capacity (i.e. (2.20) and (2.21)). The comparison to the model without debt is due to the fact that when no debt can be raised, $max\{\lambda_1, E(\lambda_2)\}$ has to be replaced by $E(\lambda_2)$ which is smaller (the comparison can be shown rigorously using monotone comparative statics similar to the proof of Part 1 d) of proposition 2.3.1). Part 2 c) and e) follow from the FOC for fiscal and legal capacity (i.e. (2.20) and (2.21)) and the definitions of λ_1 and $E(\lambda_2)$. Part 2 d) follows from (2.8).

Proof of proposition 2.3.4:

Part 1: The positive investments follow from the FOC for fiscal and legal capacity (i.e. (2.20) and (2.21)). The comparison to the model without debt is due to the fact that when no debt can be raised, $max\{\lambda_1, E(\lambda_2)\}$ has to be replaced by $E(\lambda_2)$ which is smaller (the comparison can be shown rigorously using monotone comparative statics similar to the proof of Part 1 d) of proposition 2.3.1). Part 2 follows from the FOC for fiscal and legal capacity (i.e. (2.20) and (2.21)) and the definitions of λ_1 and $E(\lambda_2)$. Part 3 follows from (2.17) and Part 4 follows from (2.8).

Proof of proposition 2.4.1:

Part 1 a) follows from $\lambda_1 < E(\lambda_2)$ and Part b) follows from $\alpha_L \geq 2(1-\theta)$. Part c) follows from the FOC for fiscal and legal capacity. Part 1 d) and e): We first want to show that fiscal and legal capacity are both monotone nondecreasing in ψ and $E(\lambda_2)$. Since ϕ enters the model only through $E(\lambda_2)$ and $E(\lambda_2)$ is increasing in ϕ, this suffices.

Let us rewrite equation (2.29):

$$f(b_1, \tau_2, \pi_2) = EV^{I_1}(\tau_2, \pi_2, b_1) - \lambda_1(F(\tau_2 - \tau_1) + L(\pi_2 - \pi_1) - b_1) \tag{A.10}$$

Since we are in case a), $b_1 = 0$ is the debt level that maximizes (A.10). Define $g(\tau_2, \pi_2) \equiv f(0, \tau_2, \pi_2)$. Following Corollary 3 of Milgrom and Shannon (1994), it remains to show that $g(\tau_2, \pi_2)$ is quasisupermodular in (τ_2, π_2) and satisfies the single crossing property in $(\tau_2, \pi_2, E(\lambda_2), \psi)$. We have:

$$\frac{\partial^2 g(\tau_2, \pi_2)}{\partial \pi_2 \partial \tau_2} = \delta\omega'(\pi_2)(E(\lambda_2) - 1) > 0 \tag{A.11}$$

$$\frac{\partial^2 g(\tau_2, \pi_2)}{\partial \pi_2 \partial E(\lambda_2)} = \delta\omega'(\pi_2)\tau_2 > 0 \tag{A.12}$$

$$\frac{\partial^2 g(\tau_2, \pi_2)}{\partial \pi_2 \partial \psi} = 0 \tag{A.13}$$

$$\frac{\partial^2 g(\tau_2, \pi_2)}{\partial \tau_2 \partial E(\lambda_2)} = \delta(\psi\bar{\omega}(\pi_2) + (1 - \psi)\underline{\omega}(\pi_2)) > 0 \tag{A.14}$$

$$\frac{\partial^2 g(\tau_2, \pi_2)}{\partial \tau_2 \partial \psi} = \delta(\bar{\omega}(\pi_2) - \underline{\omega}(\pi_2))(E(\lambda_2) - 1) > 0 \text{ since we have } E(\lambda_2) > \lambda_1 > 1 \tag{A.15}$$

By Theorem 6 of Milgrom and Shannon (1994), $g(\tau_2, \pi_2)$ has increasing differences in $(\tau_2, \pi_2, E(\lambda_2), \psi)$ and is supermodular in (τ_2, π_2). It follows that $g(\tau_2, \pi_2)$ satisfies the single crossing property in $(\tau_2, \pi_2, E(\lambda_2), \psi)$ and is quasisupermodular in (τ_2, π_2). So, fiscal and legal capacity are both monotone nondecreasing in $E(\lambda_2)$ and ψ.

It remains to show that fiscal and legal capacity are both strictly increasing in $E(\lambda_2)$ and ψ. Since we have shown that both are monotone nondecreasing, there are three other possibilities which we have to check: Fiscal capacity is strictly increasing while legal capacity remains constant, legal capacity is strictly increasing while fiscal capacity remains constant, both are constant. All of these can be shown to lead to a contradiction as demonstrated for the following case. Consider an increase in $E(\lambda_2)$. Assume fiscal capacity is strictly increasing while legal capacity remains constant. From (A.11) and (A.12) it follows that the left-hand side (LHS) of the FOC for π is increasing, so the right-hand side (RHS) has to increase as well. Since $L(\cdot)$ is convex,

π has to increase. This is a contradiction. In an analogous way, all other cases can be handled. The same can be done for an increase in ψ. In total, we conclude that fiscal and legal capacity must be strictly increasing in $E(\lambda_2)$ as well as ψ.

Part 1 f) follows from the FOC for fiscal and legal capacity and the definitions of λ_1 and $E(\lambda_2)$. Part 1 g) follows from the definition of free future revenues and the comparative statics for τ_2 and π_2.

Part 2.I a) follows from $\lambda_1 < E(\lambda_2)$ and Part b) follows from the FOC for fiscal and legal capacity. Part 2.I c)-e): We want to show that fiscal and legal capacity are both strictly increasing in ψ, θ (for $\gamma > 1/2$) and $E(\lambda_2)$. Since ϕ and γ enter the model only through $E(\lambda_2)$ and $E(\lambda_2)$ is increasing in ϕ and decreasing in γ, this suffices. For ψ and $E(\lambda_2)$, the proof is exactly as in Part 1. It remains to show that fiscal and legal capacity are both increasing in θ (for $\gamma > 1/2$).

As stated in Part a), $b_1 = 0$ is the debt level that maximizes (2.29). Define $g(\tau_2, \pi_2) \equiv f(0, \tau_2, \pi_2)$, with $f(b_1, \tau_2, \pi_2)$ denoting the objective function of (2.29). We have:

$$\frac{\partial^2 g(\tau_2, \pi_2)}{\partial \pi_2 \partial \tau_2} = \delta\omega'(\pi_2)(E(\lambda_2) - 1) > 0 \tag{A.16}$$

$$\frac{\partial^2 g(\tau_2, \pi_2)}{\partial \pi_2 \partial \theta} = \delta\omega'(\pi_2)\tau_2 2(1-\phi)(2\gamma - 1) + 2\frac{\partial L(\pi_2 - \pi_1)}{\partial \pi_2} > 0 \quad if\ \gamma > \frac{1}{2} \tag{A.17}$$

$$\frac{\partial^2 g(\tau_2, \pi_2)}{\partial \tau_2 \partial \theta} = \delta(\psi\bar{\omega}(\pi_2)+(1-\psi)\underline{\omega}(\pi_2))2(1-\phi)(2\gamma-1)+2\frac{\partial F(\tau_2 - \tau_1)}{\partial \tau_2} > 0 \quad if\ \gamma > \frac{1}{2} \tag{A.18}$$

Following the same reasoning as in the proof of Part 1, we are done.

Part 2.I f) follows from the definition of free future revenues and the comparative statics for τ_2 and π_2.

Part 2.II:

Part 2.II a): $b_1 = \bar{b}$ follows from the FOC for debt, as argued at the beginning of Section 2.4.1. The comparative statics for b_1 follow from the definition of $b_1 = \bar{b}$ and the comparative statics for τ_2 and π_2 in Part 2.II e) and f). Note that the formula for free future revenues becomes $\delta\tau_2\psi(\overline{v} - \underline{v})$, since $\bar{\omega}(\cdot)$ and $\underline{\omega}(\cdot)$ can be written as $\bar{\omega}(\cdot) = w(\cdot) + \overline{v}$ and $\underline{\omega}(\cdot) = w(\cdot) + \underline{v}$ as argued in Section 2.4. This term is increasing in τ_2. The comparative statics for free future revenues w.r.t ϕ and γ follow immediately from the comparative statics for τ_2 stated in Part 2.II e) and g). The comparative statics w.r.t ψ follow from $\frac{\partial \delta\tau_2\psi(\overline{v}-\underline{v})}{\partial\psi} = \delta\tau_2(\overline{v}-\underline{v}) + \delta\psi(\overline{v}-\underline{v})\frac{\partial\tau}{\partial\psi}$ and the comparative statics for τ_2 stated in Part 2.II f).

Part 2.II b): $\bar{b} < b_1 < \bar{\bar{b}}$ follows from the FOC for debt, as argued at the beginning of Section 2.4.1.

i: If ψ increases, the FOC for debt says that Δ has to increase. Since τ_2 and π_2 increase as stated by Part 2.II f), b_1 has to increase. *ii*: Since ϕ and γ enter the model only through $E(\lambda_2)$ and $E(\lambda_2)$ is increasing in ϕ and decreasing in γ, we have to show that free future revenues (FR) are increasing in $E(\lambda_2)$.

We have $\frac{\partial FR}{\partial E(\lambda_2)} = \frac{\partial\delta\tau_2(\psi\bar{\omega}(\pi_2)+(1-\psi)\underline{\omega}(\pi_2))}{\partial E(\lambda_2)} - \frac{\partial b_1}{\partial E(\lambda_2)}$ and $\frac{\partial\delta\tau_2(\psi\bar{\omega}(\pi_2)+(1-\psi)\underline{\omega}(\pi_2))}{\partial E(\lambda_2)} = \delta(\psi\bar{\omega}(\pi_2) + (1-\psi)\underline{\omega}(\pi_2))\frac{\partial\tau_2}{\partial E(\lambda_2)} + \delta\tau_2\omega'(\pi_2)\frac{\partial\pi_2}{\partial E(\lambda_2)}$. We cannot solve for b_1 explicitly, still we can say something about $\frac{\partial b_1}{\partial E(\lambda_2)}$. Taking the total differential w.r.t. $E(\lambda_2)$ of the FOC for b_1 we obtain $0 = 1 + \frac{(1-\psi)}{\psi}\frac{\partial^2 P(\Delta)}{\partial\Delta^2}\frac{\partial\Delta}{\partial E(\lambda_2)}$.

Since $P(\Delta)$ is convex, $\frac{\partial\Delta}{\partial E(\lambda_2)} < 0$. Since we are in case d), $\Delta = (1+R(b))b - (\tau_2\underline{\omega}(\pi_2)) = \frac{1}{\psi}((1+\rho)b_1 - \tau_2\underline{\omega}(\pi_2))$ so $\frac{\partial\Delta}{\partial E(\lambda_2)} = \frac{1}{\psi}((1+\rho)\frac{\partial b_1}{\partial E(\lambda_2)} - \underline{\omega}(\pi_2)\frac{\partial\tau_2}{\partial E(\lambda_2)} - \tau_2\omega'(\pi_2)\frac{\partial\pi_2}{\partial E(\lambda_2)})$.

This leads to $\frac{\partial b_1}{\partial E(\lambda_2)} < \delta(\underline{\omega}(\pi_2)\frac{\partial\tau_2}{\partial E(\lambda_2)} + \tau_2\omega'(\pi_2)\frac{\partial\pi_2}{\partial E(\lambda_2)})$.

Therefore, $\frac{\partial\delta\tau_2(\psi\bar{\omega}(\pi_2)+(1-\psi)\underline{\omega}(\pi_2))}{\partial E(\lambda_2)} > \frac{\partial b_1}{\partial E(\lambda_2)}$. So, free future revenues are increasing in $E(\lambda_2)$.

Part 2.II c) is due to $\alpha_L < 2(1-\theta)$. Part 2.II d) follows from the FOCs for τ_2 and π_2 in case c) and d). For Part 2.II e) and f) we apply again monotone comparative statics.

We want to show that fiscal and legal capacity are both strictly increasing in ψ and $E(\lambda_2)$ (since ϕ and γ enter the model only through $E(\lambda_2)$ and $E(\lambda_2)$ is increasing in ϕ and decreasing in γ, this suffices). We proceed in two stages, first we consider an economy in case c) (i.e. $E(\lambda_2) < \lambda_1 < E(\lambda_2) + \frac{(1-\psi)}{\psi}\left.\frac{\partial P(\Delta)}{\partial\Delta}\right|_{b=\bar{b}}$) and than in case d) (i.e. $\lambda_1 = E(\lambda_2) + \frac{(1-\psi)}{\psi}\frac{\partial P(\Delta)}{\partial\Delta}$).

In case c), $b_1 = \bar{b}$ is the debt level that maximizes (2.29). Define $g(\tau_2, \pi_2) \equiv$

$f(\bar{b}, \tau_2, \pi_2)$, with $f(b_1, \tau_2, \pi_2)$ denoting the objective function of (2.29). We have:

$$\frac{\partial^2 g(\tau_2, \pi_2)}{\partial \pi_2 \partial \tau_2} = \delta(\omega'(\pi_2)(\lambda_1 - 1)) > 0 \tag{A.19}$$

$$\frac{\partial^2 g(\tau_2, \pi_2)}{\partial \pi_2 \partial E(\lambda_2)} = 0 \tag{A.20}$$

$$\frac{\partial^2 g(\tau_2, \pi_2)}{\partial \tau_2 \partial E(\lambda_2)} = \delta\psi(\bar{\omega}(\pi_2) - \underline{\omega}(\pi_2)) > 0 \tag{A.21}$$

$$\frac{\partial^2 g(\tau_2, \pi_2)}{\partial \pi_2 \partial \psi} = 0 \tag{A.22}$$

$$\frac{\partial^2 g(\tau_2, \pi_2)}{\partial \tau_2 \partial \psi} = \delta(\bar{\omega}(\pi_2) - \underline{\omega}(\pi_2))(E(\lambda_2) - 1) > 0 \text{ if } E(\lambda_2) > 1 \tag{A.23}$$

Following the same reasoning as in the proof of Part 1, we are done.

In case d), the debt level $b^* \in (\bar{b}, \bar{\bar{b}})$ that maximizes (2.29) is implicitly defined by the FOC of b_1, $\lambda_1 = E(\lambda_2) + \frac{(1-\psi)}{\psi}\frac{\partial P(\Delta)}{\partial \Delta}$. Define $g(\tau_2, \pi_2) \equiv f(b^*, \tau_2, \pi_2)$. By the Envelope Theorem and plugging in the first order condition for debt, we obtain the same derivatives and cross-derivatives as in case c). Following the same reasoning as in case c), we are done.

Part 2.III a) follows from the FOC for debt, as argued at the beginning of Section 2.4.1. Part b) from the definition of $\bar{\bar{b}}$ and Part c) from the definitions of $\bar{\bar{b}}$ and free future revenues. Part d) is due to $\alpha_L < 2(1-\theta)$. Part e) and f) follow from the FOC for τ_2 and π_2 in case e). For g) we apply again monotone comparative statics.

As stated in Part a), $b_1 = \bar{\bar{b}}$ is the debt level that maximizes (2.29). Define $g(\tau_2, \pi_2) \equiv f(\bar{\bar{b}}, \tau_2, \pi_2)$, with $f(b_1, \tau_2, \pi_2)$ denoting the objective function of (2.29). We have:

$$\frac{\partial^2 g(\tau_2, \pi_2)}{\partial \pi_2 \partial \tau_2} = \delta\omega'(\pi_2)(\lambda_1 - 1) > 0 \tag{A.24}$$

$$\frac{\partial^2 g(\tau_2, \pi_2)}{\partial \pi_2 \partial \psi} = 0 \tag{A.25}$$

$$\frac{\partial^2 g(\tau_2,\pi_2)}{\partial\tau_2\partial\psi} = \delta(\bar{\omega}(\pi_2)-\underline{\omega}(\pi_2))(\lambda_1-1)+\psi\left.\frac{\partial P(\Delta)}{\partial\Delta}\right|_{b=\bar{\bar{b}}}(\bar{\omega}(\pi_2)-\underline{\omega}(\pi_2))>0 \quad \text{(A.26)}$$

Following the same reasoning as in the proof of Part 1, we are done. Q.E.D.

Proof of proposition 2.5.1:

In order to derive the relevant FOC, we will consider the two cases $b_1^* < \bar{b}$ and $b_1^* > \bar{b}$. The case $b_1^* = \bar{b}$ is a corner solution in terms of the optimal choice of debt where the first order condition for debt is given by inequalities. In the following, we will not present the derivation of the results for the case $b_1^* = \bar{b}$, but only mention how they differ from the other cases.

First, suppose that given the optimal τ_2^* and π_2^*, the optimal debt fulfills $b_1^* < \bar{b}$. For this constellation, we will never end up in Scenario 2 in the second period.

Therefore, using (2.42) and (2.43) in (2.45), we arrive at the following first order condition for debt b_1:

$$max\,\{2(1-\theta), V_g[\tau_1\omega_1(\pi_1)-F(\tau_2-\tau_1)-L(\pi_2-\pi_1)+b_1]\} = -\frac{\partial EV^{I_1}(\tau_2,\pi_2,b_1)}{\partial b_1} \quad \text{(A.27)}$$

The right-hand side of this equation gives the marginal benefit of public funds in the present seen from the perspective of the first-period incumbent. Since we assume that, at the solution $(\tau_2^*, \pi_2^*, b_1^*)$, it is optimal in the first period to provide transfers, the first term in the above equation evaluates to $2(1-\theta)$. We will now argue that the only possible configuration such that the first order condition for debt holds with equality is the following:[1] In the second period, for the boom situation $(\alpha_L, \bar{\omega}(\pi_2))$ we get transfers, while for the crisis situation $(\alpha_H, \underline{\omega}(\pi_2))$ no transfers are provided. The resulting first order condition for debt then is:

$$2(1-\theta) = \phi\underbrace{\alpha_H V_g(\tau_2\underline{\omega}(\pi_2)-(1+\rho)b_1)}_{>2(1-\theta)}+(1-\phi)[\underbrace{(1-\gamma)2(1-\theta)+\gamma 2\theta}_{\equiv\Gamma<2(1-\theta)}] \quad \text{(A.28)}$$

If the amount of resources available in a future crisis, $\tau_2\underline{\omega}(\pi_2)-(1+\rho)b_1$, were so big that $\alpha_H V_g[\tau_2\underline{\omega}(\pi_2)-(1+\rho)b_1] < 2(1-\theta)$ then transfer spending would also be optimal for $(\alpha_H, \underline{\omega}(\pi_2))$. The right-hand side of (A.28) would then be $\Gamma =$

[1] Recall that by assumption we want to focus on this equality case in the analysis.

$(1-\gamma)2(1-\theta)+\gamma 2\theta$, and it would be smaller than the left-hand side, $2(1-\theta)$. Intuitively, due to political instability, the benefit of future transfer spending, Γ, is lower than the benefit of current transfer spending, $2(1-\theta)$. Therefore, we need to have low enough future resources in the crisis situation such that the resulting marginal benefit of public good spending is higher than $2(1-\theta)$. This compensates for having transfer spending with a marginal benefit lower than $2(1-\theta)$ in the boom situation. However, less available resources in a future crisis, will also imply less available resources in a future boom, $\tau_2\overline{\omega}(\pi_2)-(1+\rho)b_1$. Our assumption to have (A.28) holding with equality, rules out the following: When we increase debt in order to leave low enough resources to a future crisis to make the marginal value of public good spending there high enough, the implied resources in a future boom, $\tau_2\overline{\omega}(\pi_2)-(1+\rho)b_1$, become so small that $\alpha_L V_g[\tau_2\overline{\omega}(\pi_2)-(1+\rho)b_1]$ surpasses $2(1-\theta)$ before (A.28) holds with equality. In that case, the term in square brackets of (A.28) would jump from Γ to the marginal value of public good spending which is at least $2(1-\theta)$, which means that public goods would also be provided in a boom and therefore the left-hand side would become smaller than the right-hand side of (A.28). This corner case is ruled out in the following analysis.

Let us denote the objective function to be maximized (see equation (2.45)) as:

$$f(b_1,\tau_2,\pi_2)=W(\alpha_1,\tau_1,\pi_1,m_1,n_1,b_0,b_1,2(1-\theta))+EV^{I_1}(\tau_2,\pi_2,b_1) \tag{A.29}$$

The debt level b_1^* that maximizes (A.29) is implicitly defined by the FOC for debt (A.28). Define $g(\tau_2,\pi_2)\equiv f(b_1^*,\tau_2,\pi_2)$. By the Envelope Theorem and plugging in the first order condition for debt (A.28), we arrive at the following first order conditions for future state capacities:

$$\begin{aligned}\frac{\partial g(\tau_2,\pi_2)}{\partial\tau_2}=&\delta\left\{(1-\phi)(\overline{\omega}(\pi_2)-\underline{\omega}(\pi_2))(\Gamma-1)+\underline{\omega}(\pi_2)\left[2(1-\theta)-1\right]\right\}\\&-2(1-\theta)\frac{\partial F(\tau_2-\tau_1)}{\partial\tau_2}=0\end{aligned}\tag{A.30}$$

$$\frac{\partial g(\tau_2,\pi_2)}{\partial\pi_2}=\delta\omega'(\pi_2)\left[1+\tau_2(2(1-\theta)-1)\right]-2(1-\theta)\frac{\partial L(\pi_2-\pi_1)}{\partial\pi_2}=0 \tag{A.31}$$

Now, suppose that given the optimal τ_2^* and π_2^*, the optimal debt fulfills $b_1^*>\bar{b}$. For this constellation, we will end up in Scenario 2 in the second period if $\alpha_2=\alpha_H$.

Therefore, in EV^{I_1}, i.e in equation (2.46), the terms $W(\alpha_H, \dots)$ are now given by (2.44) while the terms $W(\alpha_L, \dots)$ are still given by (2.43). The first order condition for debt b_1 is:

$$max\left\{2(1-\theta), V_g[\tau_1\omega_1(\pi_1) - F(\tau_2-\tau_1) - L(\pi_2-\pi_1) + b_1]\right\} = -\frac{\partial EV^{I_1}(\tau_2, \pi_2, b_1)}{\partial b_1} \tag{A.32}$$

It has the same structure as before, but EV^{I_1} differs in the just described way. In particular, since we assume that at the solution $(\tau_2^*, \pi_2^*, b_1^*)$, it is optimal in the first period to provide transfers, the first term in the above equation evaluates to $2(1-\theta)$. Analogously to the case $b_1^* < \bar{b}$, one can argue that the only possible configuration such that the first order condition for debt holds with equality is the following: In the second period, for the situation $(\alpha_L, \bar{\omega})$ we get transfers, while for $(\alpha_H, \underline{\omega})$ no transfers are provided. The resulting first order condition for debt is:

$$\frac{\phi}{1-\phi}\frac{\partial P(\Delta)}{\partial \Delta} = \underbrace{2(1-\theta) - [\underbrace{(1-\gamma)2(1-\theta) + \gamma 2\theta}_{\equiv \Gamma < 2(1-\theta)}]}_{\equiv N} \tag{A.33}$$

As before, write equation (2.45) as:

$$f(b_1, \tau_2, \pi_2) = W(\alpha_1, \tau_1, \pi_1, m_1, n_1, b_0, b_1, 2(1-\theta)) + EV^{I_1}(\tau_2, \pi_2, b_1) \tag{A.34}$$

The debt level b_1^* that maximizes (A.34) is implicitly defined by (A.33), the FOC with respect to debt. Define $g(\tau_2, \pi_2) \equiv f(b_1^*, \tau_2, \pi_2)$. By the Envelope Function Theorem and plugging in the first order condition for debt (A.33), we obtain:

$$\begin{aligned}\frac{\partial g(\tau_2, \pi_2)}{\partial \tau_2} =& \delta\left\{(1-\phi)(\overline{\omega}(\pi_2) - \underline{\omega}(\pi_2))(\Gamma - 1) + \underline{\omega}(\pi_2)\left[2(1-\theta) - 1\right]\right\} \\ &- 2(1-\theta)\frac{\partial F(\tau_2 - \tau_1)}{\partial \tau_2}\end{aligned} \tag{A.35}$$

$$\frac{\partial g(\tau_2, \pi_2)}{\partial \pi_2} = \delta\omega'(\pi_2)\left[1 + \tau_2(2(1-\theta) - 1)\right] - 2(1-\theta)\frac{\partial L(\pi_2 - \pi_1)}{\partial \pi_2} \tag{A.36}$$

Note that (A.35) and (A.36) are exactly the same derivatives as in (A.30) and (A.31), the first order conditions in the case $b_1^* < \bar{b}$. So, the FOCs for state capacity investments are the same for $b_1^* < \bar{b}$ and $b_1^* > \bar{b}$.[2]

Having derived these relevant FOCs, we now turn to the proof:

Part 1: has been shown in the reasoning above.

Part 2: follows from the FOC for fiscal and legal capacity and the assumption that $\tau_2 \geq \tau_1$ does not bind.

Part 3: We have

$$\frac{\partial^2 g(\tau_2, \pi_2)}{\partial \tau_2 \partial \pi_2} = \delta \left\{ \omega'(\pi_2) \left[2(1-\theta) - 1 \right] \right\} > 0 \tag{A.37}$$

$$\frac{\partial^2 g(\tau_2, \pi_2)}{\partial \tau_2 \partial \phi} = -\delta(\overline{\omega}(\pi_2) - \underline{\omega}(\pi_2))(\Gamma - 1) \begin{cases} > 0 \text{ if } \Gamma < 1 \\ < 0 \text{ if } \Gamma > 1 \end{cases} \tag{A.38}$$

$$\frac{\partial^2 g(\tau_2, \pi_2)}{\partial \pi_2 \partial \phi} = 0 \tag{A.39}$$

Following the same reasoning as in the proof of Part 1 of proposition 2.4.1, we are done.

Part 4: We have:

$$\frac{\partial^2 g(\tau_2, \pi_2)}{\partial \tau_2 \partial \gamma} = 2\delta \left\{ (1-\phi)(\bar{\omega} - \underline{\omega})[2\theta - 1] \right\} < 0 \tag{A.40}$$

$$\frac{\partial^2 g(\tau_2, \pi_2)}{\partial \pi_2 \partial \gamma} = 0 \tag{A.41}$$

and $\frac{\partial^2 g(\tau_2, \pi_2)}{\partial \tau_2 \partial \pi_2}$ as above. Following the same reasoning as in the proof of Part 1 of proposition 2.4.1, we are done.

Part 5: From the FOCs for debt for both cases $b_1^* > \bar{b}$ and $b_1^* < \bar{b}$ it follows that $\tau_2 \underline{\omega}(\pi_2) - (1+\rho)b_1$ is decreasing in γ (note that $\Delta = (1 + R(b))b - (\tau_2 \underline{\omega}(\pi_2) - \bar{g}) = \frac{1}{1-\phi}((1+\rho)b_1 - (\tau_2 \underline{\omega}(\pi_2) - \bar{g})))$, so $\delta\tau_2(\omega(\pi_2) + \underline{v}) - b_1$ is decreasing in γ. Free future revenues are given by $FR = \delta E(\tau_2 \omega(\pi_2)) - b_1 = \delta\tau_2(\phi\underline{\omega}(\pi_2) + (1-\phi)\overline{\omega}(\pi_2)) - b_1 = \delta\tau_2(\omega(\pi_2) + \underline{v}) - b_1 + \delta\tau_2(1-\phi)(\overline{v} - \underline{v})$. Since τ_2 is also decreasing in γ, we are done.

[2]The resulting FOCs for state capacity investments are the same for $b_1^* = \bar{b}$. This is similar to case (c) in the linear model and yields no new insights. In terms of the results in the proposition, Part 7 becomes superfluous and only Part 8 has to be modified when including the case $b_1^* = \bar{b}$. In particular, the result for $b_1^* = \bar{b}$ is analogous to the linear case: Debt and state capacity investments move in the *same* direction in response to a change in γ.

Part 6: From the FOCs for debt for both cases $b_1^* > \bar{b}$ and $b_1^* < \bar{b}$ it follows that $\tau_2\underline{\omega}(\pi_2) - (1+\rho)b_1$ is increasing in ϕ. Part 6 follows form the comparative statics for τ_2 and π_2.

Part 7: We want to show that for $\theta \to 1/2$, $b_1^* < \bar{b}$ is the case. For the FOCs for debt, we had (A.28) for $b_1^* < \bar{b}$:

$$2(1-\theta) = \underbrace{\phi \underbrace{\alpha_H V_g[\tau_2\underline{\omega}(\pi_2) - (1+\rho)b_1]}_{>2(1-\theta)} + (1-\phi)[\underbrace{(1-\gamma)2(1-\theta) + \gamma 2\theta}_{\equiv \Gamma < 2(1-\theta)}]}_{RHS_1} \quad \text{(A.42)}$$

and (A.33) for $b_1^* > \bar{b}$:

$$2(1-\theta) = \underbrace{\frac{\phi}{1-\phi}\frac{\partial P(\Delta)}{\partial \Delta} + [\underbrace{(1-\gamma)2(1-\theta) + \gamma 2\theta}_{\equiv \Gamma < 2(1-\theta)}]}_{RHS_2} \quad \text{(A.43)}$$

Since $2(1-\theta) \overset{\theta \to 1/2}{\to} 1$ and $RHS_2 \overset{\theta \to 1/2}{\to} x \geq \frac{\phi}{1-\phi} \frac{\partial P(\Delta)}{\partial \Delta}\Big|_{b=\bar{b}} + 1 > 1$, we have that $2(1-\theta) < RHS_2$ for $\theta \to 1/2$. So we cannot be in case $b_1^* > \bar{b}$ and therefore have to be in case $b_1^* < \bar{b}$. [3]

Part 8: From the FOCs for debt for both cases $b_1^* > \bar{b}$ and $b_1^* < \bar{b}$ it follows that $\tau_2\underline{\omega}(\pi_2) - (1+\rho)b_1$ is decreasing in γ (note that $\Delta = (1+R(b))b - (\tau_2\underline{\omega}(\pi_2) - \bar{g}) = \frac{1}{1-\phi}((1+\rho)b_1 - (\tau_2\underline{\omega}(\pi_2) - \bar{g})))$.

As we know, τ_2^* and π_2^* decrease with an increase in γ, thereby moving down $\tau_2\underline{\omega}(\pi_2) - (1+\rho)b_1$. This implies that $\tau_2\underline{\omega}(\pi_2) - (1+\rho)b_1$ is adjusted in the right direction, which makes it unclear if b_1^* also has to decrease or should increase in order to make $\tau_2\underline{\omega}(\pi_2) - (1+\rho)b_1$ move down by the required amount. However, the stronger τ_2^* and π_2^* decrease, the more likely that the induced decrease in $\tau_2\underline{\omega}(\pi_2) - (1+\rho)b_1$ is already enough. Even more, if they decrease a lot, they could induce a decrease in $\tau_2\underline{\omega}(\pi_2) - (1+\rho)b_1$ that is too high and b_1^* would then have to *decrease*.

Therefore, in the following, we investigate if the optimal values for the state capacities react stronger to an increase in γ for higher γ. If this is the case, then we get debt and state capacity investments to move in opposite directions in response to a change in γ for high γ.

[3] This can also be directly shown: By assumption (2.38), we have that for each constellation of parameters and optimal policies, $RHS_1 < RHS_2$. Moreover, for every $\theta = 1/2 - \epsilon$ with $\epsilon \to 1/2$ there exist optimal policies such that (A.42) holds with equality since $\Gamma \overset{\theta \to 1/2}{\to} 1$ and $\alpha_H V_g[\tau_2^*\underline{\omega}(\pi_2) - (1+\rho)b_1^*] \in (2(1-\theta), \alpha_H V_g(\overline{g})]$.

By the implicit function theorem, we get:

$$\frac{\partial \tau_2^*}{\partial \gamma} = \frac{1}{det(J)} \left(\underbrace{-\frac{\partial^2 g(\tau_2^*, \pi_2^*)}{\partial \pi_2^2}}_{>0} \cdot \underbrace{\frac{\partial^2 g(\tau_2^*, \pi_2^*)}{\partial \tau_2 \partial \gamma}}_{<0} + \underbrace{\frac{\partial^2 g(\tau_2^*, \pi_2^*)}{\partial \tau_2 \partial \pi_2}}_{>0} \cdot \underbrace{\frac{\partial^2 g(\tau_2^*, \pi_2^*)}{\partial \pi_2 \partial \gamma}}_{=0} \right) < 0 \quad (A.44)$$

$$\frac{\partial \pi_2^*}{\partial \gamma} = \frac{1}{det(J)} \left(\underbrace{-\frac{\partial^2 g(\tau_2^*, \pi_2^*)}{\partial \tau_2^2}}_{>0} \cdot \underbrace{\frac{\partial^2 g(\tau_2^*, \pi_2^*)}{\partial \pi_2 \partial \gamma}}_{=0} + \underbrace{\frac{\partial^2 g(\tau_2^*, \pi_2^*)}{\partial \tau_2 \partial \pi_2}}_{>0} \cdot \underbrace{\frac{\partial^2 g(\tau_2^*, \pi_2^*)}{\partial \tau_2 \partial \gamma}}_{<0} \right) < 0 \quad (A.45)$$

where $det(J)$ denotes the determinant of the Hessian of $g(\tau_2^*, \pi_2^*)$. By assuming enough curvature in the cost functions ($F_{\tau\tau}, L_{\pi\pi}$ big enough), we can ensure that $det(J) > 0$ and that the function $g(\tau_2, \pi_2)$ is strictly concave.

Preferably, we would like to derive $\frac{\partial^2 \tau_2^*}{\partial \gamma^2}$ and $\frac{\partial^2 \pi_2^*}{\partial \gamma^2}$. However, the resulting formulas are intractable without additional assumptions. Therefore, we opt here for the approach of considering first the individual terms in the equations and then determining if their interaction is likely to move $\frac{\partial \tau_2^*}{\partial \gamma}$ and $\frac{\partial \pi_2^*}{\partial \gamma}$ up. In the following, we keep all other parameters except for γ constant.

1. $\frac{\partial^2 g(\tau_2^*, \pi_2^*)}{\partial \tau_2^2} = -2(1-\theta) F_{\tau\tau}(\tau_2^* - \tau_1)$
   Assuming that $\frac{\partial F_{\tau\tau}(\cdot)}{\partial \tau}$ is constant, this term does not change with γ.

2. $\frac{\partial^2 g(\tau_2^*, \pi_2^*)}{\partial \pi_2^2} = \delta \omega''(\pi_2^*) \left\{1 + \tau_2^*(2(1-\theta) - 1)\right\} - 2(1-\theta) L_{\pi\pi}(\pi_2^* - \pi_1)$
   Assume that $\frac{\partial L_{\pi\pi}(\cdot)}{\partial \pi}$ and $\frac{\partial \omega''(\cdot)}{\partial \pi}$ are constant. [4] Then we get:

$$\frac{\frac{\partial^2 g(\tau_2^*, \pi_2^*)}{\partial \pi_2^2}}{\partial \gamma} = \delta \Big\{ \underbrace{\omega''}_{<0} \underbrace{[2(1-\theta) - 1]}_{>0} \underbrace{\frac{\partial \tau_2^*}{\partial \gamma}}_{<0} \Big\} > 0$$

3. $\frac{\partial^2 g(\tau_2^*, \pi_2^*)}{\partial \tau_2 \partial \pi_2} = \delta \left\{\omega'(\pi_2^*) \left[2(1-\theta) - 1\right]\right\}$
   This expression increases with γ, since π_2^* is decreasing with γ and $\omega(\cdot)$ is concave.

4. $det(J) = \underbrace{\left| \frac{\partial^2 g}{\partial \pi_2^2} \right|}_{\downarrow} \cdot \underbrace{\left| \frac{\partial^2 g}{\partial \tau_2^2} \right|}_{constant} + \underbrace{\left(- \left[\frac{\partial^2 g}{\partial \tau_2 \partial \pi_2} \right]^2 \right)}_{\downarrow}$
   The directional indicators refer to the reaction of the respective term to an

[4] Note that $\underline{\omega}''(\pi_2) = \overline{\omega}''(\pi_2) = \omega''(\pi_2)$ follows from $\underline{\omega}'(\pi_2) = \overline{\omega}'(\pi_2) = \omega'(\pi_2)$. $\omega''(\pi_2) < 0$ follows from the concavity of $\omega(\cdot)$.

increase in γ. As can be seen, $det(J)$ moves down in reaction to an increase in γ.

With all these results, we can now go back to (A.44) and (A.45):

$$\frac{\partial \pi_2^*}{\partial \gamma} = \underbrace{\frac{1}{det(J)}}_{\uparrow} \left(\underbrace{\frac{\partial^2 g(\tau_2^*, \pi_2^*)}{\partial \tau_2 \partial \pi_2}}_{\uparrow} \cdot \underbrace{\frac{\partial^2 g(\tau_2^*, \pi_2^*)}{\partial \tau_2 \partial \gamma}}_{constant} \right)$$

Thus, the reaction of legal capacity π_2^* to an increase in γ unambiguously gets stronger under the assumptions used in the preceding derivations. This is because $\frac{\partial^2 g(\tau_2^*, \pi_2^*)}{\partial \tau_2 \partial \gamma} < 0$ and therefore the increase in the first two (positive) factors makes the whole (negative) expression $\frac{\partial \pi_2^*}{\partial \gamma}$ more negative. Stated differently, $\frac{\partial \pi_2^*}{\partial \gamma}$ goes up in absolute value.

The reaction of fiscal capacity τ_2^* to an increase in γ also unambiguously gets stronger, as can be seen from the following:

$$\frac{\partial \left(\frac{\partial \tau_2^*}{\partial \gamma} \right)}{\partial \gamma} = - \underbrace{\frac{1}{\left[\left| \frac{\partial^2 g}{\partial \pi_2^2} \right| \left| \frac{\partial^2 g}{\partial \tau_2^2} \right| - \left(\frac{\partial^2 g}{\partial \tau_2 \partial \pi_2} \right)^2 \right]^2}}_{<0}$$
$$\cdot \left(\underbrace{2 \underbrace{\left| \frac{\partial^2 g}{\partial \pi_2^2} \right|}_{>0} \underbrace{\left| \frac{\partial^2 g}{\partial \tau_2 \partial \gamma} \right|}_{>0} \underbrace{\frac{\partial^2 g}{\partial \tau_2 \partial \pi_2}}_{>0} \underbrace{\frac{\partial \left(\frac{\partial^2 g}{\partial \tau_2 \partial \pi_2} \right)}{\partial \gamma}}_{>0}}_{>0} + \underbrace{\underbrace{\left[- \frac{\partial \left| \frac{\partial^2 g}{\partial \pi_2^2} \right|}{\partial \gamma} \right]}_{>0} \underbrace{\left| \frac{\partial^2 g}{\partial \tau_2 \partial \gamma} \right|}_{>0} \underbrace{\left(\frac{\partial^2 g}{\partial \tau_2 \partial \pi_2} \right)^2}_{>0}}_{>0} \right) < 0$$

Again, the whole (negative) expression $\frac{\partial \tau_2^*}{\partial \gamma}$ gets more negative or stated differently $\frac{\partial \tau_2^*}{\partial \gamma}$ goes up in absolute value. The reaction is stronger.

Therefore, we get indeed that for rising political instability γ, it is more likely that debt and state capacity investments move in opposite directions in response to a change in γ.

Q.E.D.

Proposition A.1.1. *Suppose an economy in the quasi-linear model with sovereign default starts in the first period with $\alpha_1 = \alpha_L$. Moreover, suppose that there are enough resources to provide transfers in period 1 and that the constraint $\tau_2 \geq \tau_1$ does* *bind. Furthermore, assume that the public good subutility function and the values of α_H and α_L are such that the first order condition for debt holds with equality for $b_1^* \neq \bar{b}$. For such $b_1^* \neq \bar{b}$, we get:*[5]

1. *If $\alpha_2 = \alpha_L$ ($\alpha_2 = \alpha_H$), transfers (no transfers) will be provided in the second period.*
2. *There is positive investment in legal capacity and zero investment in fiscal capacity.*
3. *Investment in legal capacity is constant w.r.t. ϕ.*
4. *Investment in legal capacity is constant w.r.t. γ.*
5. *Lower γ leads to an increase of free future revenues.*
6. *Lower γ leads to a decrease of debt.*
7. *Higher ϕ leads to a decrease of debt.*
8. *For $\theta \rightarrow 1/2$, the probability that a country will end up in a situation with sovereign default approaches 0.*

Proof of proposition A.1.1:

Part 1: This proof is equivalent to the proof of Part 1 of proposition 2.5.1. **Part 2, 3 and 4** follow from the FOC for legal capacity and the assumption that $\tau_2 \geq \tau_1$ binds. **Part 5** follows from the definition of free future revenues and the comparative statics for b_1, π_2 and the assumption that $\tau_2 \geq \tau_1$ binds. **Part 6 and 7** follow from the FOC for debt, the comparative statics for π_2 and the assumption that $\tau_2 \geq \tau_1$ binds. **Part 8:** This proof is equivalent to the proof of Part 7 of proposition 2.5.1.

Q.E.D.

[5]For $b_1^* = \bar{b}$, parts 1-4 are the same, free future revenues are constant w.r.t. γ (cf. Part 5), debt is constant w.r.t. γ and ϕ (cf. Part 6 and 7) and Part 8 becomes superfluous.

A.2 Variable Descriptions and Additional Figures

A. Variable Descriptions

Share of taxes in GDP is the variable "taxrevenuegdp99" of Besley and Persson (2011): "The ratio of total tax revenue to GDP in 1999. This is directly taken from Baunsgaard and Keen (2005)."[6]

Shadow economy is the variabel "minform" of Besley and Persson (2011): "This is the original variable (Informal Economy in % of GNP 1999/2000) from Schneider (2002)."[7]

Property Rights Protection Index is the variable "mgadp97" of Besley and Persson (2011): "This variable tries to measure the extent of government antidiversion policies. It is calculated as an average of indexes of 'law and order', 'bureaucratic quality', 'corruption', 'risk of expropriation' and 'government repudiation of contracts' from ICRG dataset in 1997 (International Country Risk Guide, The PRS Group (1980-present))."[8]

Cohesiveness is the variable "mxconst00" of Besley and Persson (2011): "Average executive constraints up to 2000. This measures the average value of the variable xconst (from Polity IV dataset (Marshall and Jaggers, 2010)) from 1800 (or independence date if later) up to 2000. The average is taken over non missing values of xconst (values outside $[1, 7]$ are treated as missing). This variable is normalized so that each country's scores lie between 0 and 1 (subtract 1 and divide by 6 as the possible range for the average score is from 1 to 7). This variable captures the parameter θ in the model."[9]

Political Stability is the variable "mgamma00" of Besley and Persson (2011): "Average non-open executive recruitment up to 2000. This measures average values of the sum of xropen and xrcomp variables in Polity IV dataset (Marshall and

[6] Variable description is taken from the codebook of Besley and Persson (2011). The codebook and the data are available at `http://www-2.iies.su.se/pop/Data_1.html`.

[7] Variable description is taken from the codebook of Besley and Persson (2011). The codebook and the data are available at `http://www-2.iies.su.se/pop/Data_1.html`.

[8] Variable description is taken from the codebook of Besley and Persson (2011). The codebook and the data are available at `http://www-2.iies.su.se/pop/Data_1.html`.

[9] Variable description is taken from the codebook of Besley and Persson (2011). The codebook and the data are available at `http://www-2.iies.su.se/pop/Data_1.html`.

Jaggers, 2010) from 1800 (or independence if later) to 2000. Note that the average is taken when both xropen and xrcomp are not missing (we treat xropen and xrcomp as missing if they are less than one). The sum of xropen and xrcomp takes values between 2 and 7 in any given year so in order to normalize the average we subtract 2 and divide by 5. To get a measure of political stability this average is inverted (multiplied by minus one and add with one). This variable corresponds to the parameter $1-\gamma$ in the model."[10]

Debt to GDP is the debt-to-GDP ratio in 2000, taken from Reinhart and Rogoff (2009). It measures the central government debt-to-GDP ratio. For 8 countries, this measure is not available and we use the general government debt-to-GDP ratio instead.[11]

[10] Variable description is taken from the codebook of Besley and Persson (2011). The codebook and the data are available at http://www-2.iies.su.se/pop/Data_1.html.

[11] The data is available at http://www.reinhartandrogoff.com/data/browse-by-topic/topics/9/.

B. Additional Figures

Country names of the figures of Section 2.4.2:

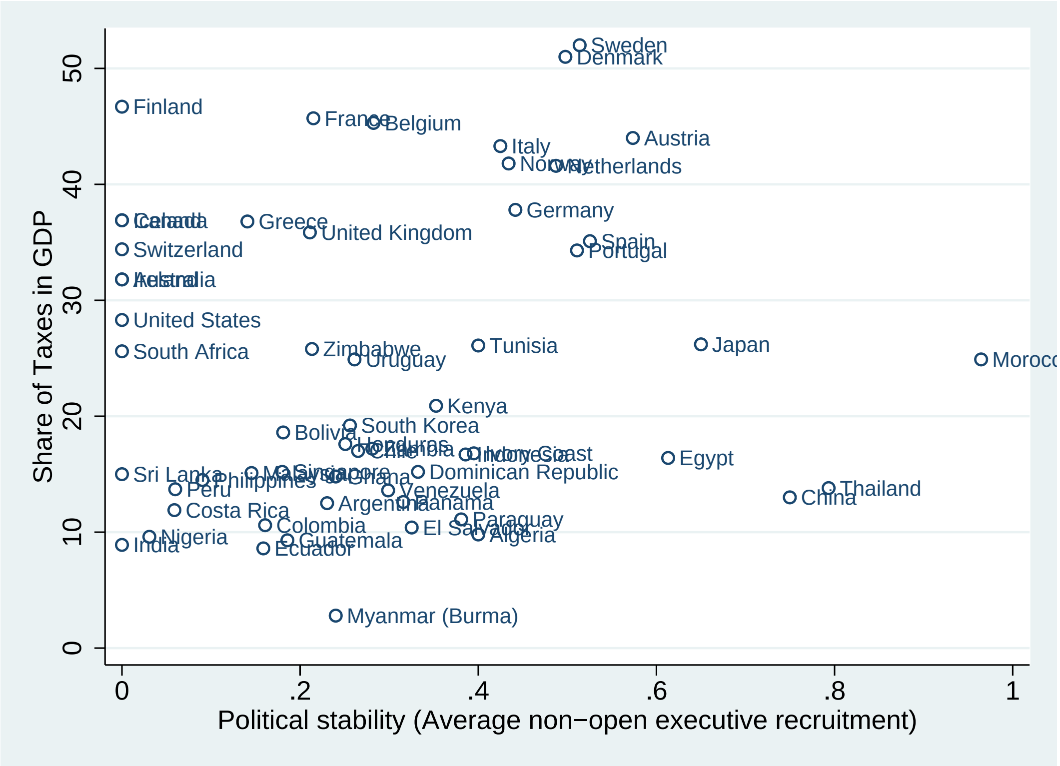


Figure A.1: Country names of Figure 2.2

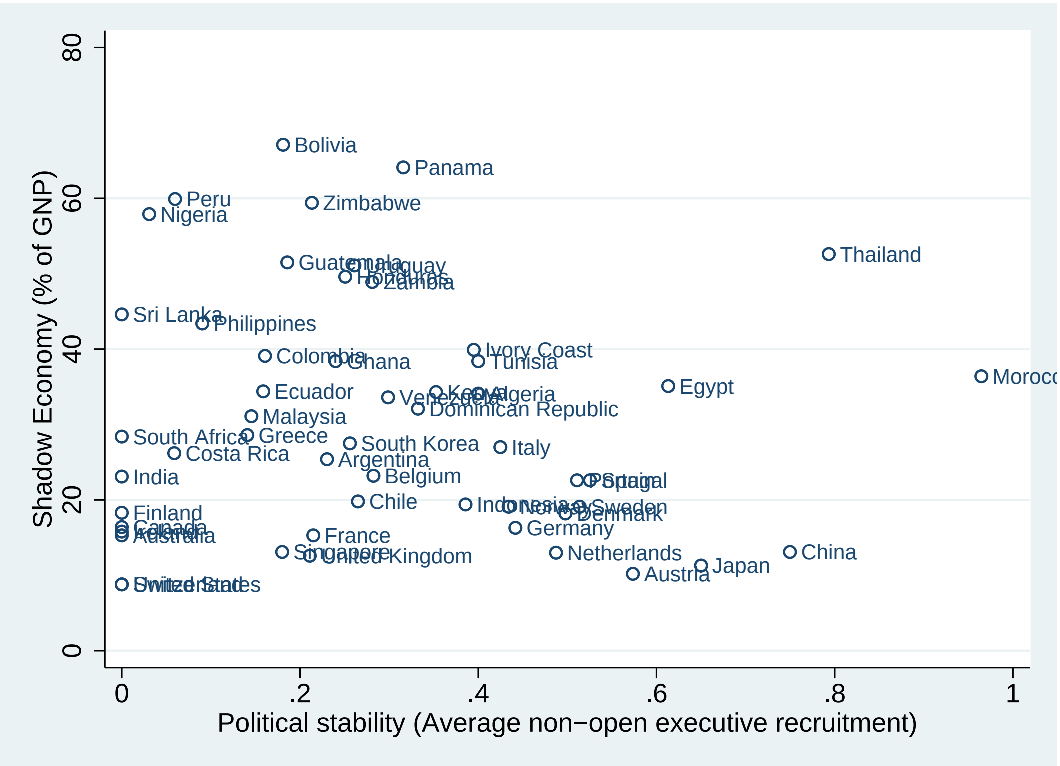


Figure A.2: Country names of Figure 2.3

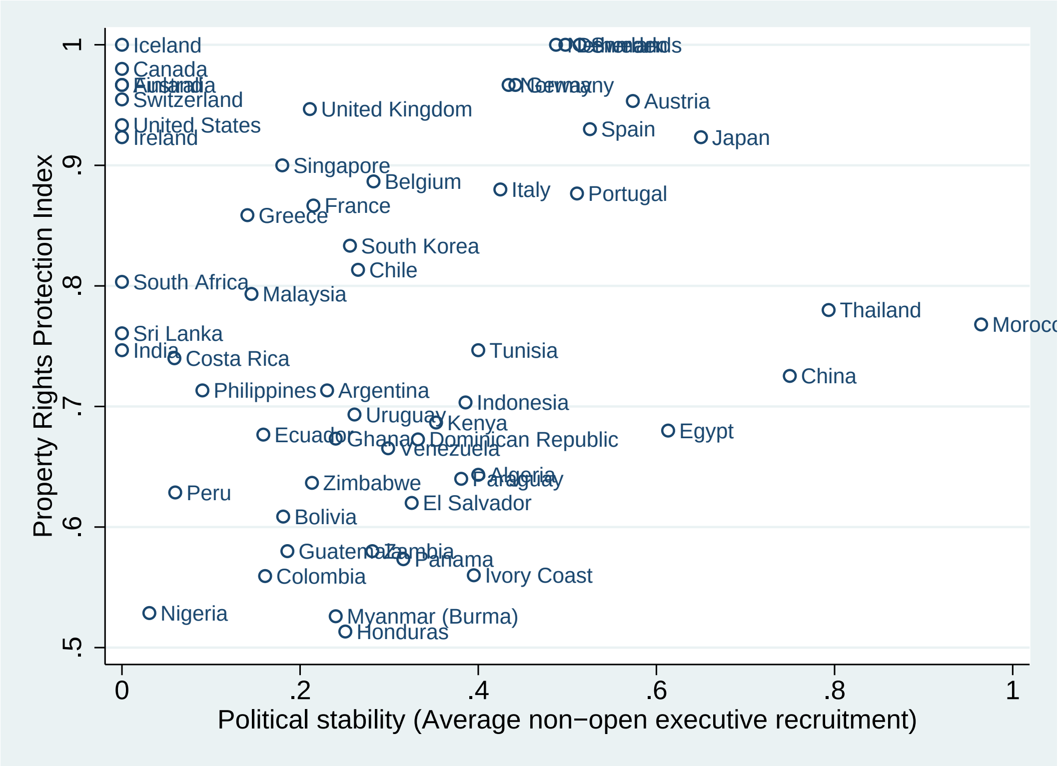


Figure A.3: Country names of Figure 2.4

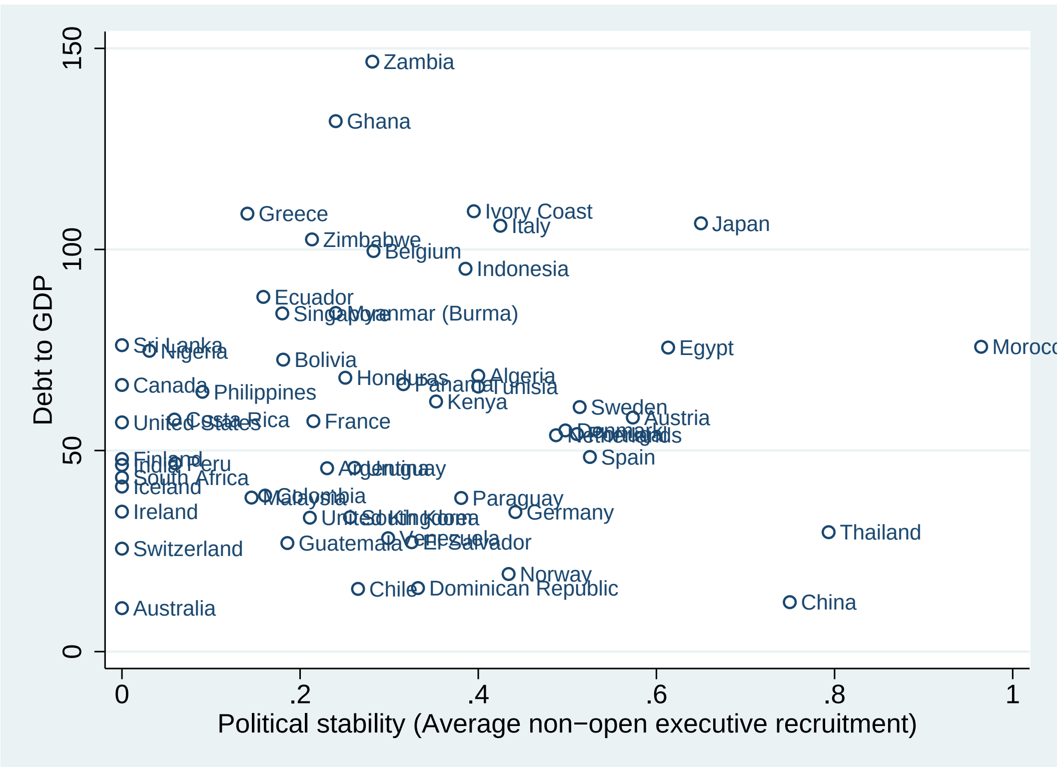


Figure A.4: Country names of Figure 2.5

Correlations with debt:

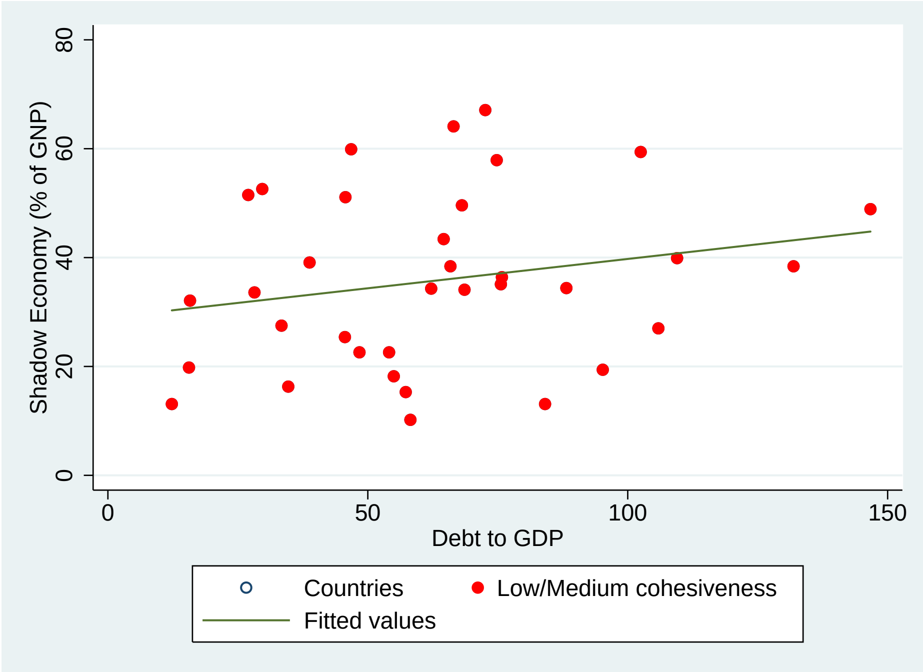


Figure A.5: Cross-country correlation between fiscal capacity and public debt (excluding countries with high cohesiveness). Correlation 0.2152; p-value 0.2145

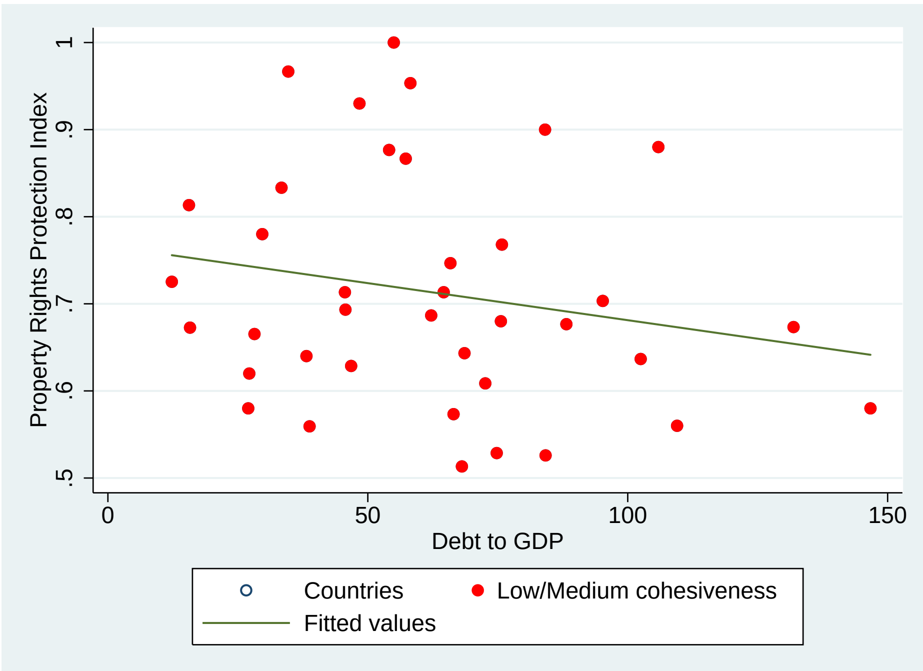


Figure A.6: Cross-country correlation between legal capacity and public debt (excluding countries with high cohesiveness). Correlation -0.2002; p-value 0.2282

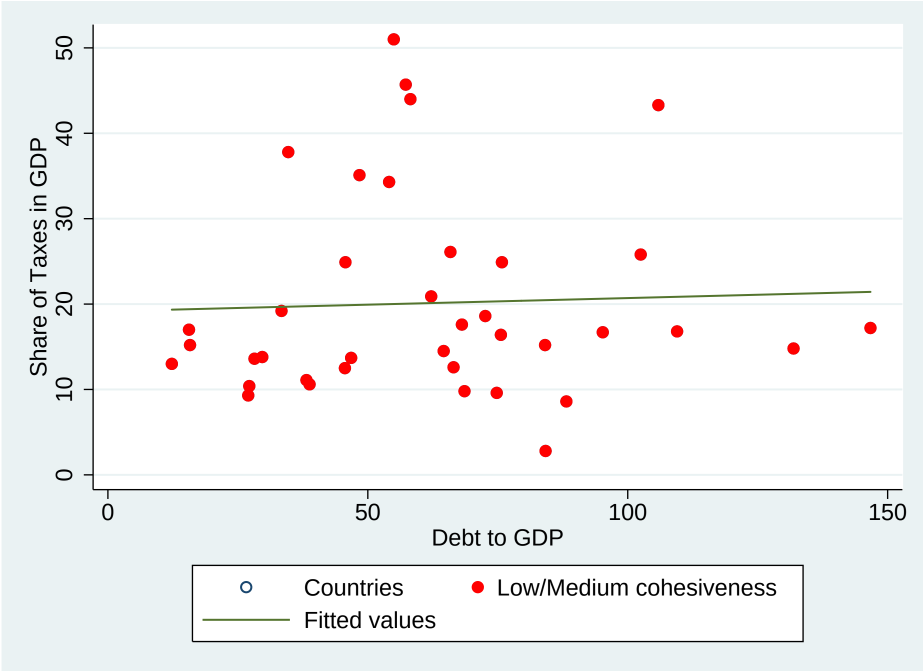


Figure A.7: Cross-country correlation between fiscal capacity and public debt (excluding countries with high cohesiveness). Correlation 0.0416; p-value 0.8040

Further figures:

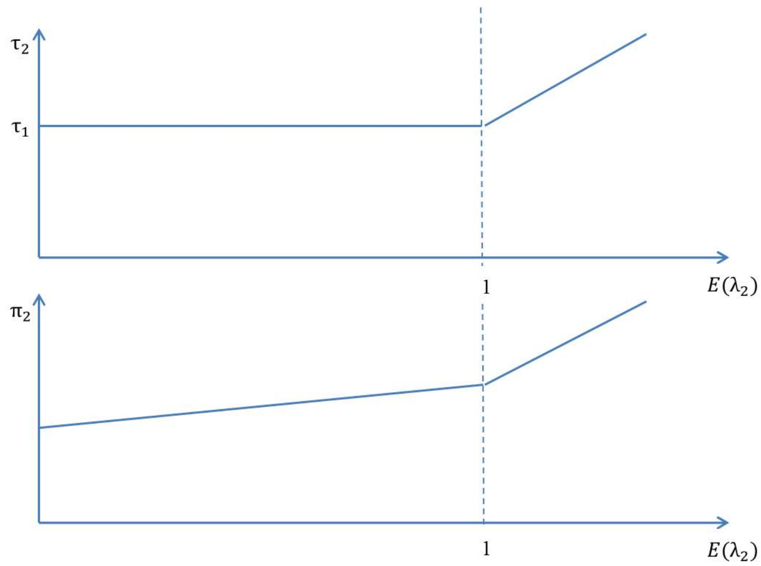


Figure A.8: This figure is the corresponding one to Figure 2.1 for the model without debt and is derived from equations 3.4 and 3.5 on p.111 in Besley and Persson (2011).

Appendix B

Appendix to Chapter 3

B.1 Additional Tables and Figures

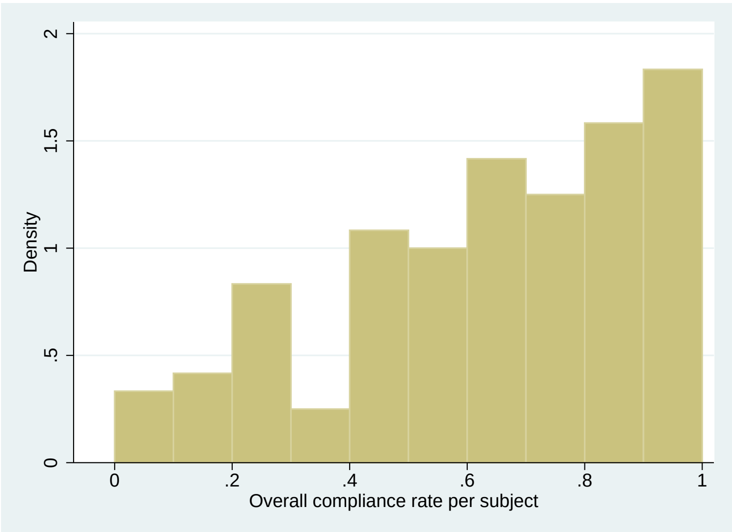


Figure B.1: Histogram of the overall compliance rate per subject, i.e. the average compliance rate across all rounds per subject

Table B.1: Estimation results for *Compliance rate*

	Spec. 1 Tobit(0)	Spec. 2 Tobit(0/1)	Spec. 3 Tobit(0)	Spec. 4 Tobit(0) 1-30
Income	-0.0030***	-0.0106***	-0.0030***	-0.0027***
	(0.0006)	(0.0022)	(0.0006)	(0.0007)
High audit rate	-0.0202	-0.0315	-0.0202	-0.0364*
	(0.0157)	(0.0519)	(0.0157)	(0.0215)
High audit rate * currInf	0.5480***	1.5899***	0.5480***	0.5561***
	(0.0659)	(0.2586)	(0.0659)	(0.0725)
Lag high audit rate	-0.0277	-0.0690	-0.0277	-0.0208
	(0.0192)	(0.0629)	(0.0192)	(0.0328)
Lag high audit rate * pastInf	0.2927***	0.9057***	0.2927***	0.2055***
	(0.0606)	(0.2140)	(0.0606)	(0.0714)
Lag high audit rate * currInf	-0.1083***	-0.3240***	-0.1083***	-0.1075**
	(0.0342)	(0.1045)	(0.0342)	(0.0494)
Amnesty	0.0130	0.0751	-0.0715**	-0.2482**
	(0.0220)	(0.0727)	(0.0337)	(0.1081)
Amnesty * currInf	-0.0845**	-0.2918**		
	(0.0422)	(0.1272)		
Amnesty * pastInf	-0.0571	-0.1756	0.0274	0.2083
	(0.0419)	(0.1321)	(0.0479)	(0.1470)
Amnesty * noInf			0.0845**	0.1758
			(0.0422)	(0.1374)
Amnesty first half	-0.1104*	-0.2619	-0.1104*	
	(0.0620)	(0.2135)	(0.0620)	
Age	0.0078	0.0352	0.0078	0.0075
	(0.0073)	(0.0290)	(0.0073)	(0.0067)
Male	-0.1304**	-0.3923**	-0.1304**	-0.1208**
	(0.0586)	(0.1928)	(0.0586)	(0.0547)
Prepared own tax return	-0.0036	-0.1231	-0.0036	0.0012
	(0.0755)	(0.2143)	(0.0755)	(0.0713)
Risk aversion	0.0515***	0.1503**	0.0515***	0.0358**
	(0.0174)	(0.0595)	(0.0174)	(0.0156)
Lag vol. disclosure	-0.1794**	-0.5959**	-0.1794**	-0.2666**
	(0.0872)	(0.2387)	(0.0872)	(0.1301)
Lag vol. disclosure * currInf	0.1874*	0.6014**	0.1874*	0.2334
	(0.1065)	(0.3049)	(0.1065)	(0.1696)
Lag vol. disclosure * pastInf	0.1988	0.5793	0.1988	0.0710
	(0.1213)	(0.3625)	(0.1213)	(0.4305)
Lag audit	-0.1706***	-0.5096***	-0.1706***	-0.1000*
	(0.0510)	(0.1563)	(0.0510)	(0.0537)
Lag audit * currInf	0.1078	0.3414	0.1078	0.0654
	(0.0714)	(0.2216)	(0.0714)	(0.0868)
Lag audit * pastInf	0.0359	0.0943	0.0359	0.0230
	(0.0598)	(0.1861)	(0.0598)	(0.0612)
Round	-0.0008	-0.0002	-0.0008	-0.0053**
	(0.0008)	(0.0026)	(0.0008)	(0.0022)
Round * currInf	0.0006	0.0005	0.0006	0.0012
	(0.0012)	(0.0035)	(0.0012)	(0.0028)
Round * pastInf	-0.0028**	-0.0082**	-0.0028**	0.0012
	(0.0012)	(0.0040)	(0.0012)	(0.0030)
currInf	-0.4647***	-1.2062***	-0.4647***	-0.4039***
	(0.0773)	(0.2508)	(0.0773)	(0.0806)
pastInf	-0.0925	-0.1494	-0.0925	-0.1582*
	(0.0674)	(0.2504)	(0.0674)	(0.0919)
Constant	0.6977***	1.1148	0.6977***	0.8135***
	(0.1919)	(0.7287)	(0.1919)	(0.1771)
N	7080	7080	7080	3480
Subjects	120	120	120	120
Log-Likelihood	-3996.105	-5082.827	-3996.105	-1985.169

The dependent variable is the compliance rate (declared income over true income) per subject and round. Cluster-robust standard errors (subject level, for Tobit estimations obtained via bootstrapping with 100 replications) are provided in parentheses. ***,** and * indicate significance at the 1%, 5% and 10% level. Tobit(0) treats 0 as censored data while Tobit(0/1) treats 0 and 1 as censored.

Table B.2: Estimation results for *Full compliance*

	Spec. 1 Probit	Spec. 2 Probit	Spec. 3 Probit 1-30
Income	-0.0158***	-0.0158***	-0.0151***
	(0.0021)	(0.0021)	(0.0026)
High audit rate	0.0526	0.0526	0.0370
	(0.0530)	(0.0530)	(0.0827)
High audit rate * currInf	1.6988***	1.6988***	1.7021***
	(0.2166)	(0.2166)	(0.2315)
Lag high audit rate	-0.0403	-0.0403	0.0159
	(0.0872)	(0.0872)	(0.1241)
Lag high audit rate * pastInf	1.0306***	1.0306***	0.7570***
	(0.1950)	(0.1950)	(0.2347)
Lag high audit rate * currInf	-0.3548**	-0.3548**	-0.3927**
	(0.1392)	(0.1392)	(0.1903)
Amnesty	0.1220	-0.2679**	-0.7735***
	(0.0882)	(0.1293)	(0.2977)
Amnesty * currInf	-0.3899**		
	(0.1565)		
Amnesty * pastInf	-0.1820	0.2079	0.5128
	(0.1598)	(0.1857)	(0.5133)
Amnesty * noInf		0.3899**	0.5048
		(0.1565)	(0.4889)
Amnesty first half	-0.4358*	-0.4358*	
	(0.2436)	(0.2436)	
Age	0.0413	0.0413	0.0478
	(0.0354)	(0.0354)	(0.0347)
Male	-0.2078	-0.2078	-0.0990
	(0.2386)	(0.2386)	(0.2247)
Prepared own tax return	-0.1868	-0.1868	-0.1293
	(0.2436)	(0.2436)	(0.2226)
Risk aversion	0.1358**	0.1358**	0.0888
	(0.0676)	(0.0676)	(0.0632)
Lag vol. disclosure	-0.6650***	-0.6650***	-0.7147*
	(0.2414)	(0.2414)	(0.4073)
Lag vol. disclosure * currInf	0.6116*	0.6116*	0.9130
	(0.3621)	(0.3621)	(0.6098)
Lag vol. disclosure * pastInf	0.5652	0.5652	0.0647
	(0.3634)	(0.3634)	(0.7424)
Lag audit	-0.4555**	-0.4555**	-0.2754
	(0.1888)	(0.1888)	(0.1951)
Lag audit * currInf	0.3049	0.3049	0.1529
	(0.2348)	(0.2348)	(0.2674)
Lag audit * pastInf	0.0331	0.0331	0.0049
	(0.2574)	(0.2574)	(0.2741)
Round	0.0018	0.0018	-0.0083
	(0.0029)	(0.0029)	(0.0082)
Round * currInf	0.0014	0.0014	0.0101
	(0.0044)	(0.0044)	(0.0110)
Round * pastInf	-0.0062	-0.0062	-0.0024
	(0.0052)	(0.0052)	(0.0111)
currInf	-1.0973***	-1.0973***	-1.1087***
	(0.3157)	(0.3157)	(0.3183)
pastInf	-0.1651	-0.1651	-0.2053
	(0.3393)	(0.3393)	(0.3520)
Constant	0.3524	0.3524	0.4322
	(0.8375)	(0.8375)	(0.8080)
N	7080	7080	3480
Subjects	120	120	120
Log-Likelihood	-3085.246	-3085.246	-1650.626

The dependent variable is *Full compliance* (1 or 0) per subject and round. Cluster-robust standard errors (subject level) are provided in parentheses. ***,** and * indicate significance at the 1%, 5% and 10% level.

Table B.3: Estimation results for *Full compliance*

	Spec. 1 Logit	Spec. 2 Logit	Spec. 3 Logit 1-30
Income	-0.0283***	-0.0283***	-0.0268***
	(0.0037)	(0.0037)	(0.0044)
High audit rate	0.0976	0.0976	0.0710
	(0.0902)	(0.0902)	(0.1454)
High audit rate * currInf	3.0147***	3.0147***	3.0591***
	(0.4130)	(0.4130)	(0.4363)
Lag high audit rate	-0.0836	-0.0836	0.0098
	(0.1486)	(0.1486)	(0.2197)
Lag high audit rate * pastInf	1.8601***	1.8601***	1.3666***
	(0.3493)	(0.3493)	(0.4126)
Lag high audit rate * currInf	-0.6361**	-0.6361**	-0.6819*
	(0.2494)	(0.2494)	(0.3499)
Amnesty	0.1998	-0.4705**	-1.3717**
	(0.1537)	(0.2262)	(0.5486)
Amnesty * currInf	-0.6702**		
	(0.2736)		
Amnesty * pastInf	-0.3051	0.3652	0.9179
	(0.2797)	(0.3254)	(0.9202)
Amnesty * noInf		0.6702**	0.9076
		(0.2736)	(0.8810)
Amnesty first half	-0.7836*	-0.7836*	
	(0.4407)	(0.4407)	
Age	0.0765	0.0765	0.0880
	(0.0649)	(0.0649)	(0.0627)
Male	-0.3847	-0.3847	-0.1701
	(0.4331)	(0.4331)	(0.4009)
Prepared own tax return	-0.3208	-0.3208	-0.2177
	(0.4422)	(0.4422)	(0.3975)
Risk aversion	0.2384*	0.2384*	0.1540
	(0.1217)	(0.1217)	(0.1132)
Lag vol. disclosure	-1.1782***	-1.1782***	-1.2809*
	(0.4141)	(0.4141)	(0.7257)
Lag vol. disclosure * currInf	1.0732*	1.0732*	1.6348
	(0.6167)	(0.6167)	(1.0718)
Lag vol. disclosure * pastInf	1.0038	1.0038	0.1465
	(0.6248)	(0.6248)	(1.2870)
Lag audit	-0.8139**	-0.8139**	-0.4585
	(0.3290)	(0.3290)	(0.3411)
Lag audit * currInf	0.4864	0.4864	0.1858
	(0.4052)	(0.4052)	(0.4555)
Lag audit * pastInf	0.0116	0.0116	-0.0363
	(0.4494)	(0.4494)	(0.4869)
Round	0.0025	0.0025	-0.0141
	(0.0052)	(0.0052)	(0.0142)
Round * currInf	0.0036	0.0036	0.0172
	(0.0078)	(0.0078)	(0.0191)
Round * pastInf	-0.0098	-0.0098	-0.0055
	(0.0094)	(0.0094)	(0.0193)
currInf	-1.9942***	-1.9942***	-1.9662***
	(0.5786)	(0.5786)	(0.5820)
pastInf	-0.3026	-0.3026	-0.3206
	(0.6123)	(0.6123)	(0.6317)
Constant	0.6343	0.6343	0.6858
	(1.5185)	(1.5185)	(1.4490)
N	7080	7080	3480
Subjects	120	120	120
Log-Likelihood	-3075.539	-3075.539	-1644.768

The dependent variable is *Full compliance* (1 or 0) per subject and round. Cluster-robust standard errors (subject level) are provided in parentheses. ***,** and * indicate significance at the 1%, 5% and 10% level.

Table B.4: Estimation results for *Full compliance*

	Spec. 1 Linear probability	Spec. 2 Linear probability	Spec. 3 Linear probability 1-30
Income	-0.0037***	-0.0037***	-0.0038***
	(0.0005)	(0.0005)	(0.0006)
High audit rate	0.0119	0.0119	0.0093
	(0.0121)	(0.0121)	(0.0204)
High audit rate * currInf	0.4339***	0.4339***	0.4504***
	(0.0486)	(0.0486)	(0.0525)
Lag high audit rate	-0.0110	-0.0110	0.0020
	(0.0207)	(0.0207)	(0.0322)
Lag high audit rate * pastInf	0.2411***	0.2411***	0.1858***
	(0.0486)	(0.0486)	(0.0601)
Lag high audit rate * currInf	-0.0814***	-0.0814***	-0.0857*
	(0.0316)	(0.0316)	(0.0455)
Amnesty	0.0294	-0.0562*	-0.1811**
	(0.0216)	(0.0309)	(0.0743)
Amnesty * currInf	-0.0856**		
	(0.0377)		
Amnesty * pastInf	-0.0491	0.0364	0.0956
	(0.0368)	(0.0428)	(0.1233)
Amnesty * noInf		0.0856**	0.0899
		(0.0377)	(0.1223)
Amnesty first half	-0.1164**	-0.1164**	
	(0.0552)	(0.0552)	
Age	0.0106	0.0106	0.0108
	(0.0075)	(0.0075)	(0.0073)
Male	-0.0362	-0.0362	-0.0101
	(0.0556)	(0.0556)	(0.0556)
Prepared own tax return	-0.0484	-0.0484	-0.0299
	(0.0588)	(0.0588)	(0.0572)
Risk aversion	0.0328**	0.0328**	0.0224
	(0.0148)	(0.0148)	(0.0152)
Lag vol. disclosure	-0.1764**	-0.1764**	-0.1549
	(0.0739)	(0.0739)	(0.1111)
Lag vol. disclosure * currInf	0.1771*	0.1771*	0.2107
	(0.0997)	(0.0997)	(0.1571)
Lag vol. disclosure * pastInf	0.1776*	0.1776*	0.0022
	(0.1000)	(0.1000)	(0.1869)
Lag audit	-0.1138**	-0.1138**	-0.0661
	(0.0491)	(0.0491)	(0.0511)
Lag audit * currInf	0.0720	0.0720	0.0265
	(0.0598)	(0.0598)	(0.0671)
Lag audit * pastInf	0.0188	0.0188	0.0053
	(0.0633)	(0.0633)	(0.0691)
Round	0.0004	0.0004	-0.0022
	(0.0007)	(0.0007)	(0.0020)
Round * currInf	0.0007	0.0007	0.0025
	(0.0011)	(0.0011)	(0.0026)
Round * pastInf	-0.0014	-0.0014	-0.0000
	(0.0012)	(0.0012)	(0.0027)
currInf	-0.2979***	-0.2979***	-0.3216***
	(0.0780)	(0.0780)	(0.0844)
pastInf	-0.0815	-0.0815	-0.1041
	(0.0835)	(0.0835)	(0.0883)
Constant	0.5629***	0.5629***	0.6467***
	(0.1810)	(0.1810)	(0.1793)
N	7080	7080	3480
Subjects	120	120	120
R^2 overall	0.1348	0.1348	0.1215

The dependent variable is *Full compliance* (1 or 0) per subject and round.
Cluster-robust standard errors (subject level) are provided in parentheses.
***,** and * indicate significance at the 1%, 5% and 10% level.

Table B.5: Estimation results for *Compliance rate*

	Spec. 1 fractional GLM	Spec. 2 fractional GLM	Spec. 3 fractional GLM 1-30
Income	-0.0135***	-0.0135***	-0.0124***
	(0.0026)	(0.0026)	(0.0032)
High audit rate	-0.0848	-0.0848	-0.1402
	(0.0711)	(0.0711)	(0.1025)
High audit rate * currInf	2.1158***	2.1158***	2.1783***
	(0.2457)	(0.2457)	(0.2694)
Lag high audit rate	-0.1404	-0.1404	-0.1124
	(0.1214)	(0.1214)	(0.1903)
Lag high audit rate * pastInf	1.3319***	1.3319***	1.0608***
	(0.2833)	(0.2833)	(0.3500)
Lag high audit rate * currInf	-0.3273*	-0.3273*	-0.2871
	(0.1706)	(0.1706)	(0.2548)
Amnesty	0.0567	-0.2436*	-0.8093**
	(0.1216)	(0.1295)	(0.3825)
Amnesty * currInf	-0.3003*		
	(0.1795)		
Amnesty * pastInf	-0.2716	0.0287	0.4552
	(0.1879)	(0.1926)	(0.5439)
Amnesty * noInf		0.3003*	0.4534
		(0.1795)	(0.5022)
Amnesty first half	-0.4305*	-0.4305*	
	(0.2282)	(0.2282)	
Age	0.0436	0.0436	0.0460
	(0.0327)	(0.0327)	(0.0319)
Male	-0.4544*	-0.4544*	-0.4271*
	(0.2370)	(0.2370)	(0.2232)
Prepared own tax return	-0.1064	-0.1064	-0.0431
	(0.2901)	(0.2901)	(0.2857)
Risk aversion	0.1959***	0.1959***	0.1320**
	(0.0656)	(0.0656)	(0.0615)
Lag vol. disclosure	-0.5239	-0.5239	-0.6169
	(0.4631)	(0.4631)	(0.6425)
Lag vol. disclosure * currInf	0.4321	0.4321	0.5421
	(0.6064)	(0.6064)	(0.8560)
Lag vol. disclosure * pastInf	1.1309	1.1309	1.2194
	(0.8333)	(0.8333)	(1.2724)
Lag audit	-0.5854**	-0.5854**	-0.3606
	(0.2478)	(0.2478)	(0.2598)
Lag audit * currInf	0.4124	0.4124	0.1523
	(0.3029)	(0.3029)	(0.3383)
Lag audit * pastInf	-0.0295	-0.0295	-0.0303
	(0.3114)	(0.3114)	(0.3263)
Round	-0.0035	-0.0035	-0.0270**
	(0.0039)	(0.0039)	(0.0110)
Round * currInf	0.0042	0.0042	0.0150
	(0.0049)	(0.0049)	(0.0133)
Round * pastInf	-0.0107*	-0.0107*	0.0089
	(0.0055)	(0.0055)	(0.0142)
currInf	-1.7154***	-1.7154***	-1.7725***
	(0.2964)	(0.2964)	(0.3154)
pastInf	-0.3897	-0.3897	-0.7414*
	(0.3350)	(0.3350)	(0.3969)
Constant	1.0365	1.0365	1.5331**
	(0.8040)	(0.8040)	(0.7501)
N	7080	7080	3480
Subjects	120	120	120
Log-Likelihood	-3595.247	-3595.247	-1734.253

The dependent variable is the compliance rate (declared income over true income) per subject and round (values above 1 are treated as 1 in these estimations). Cluster-robust standard errors (subject level) are provided in parentheses. ***,** and * indicate significance at the 1%, 5% and 10% level.

Table B.6: Estimation results for *Compliance rate*

	Spec. 1 GLS currInf	Spec. 2 GLS pastInf	Spec. 3 GLS noInf
Income	-0.0029***	-0.0019**	-0.0029***
	(0.0007)	(0.0009)	(0.0008)
High audit rate	0.3991***	0.0064	-0.0397**
	(0.0416)	(0.0163)	(0.0172)
Lag high audit rate	-0.0969***	0.2037***	-0.0121
	(0.0197)	(0.0409)	(0.0198)
Amnesty	-0.0498**	-0.0336	0.0124
	(0.0251)	(0.0250)	(0.0184)
Amnesty first half	-0.1278	-0.0251	-0.0827
	(0.0783)	(0.0816)	(0.0580)
Age	0.0070	0.0122	0.0048
	(0.0114)	(0.0076)	(0.0062)
Male	-0.0801	-0.0710	-0.0895
	(0.0950)	(0.0765)	(0.0585)
Prepared own tax return	0.0865	-0.0878	-0.0613
	(0.1014)	(0.1157)	(0.0653)
Risk aversion	0.0558***	0.0418**	0.0153
	(0.0212)	(0.0203)	(0.0179)
Lag vol. disclosure	0.0102	0.0049	-0.1583**
	(0.0553)	(0.0650)	(0.0807)
Lag audit	-0.0451	-0.1129***	-0.1383***
	(0.0317)	(0.0311)	(0.0458)
Round	0.0002	-0.0027***	-0.0006
	(0.0006)	(0.0008)	(0.0006)
Constant	0.3057	0.4587**	0.9641***
	(0.2635)	(0.2316)	(0.1527)
N	2360	2360	2360
Subjects	40	40	40
R^2 overall	0.2583	0.1211	0.0735

The dependent variable is the compliance rate (declared income over true income) per subject and round. Cluster-robust standard errors (subject level) are provided in parentheses. ***,** and * indicate significance at the 1%, 5% and 10% level.

Table B.7: Estimation results for *Number of voluntary disclosures*

	Spec. 1 Poisson	Spec. 2 Poisson	Spec. 3 Poisson
currInf	0.5280*	0.5062*	0.4677
	(0.2887)	(0.2883)	(0.2860)
Mean auditrate	14.2334***		
	(4.7963)		
Log mean auditrate		1.4656***	
		(0.5021)	
Log jumps			1.0463***
			(0.3683)
Amnesty first half	0.2690	0.2615	0.1566
	(0.2907)	(0.2863)	(0.2620)
Age	-0.0549	-0.0532	-0.0586
	(0.0431)	(0.0423)	(0.0448)
Male	0.3309	0.3170	0.2676
	(0.3456)	(0.3418)	(0.3112)
Prepared own tax return	0.1759	0.1641	0.2406
	(0.4022)	(0.3991)	(0.4056)
Risk aversion	-0.1581**	-0.1558**	-0.1475**
	(0.0756)	(0.0747)	(0.0654)
Constant	0.1784	4.9990***	0.4936
	(1.1196)	(1.8773)	(1.0205)
N	80	80	79
Subjects	80	80	79
pseudo R^2	0.1372	0.1399	0.1427
Log-Likelihood	-118.946	-118.5771	-117.101

The dependent variable are the number of voluntary disclosures per subject. The sample comprises the treatments currInf and pastInf. Robust standard errors are provided in parentheses. ***,** and * indicate significance at the 1%, 5% and 10% level.

Table B.8: Voluntary disclosures by income (noInf treatment)

Income	Number of voluntary disclosures	Number of voluntary disclosures without the two outliers (cf. Figure 3.4c))
60	12	4
70	9	7
80	7	6
90	7	5
100	10	6
total	45	28

Table B.9: Estimation results for *Revenue share* (excluding round 30-33)

	Spec. 1 currInf (GLS)	Spec. 2 currInf (OLS-FE)	Spec. 3 pastInf (GLS)	Spec. 4 pastInf (OLS-FE)	Spec. 5 noInf (GLS)	Spec. 6 noInf (OLS-FE)
Mean auditrate	0.8009***	0.5838	0.6755***	0.7027***	0.2589*	0.1190
	(0.2941)	(0.3590)	(0.1520)	(0.1759)	(0.1408)	(0.1440)
Amnesty	0.0093	0.0130	-0.0018	-0.0018	0.0030	0.0016
	(0.0117)	(0.0118)	(0.0099)	(0.0099)	(0.0055)	(0.0053)
Constant	0.1216***	0.1403***	0.1582***	0.1556***	0.2075***	0.2205***
	(0.0290)	(0.0323)	(0.0155)	(0.0149)	(0.0145)	(0.0127)
N	80	80	80	80	80	80
Subjects	40	40	40	40	40	40
R^2 overall (FE: within)	0.1824	0.1832	0.1540	0.2398	0.0752	0.0164

The dependent variable is the revenue share (total taxes, penalties and amnesty payments over total income) per subject, separately calculated for rounds with and without permanent tax amnesty. Cluster-robust standard errors (subject level) are provided in parentheses. ***,** and * indicate significance at the 1%, 5% and 10% level.

B.2 Instructions

The original instructions are written in German. In the following, you will find an English translation. The parts which are specific to the treatments are surrounded by square brackets, i.e. [**currInf:** ...], [**pastInf:** ...], [**noInf:** ...].

A. Instructions for sessions with the permanent tax amnesty during the second half of the experiment:

Welcome to this experiment! Please read the following instructions carefully. Your final payoff depends among others on how well you have understood these instructions. You can ask questions at any time, just raise your hand. But please do not talk anymore to the other participants of the experiment.

Overview

You participate in a study about "taxes". Each of you has the role of a taxpayer who receives an income in each round and has to pay taxes on it. In each round, there is a probability of being selected for a tax audit. In this case, your tax declarations of the current round and the three previous rounds are investigated. If you have evaded taxes in these rounds, you have to pay the evaded taxes plus a penalty.

Concrete procedure

The experiment consists of several rounds. After some rounds, there can be changes. In this case, you are provided with additional instructions. The number of rounds that will be examined in case of a tax audit and the penalty fee for discovered evaded taxes will, however, not change at all. The number of rounds of the experiment is unknown to you, the duration of the experiment is, however, at most 1.5 hours. Before each round the computer will randomly assign an income of 60, 70, 80, 90 or 100 points to you. Each income is equally likely. Each round proceeds as follows:

Phase 1: (Tax Declaration)
Your income of the current round is displayed. You will also see the form of your tax declaration, in which you are asked for your income. You can enter values greater than or equal to 0. Your stated income is then taxed at a tax rate of 25%. (If you state more than your actual income, you pay more taxes than required. However, you cannot redeem evaded taxes from other rounds in this way.) In the following, you see the screen which is displayed during Phase 1. On the top right, you will see the time that you have for your decision. When the time has expired and you have not decided yet (i.e. you have not submitted your tax declaration in time by clicking OK), you will be immediately selected for a tax audit and your current income is considered as completely evaded. Otherwise, tax audits are purely random, i.e. the tax audits are independent of your decisions as well as of the outcome of past tax audits. The probability of a tax audit is greater than 0% and less than 100 %. A probability of X % means that, on average, X from 100 tax returns are selected for a tax audit.

[**currInf:** The probability of a tax audit in the current round is displayed.]

[**pastInf:** The probability of a tax audit in the current round is unknown to you, however, the probability which existed in the previous round is displayed.]

[**noInf:** The probability of a tax audit in the current round is unknown to you.]

The probability of a tax audit can vary over the rounds between two values. Starting from the default value (= value in round 1), the probability of a jump at the transition to the next round is 15%, i.e. on average in 15 of 100 cases in which the probability of a tax audit is at the default value, there is a jump to a higher value for the next round. This probability of a jump to the higher value is independent of how many rounds the default value was already in force. If there is a jump to the higher value, the probability of a tax audit remains for a length of 1-5 rounds (each equally probable, so on average 3 rounds) on the higher value, before it falls back to the default value.

Phase 2a: (Tax Audit)
You are informed whether you have been selected by the computer for a tax audit. If so, you have to pay the evaded taxes of the current round and the three previous rounds. In addition, a penalty will be charged. This is the sum of evaded taxes. So, in the event of a tax audit you have to pay twice the evaded taxes of the current and the three previous rounds.

Phase 2b: (Result)
A summary of the current round is displayed, with the total income at the end. This is composed as follows:

Total income = income at the beginning of the round
- taxes of the current round according to the tax declaration
- If applicable, subsequent payment of evaded taxes from the current round
- If applicable, subsequent payment of evaded taxes from past rounds
- If applicable, penalty fees

Note:
During the experiment, the following additional information are available:
- Your evaded taxes of the three previous rounds

[**currInf:** - The probability of a tax audit in the current round]

[**pastInf:** - The probability of a tax audit which existed in the previous round]

Payments

At the end of the experiment you will be paid individually and confidentially. Your payoff is the sum of the total incomes from the individual rounds (see Phase 2b). The points are converted as follows: 3.5 points = 1 eurocent. The taxes and penalty fees, if applicable, paid by you are also converted into euros and are transferred after the experiment to the account of Bundeskasse and flow into the federal budget of the Federal Republic of Germany. At the end of the experiment, you have the option to enter your email address to receive a copy of the deposit slip.

Examples

Situation 1: Income in the current round is 100 points. In the tax declaration, 100 is stated as income. No tax evasion in the three previous rounds. Tax audit occurs.

Taxes of the current round according to the tax declaration = 100 * 0.25 = 25

Subsequent payment of evaded taxes from the current round = 0

Subsequent payment of evaded taxes from past rounds = 0

Penalty fees = 0

Total income = 100 -25 -0 -0 -0 = 75

Situation 2: Income in the current round is 100 points. In the tax declaration, 50 is stated as income. In the three previous rounds evaded taxes are 30 in total. Tax audit does not occur.

Taxes of the current round according to the tax declaration = 50 * 0.25 = 12.5

Subsequent payment of evaded taxes from the current round = 0

Subsequent payment of evaded taxes from past rounds = 0

Penalty fees = 0

Total income =100 -12.5 -0 -0 -0 = 87.5

Situation 3: Income in the current round is 100 points. In the tax declaration, 60 is stated as income. In the previous round, evaded taxes are 20, in the round before 10 and in the round before 5. Tax audit occurs.

Taxes of the current round according to the tax declaration = 60 * 0.25 = 15

Subsequent payment of evaded taxes from the current round = 40*0.25 = 10

Subsequent payment of evaded taxes from past rounds = 20+10+5= 35

Penalty fees = 10+35=45

Total income =100 -15-10-35-45 = -5

Further procedure

If you have read the instructions, please work on the further situations in the following. Of course, you can always ask questions. When all participants have answered these correctly, the actual experiment starts.

Please edit!

Situation 1: Income in the current round is 80 points. In the tax declaration, 80 is stated as income. No tax evasion in the three previous rounds. Tax audit occurs.
Taxes of the current round according to the tax declaration =...
Subsequent payment of evaded taxes from the current round =...
Subsequent payment of evaded taxes from past rounds =...
Penalty fees =...
Total income =...

Situation 2: Income in the current round is 80 points. In the tax declaration, 40 is stated as income. In the three previous rounds evaded taxes are 30 in total. Tax audit does not occur.
Taxes of the current round according to the tax declaration =...
Subsequent payment of evaded taxes from the current round =...
Subsequent payment of evaded taxes from past rounds =...
Penalty fees =...
Total income =...

Situation 3: Income in the current round is 80 points. In the tax declaration, 0 is stated as income. In the previous round, evaded taxes are 5, in the round before 10 and in the round before 5. Tax audit occurs.
Taxes of the current round according to the tax declaration =...
Subsequent payment of evaded taxes from the current round =...
Subsequent payment of evaded taxes from past rounds =...
Penalty fees =...
Total income =...

Instructions II [distributed after round 30]

For the further course of the experiment there is a change in the instructions: From now on there is in every round the option of a voluntary disclosure, i.e. to admit tax evasion. This results in an additional phase at the beginning of each round:

Phase 0: (Voluntary disclosure)
Your income of the current round is displayed. You have the possibility to opt for a voluntary disclosure, i.e. to admit tax evasion (this option exists regardless of whether you actually have evaded taxes or not). If you have evaded taxes in the previous rounds and opt for the voluntary disclosure, your income of the current round is fully taxed and you have to pay the evaded taxes of the three previous rounds - but no penalty - and you arrive directly at phase 2b. In the event of a future tax audit, the redeemed taxes are treated as if they had been correctly paid, i.e. you will not receive punishment for these. If you do not opt for a voluntary disclosure, you get to phase 1. Below you can see the screen that is displayed during Phase 0. If you want to choose the voluntary disclosure, you must check the box (click into the white box) and then click OK. The time that you have for your decision will be shown. When the time has expired and you have not yet decided - i.e. you have not yet clicked OK - you also get to phase 1.

Everything else remains as described in the previous instructions.

Example

Situation 4: Income in the current round is 100 points. Voluntary disclosure is chosen. In the previous round, evaded taxes are 20, in the round before 10 and in the round before 5. (Note: corresponds to situation 3 of the examples so far, only with voluntary disclosure instead of further tax evasion)
Taxes of the current round according to the voluntary disclosure = 100 * 0.25 = 25
Subsequent payment of evaded taxes from the current round = 0
Subsequent payment of evaded taxes from past rounds = 20+10+5= 35
Penalty fees = 0
Total income =100 -25-0-35-0 = 40

Please edit!

Situation 4: Income in the current round is 80 points. Voluntary disclosure is chosen. In the previous round, evaded taxes are 5, in the round before 10 and in the round before 5. (Note: corresponds to situation 3 of the examples so far, only with voluntary disclosure instead of further tax evasion)

Taxes of the current round according to the voluntary disclosure = ...

Subsequent payment of evaded taxes from the current round = ...

Subsequent payment of evaded taxes from past rounds = ...

Penalty fees = ...

Total income = ...

B. Instructions for sessions with the permanent tax amnesty during the first half of the experiment:

Welcome to this experiment! Please read the following instructions carefully. Your final payoff depends among others on how well you have understood these instructions. You can ask questions at any time, just raise your hand. But please do not talk anymore to the other participants of the experiment.

Overview

You participate in a study about "taxes". Each of you has the role of a taxpayer who receives an income in each round and has to pay taxes on it. In each round, there is a probability of being selected for a tax audit. In this case, your tax declarations of the current round and the three previous rounds are investigated. If you have evaded taxes in these rounds, you have to pay the evaded taxes plus a penalty.

However, in every round you can opt for a voluntary disclosure, i.e. to admit tax. If you have evaded taxes in the previous rounds and opt for the voluntary disclosure, your income of the current round is fully taxed and you have to pay the evaded taxes of the three previous rounds - but no penalty. In the event of a future tax audit, the redeemed taxes are treated as if they had been correctly paid, i.e. you will not receive punishment for these.

Concrete procedure

The experiment consists of several rounds. After some rounds, there can be changes. In this case, you are provided with additional instructions. The number of rounds that will be examined in case of a tax audit and the penalty fee for discovered evaded taxes will, however, not change at all. The number of rounds of the experiment is unknown to you, the duration of the experiment is, however, at most 1.5 hours. Before each round the computer will randomly assign an income of 60, 70, 80, 90 or 100 points to you. Each income is equally likely. Each round proceeds as follows:

Phase 0: (Voluntary disclosure)
Your income of the current round is displayed. You have the possibility to opt for a voluntary disclosure, i.e. to admit tax evasion (this option exists regardless of whether you actually have evaded taxes or not). If you have evaded taxes in the previous rounds and opt for the voluntary disclosure, your income of the current round is fully taxed and you have to pay the evaded taxes of the three previous rounds - but no penalty - and you arrive directly at phase 2b. In the event of a future tax audit, the redeemed taxes are treated as if they had been correctly paid, i.e. you will not receive punishment for these. If you do not opt for a voluntary disclosure, you get to phase 1. Below you can see the screen that is displayed during Phase 0. If you want to choose the voluntary disclosure, you must check the box (click into the white box) and then click OK. The time that you have for your decision will be shown. When the time has expired and you have not yet decided - i.e. you have not yet clicked OK - you also get to phase 1.

Phase 1: (Tax Declaration)
Your income of the current round is displayed. You will also see the form of your tax declaration, in which you are asked for your income. You can enter values greater than or equal to 0. Your stated income is then taxed at a tax rate of 25%. (If you state more than your actual income, you pay more taxes than required. However, you cannot redeem evaded taxes from other rounds in this way.) In the following, you see the screen which is displayed during Phase 1. On the top right, you will see the time that you have for your decision. When the time has expired and you have not decided yet (i.e. you have not submitted your tax declaration in time by clicking OK), you will be immediately selected for a tax audit and your current income is considered as completely evaded. Otherwise, tax audits are purely random, i.e. the

tax audits are independent of your decisions as well as of the outcome of past tax audits. The probability of a tax audit is greater than 0% and less than 100%. A probability of X % means that, on average, X from 100 tax returns are selected for a tax audit.

[**currInf:** The probability of a tax audit in the current round is displayed.]

[**pastInf:** The probability of a tax audit in the current round is unknown to you, however, the probability which existed in the previous round is displayed.]

[**noInf:** The probability of a tax audit in the current round is unknown to you.]

The probability of a tax audit can vary over the rounds between two values. Starting from the default value (= value in round 1), the probability of a jump at the transition to the next round is 15%, i.e. on average in 15 of 100 cases in which the probability of a tax audit is at the default value, there is a jump to a higher value for the next round. This probability of a jump to the higher value is independent of how many rounds the default value was already in force. If there is a jump to the higher value, the probability of a tax audit remains for a length of 1-5 rounds (each equally probable, so on average 3 rounds) on the higher value, before it falls back to the default value.

Phase 2a: (Tax Audit)

You are informed whether you have been selected by the computer for a tax audit. If so, you have to pay the evaded taxes of the current round and the three previous rounds. In addition, a penalty will be charged. This is the sum of evaded taxes. So, in the event of a tax audit you have to pay twice the evaded taxes of the current and the three previous rounds.

Phase 2b: (Result)

A summary of the current round is displayed, with the total income at the end. This is composed as follows:

Total income = income at the beginning of the round

- taxes of the current round according to the tax declaration
- If applicable, subsequent payment of evaded taxes from the current round
- If applicable, subsequent payment of evaded taxes from past rounds
- If applicable, penalty fees

Note:

During the experiment, the following additional information are available:

- Your evaded taxes of the three previous rounds

[**currInf:** - The probability of a tax audit in the current round]

[**pastInf:** - The probability of a tax audit which existed in the previous round]

Payments

At the end of the experiment you will be paid individually and confidentially. Your payoff is the sum of the total incomes from the individual rounds (see Phase 2b). The points are converted as follows: 3.5 points = 1 eurocent. The taxes and penalty fees, if applicable, paid by you are also converted into euros and are transferred after the experiment to the account of Bundeskasse and flow into the federal budget of the Federal Republic of Germany. At the end of the experiment, you have the option to enter your email address to receive a copy of the deposit slip.

Examples

Situation 1: Income in the current round is 100 points. In the tax declaration, 100 is stated as income. No tax evasion in the three previous rounds. Tax audit occurs.

Taxes of the current round according to the tax declaration = 100 * 0.25 = 25

Subsequent payment of evaded taxes from the current round = 0

Subsequent payment of evaded taxes from past rounds = 0

Penalty fees = 0

Total income = 100 -25 -0 -0 -0 = 75

Situation 2: Income in the current round is 100 points. In the tax declaration, 50 is stated as income. In the three previous rounds evaded taxes are 30 in total. Tax audit does not occur.

Taxes of the current round according to the tax declaration = 50 * 0.25 = 12.5

Subsequent payment of evaded taxes from the current round = 0

Subsequent payment of evaded taxes from past rounds = 0

Penalty fees = 0

Total income =100 -12.5 -0 -0 -0 = 87.5

Situation 3: Income in the current round is 100 points. In the tax declaration, 60 is stated as income. In the previous round, evaded taxes are 20, in the round before 10 and in the round before 5. Tax audit occurs.

Taxes of the current round according to the tax declaration = 60 * 0.25 = 15

Subsequent payment of evaded taxes from the current round = 40*0.25 = 10

Subsequent payment of evaded taxes from past rounds = 20+10+5= 35

Penalty fees = 10+35=45

Total income =100 -15-10-35-45 = -5

Situation 4: Income in the current round is 100 points. Voluntary disclosure is chosen. In the previous round, evaded taxes are 20, in the round before 10 and in the round before 5. (Note: corresponds to situation 3 of the examples so far, only with voluntary disclosure instead of further tax evasion)

Taxes of the current round according to the voluntary disclosure = 100 * 0.25 = 25

Subsequent payment of evaded taxes from the current round = 0

Subsequent payment of evaded taxes from past rounds = 20+10+5= 35

Penalty fees = 0

Total income =100 -25-0-35-0 = 40

Further procedure

If you have read the instructions, please work on the further situations in the following. Of course, you can always ask questions. When all participants have answered these correctly, the actual experiment starts.

Please edit!

Situation 1: Income in the current round is 80 points. In the tax declaration, 80 is stated as income. No tax evasion in the three previous rounds. Tax audit occurs.

Taxes of the current round according to the tax declaration = ...

Subsequent payment of evaded taxes from the current round = ...

Subsequent payment of evaded taxes from past rounds = ...

Penalty fees = ...

Total income = ...

Situation 2: Income in the current round is 80 points. In the tax declaration, 40 is stated as income. In the three previous rounds evaded taxes are 30 in total. Tax audit does not occur.

Taxes of the current round according to the tax declaration = ...

Subsequent payment of evaded taxes from the current round = ...

Subsequent payment of evaded taxes from past rounds = ...

Penalty fees = ...

Total income = ...

Situation 3: Income in the current round is 80 points. In the tax declaration, 0 is stated as income. In the previous round, evaded taxes are 5, in the round before 10 and in the round before 5. Tax audit occurs.

Taxes of the current round according to the tax declaration = ...

Subsequent payment of evaded taxes from the current round = ...

Subsequent payment of evaded taxes from past rounds = ...

Penalty fees = ...

Total income = ...

Situation 4: Income in the current round is 80 points. Voluntary disclosure is chosen. In the previous round, evaded taxes are 5, in the round before 10 and in the round before 5. (Note: corresponds to situation 3 of the examples so far, only with voluntary disclosure instead of further tax evasion)

Taxes of the current round according to the voluntary disclosure = ...

Subsequent payment of evaded taxes from the current round = ...

Subsequent payment of evaded taxes from past rounds = ...

Penalty fees = ...

Total income =...

Instructions II [distributed after round 29]

For the further course of the experiment there is a change in the instructions: The possibility to opt for a voluntary disclosure will be abolished after the next round. Phase 0 will disappear from then on.

Everything else remains as described in the previous instructions.

B.3 Screenshots

currInf:

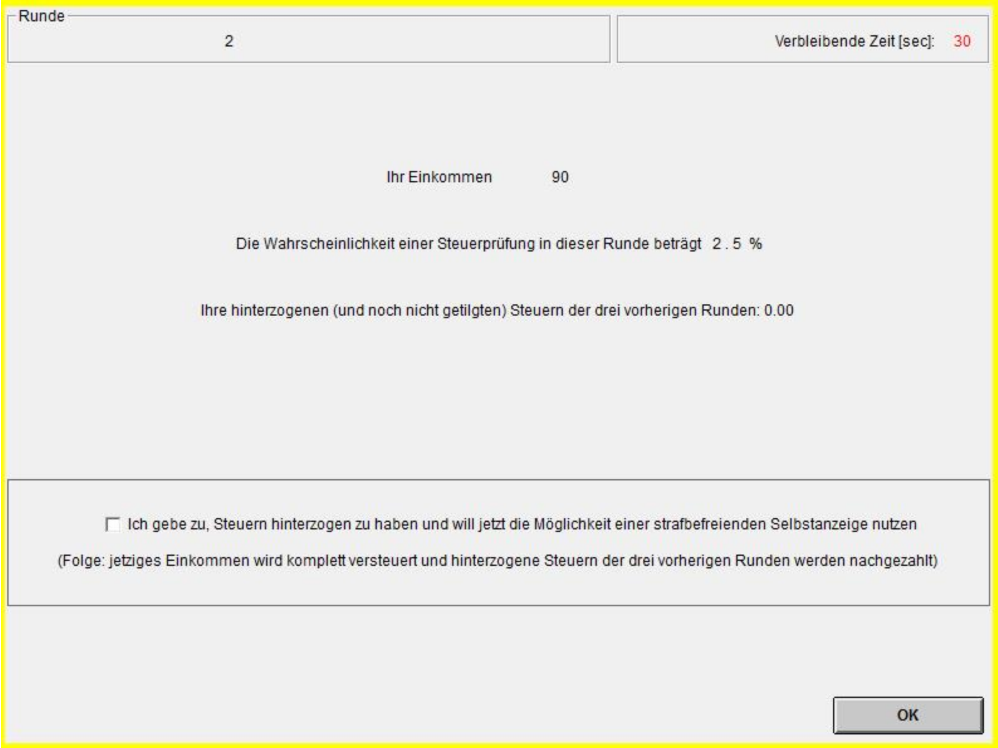


Figure B.2: currInf: Voluntary disclosure (Phase 0)

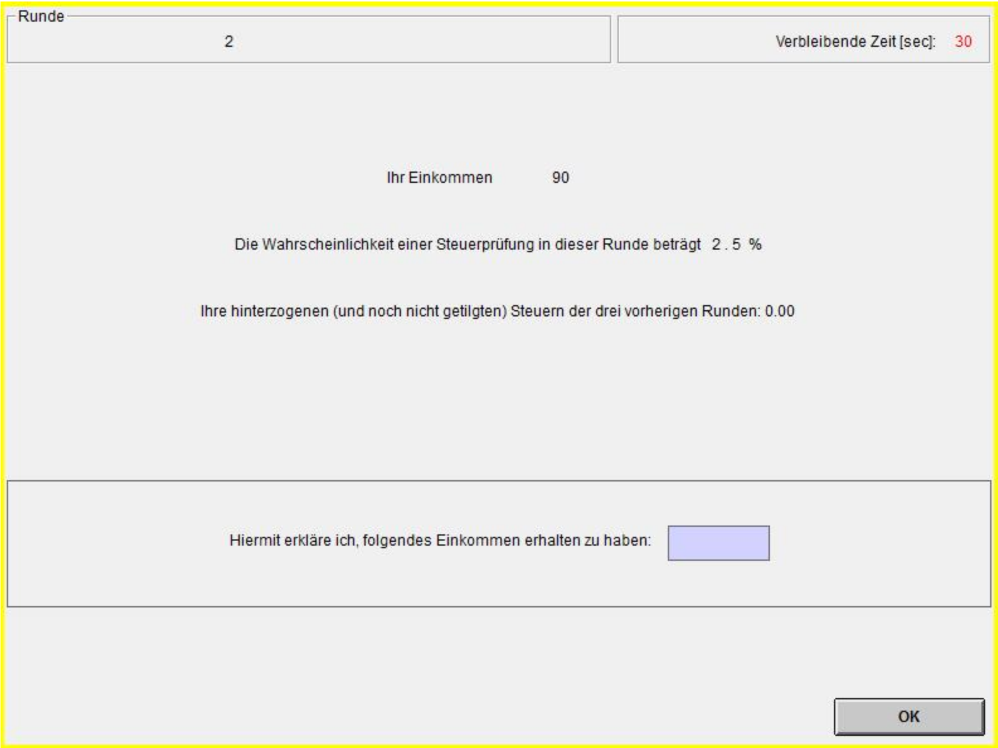


Figure B.3: currInf: Tax declaration (Phase 1)

pastInf:

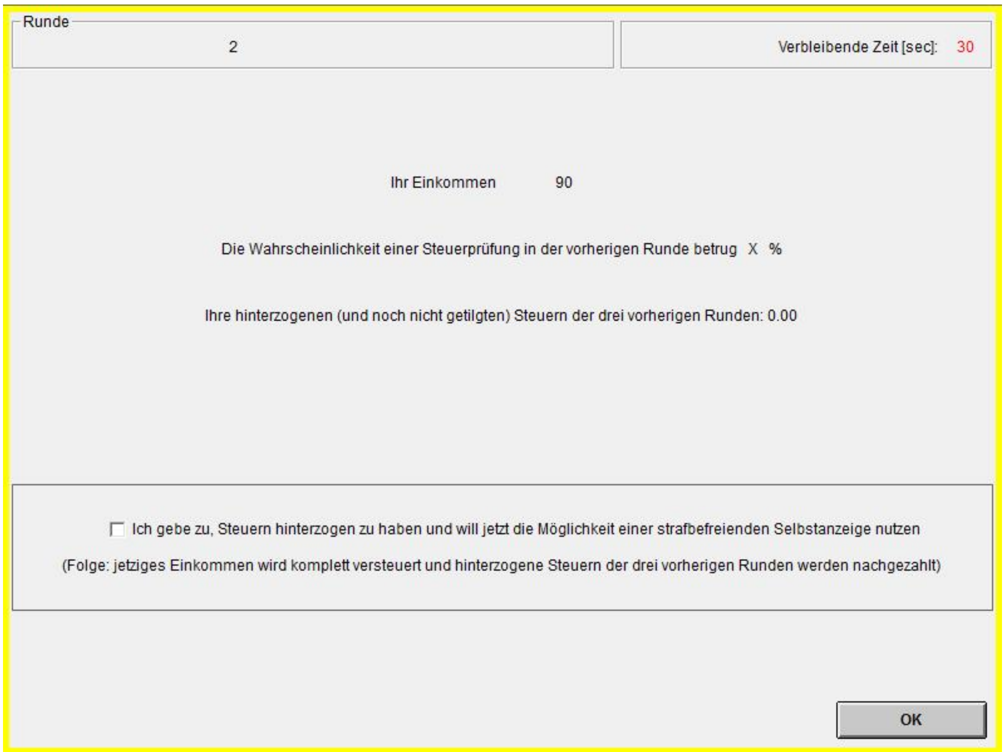


Figure B.4: pastInf: Voluntary disclosure (Phase 0)

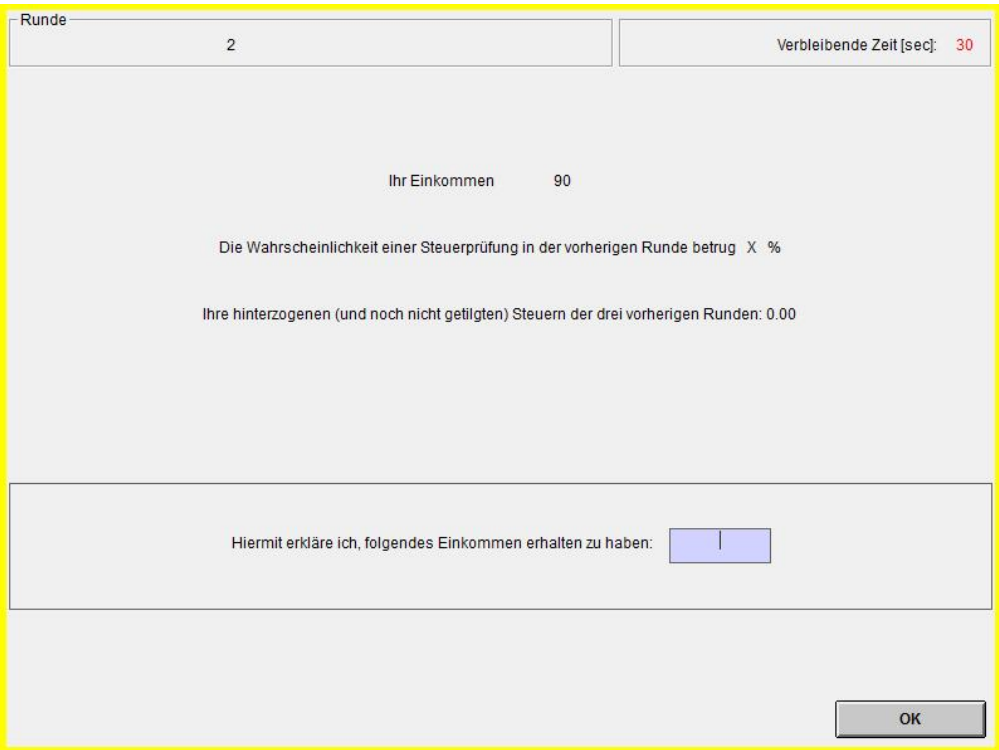


Figure B.5: pastInf: Tax declaration (Phase 1)

noInf:

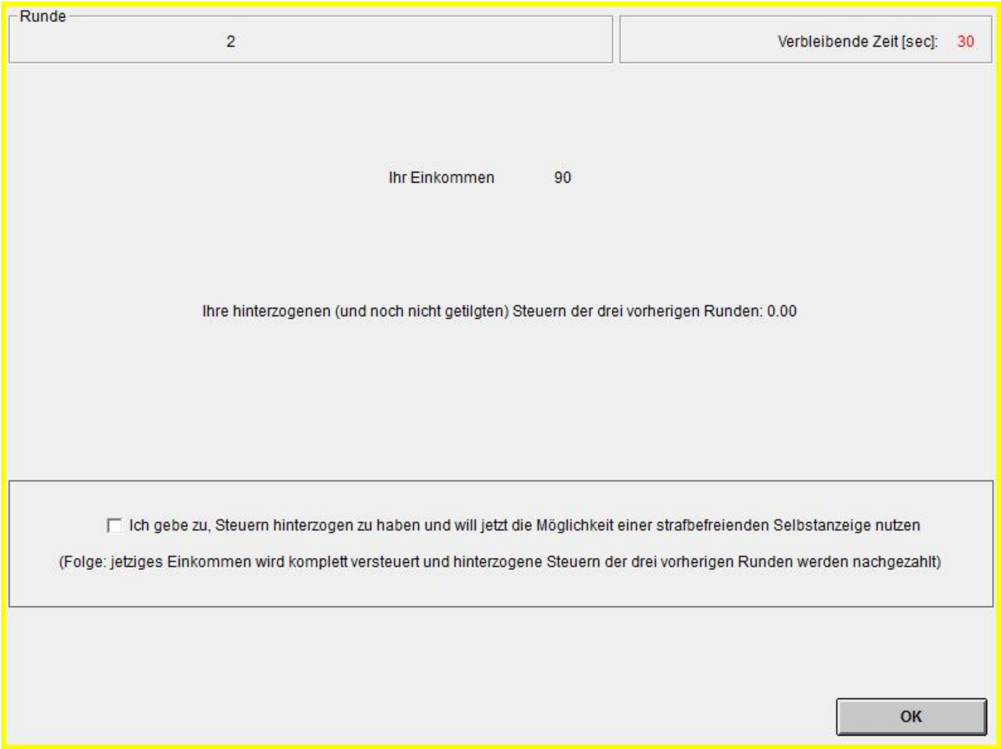


Figure B.6: noInf: Voluntary disclosure (Phase 0)

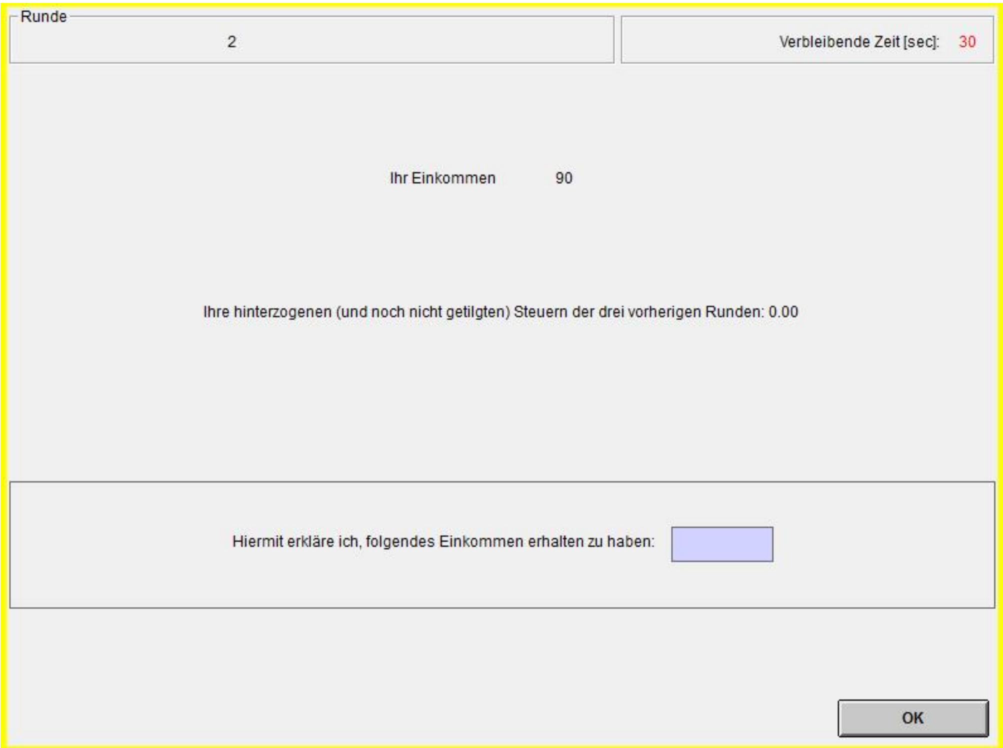


Figure B.7: noInf: Tax declaration (Phase 1)

Appendix C

Appendix to Chapter 4

C.1 Robustness

This section provides additional robustness checks.

Table C.1 shows that our findings are robust when including the interactions between GDP and tax complexity (Spec. 1), bureaucracy and the corporate income tax rate (Spec. 2), and enforcement and the corporate income tax rate (Spec. 3). $Enforcement_j$ is the log of the variable "Coverage" of Robinson and Slemrod (2012), which measures the number of administrators of the tax authority per thousand of working age population in 2005. Since we have this data only for one year, we cannot include the variable itself (due to the fixed effects) but we can include its interaction with the corporate income tax rate. Specification 4 shows the estimation results when we use the effective marginal tax rate (data source: Oxford University Center for Business Taxation). However, since we investigate lumpy investment decisions, economic theory suggests that the effective average tax rate is the more appropriate measure, as used in Table 4.3 Specification 3. Specification 5 includes $Tax\ payments_j$ (which measures the total number of tax payments per year, taken from the Doing Business data) in the estimation without finding a significant coefficient. This suggests that not the number of tax payments but indeed the amount of time needed to comply with taxation causes compliance cost, which is not surprising.

Table C.1: Estimation results

	Spec. 1	Spec. 2	Spec. 3	Spec. 4	Spec. 5
$Tax\ complex._j$	-4.4481*	-2.8604***	-2.3036**	-1.2340**	-2.3944***
	(2.5582)	(1.0985)	(0.9398)	(0.5732)	(0.9196)
$Corp.\ tax_j$	-0.2188*	-0.3055**	-0.2783**		-0.2932**
	(0.1226)	(0.1326)	(0.1256)		(0.1232)
$Corp.\ tax * Tax\ complex._j$	0.0429*	0.0671**	0.0539**		0.0560**
	(0.0240)	(0.0279)	(0.0244)		(0.0240)
$Enforcement * Corp.\ tax_j$			-0.0107		
			(0.0214)		
$EMTR_j$				-0.2498*	
				(0.1453)	
$EMTR * Tax\ complex._j$				0.0470*	
				(0.0284)	
VAT_j	-0.0539	-0.0811**	-0.0611	-0.0497	-0.0670*
	(0.0422)	(0.0373)	(0.0382)	(0.0395)	(0.0402)
GDP_j	2.3342*	2.6987**	2.8572**	2.9804*	2.9443**
	(1.4085)	(1.3400)	(1.4260)	(1.6187)	(1.4242)
$GDP * Tax\ complex._j$	0.0901				
	(0.0912)				
$Tax\ payments_j$					0.0478
					(0.1032)
$Bureaucracy_j$	-0.1048*	0.3250	-0.1016	-0.1094*	-0.1031*
	(0.0628)	(0.3170)	(0.0620)	(0.0652)	(0.0617)
$Bureaucracy * Corp.\ tax_j$		-0.0149			
		(0.0113)			
N	118992	118992	118992	118992	118992
Affiliates	4474	4474	4474	4474	4474
Countries	27	27	27	27	27
pseudo R^2	0.1223	0.1224	0.1223	0.1223	.1223
Log-Likelihood	-12881.82	-12881.09	-12882.24	-12882.56	-12882.29
Clusters	71	71	71	71	71
Country FE	✓	✓	✓	✓	✓
Country controls	✓	✓	✓	✓	✓

The dependent variable is y_{kj} (i.e. 0 or 1). All independent variables correspond to the year $t(k) - 1$ before the investment k takes place. Cluster-robust standard errors (regarding affiliate sector) are provided in parentheses. ***,** and * indicate significance at the 1%, 5% and 10% level. All specifications are conditional logit estimations. Country controls are the variables $Labor\ costs_j$, $Trade\ freedom_j$, $Corruption_j$, $Inflation_j$, $Exch.\ rate_j$, $Country\ risk_j$, $Lending\ rate_j$ and $Invest.\ freedom_j$.

Table C.2: Estimation results

	Spec. 1	Spec. 2	Spec. 3	Spec. 4	Spec. 5
$Tax\ complex._j$	-2.4741**	-3.3281***	-3.5153*	-2.9216**	-1.0055
	(1.0927)	(1.2452)	(1.9983)	(1.1591)	(1.6069)
$Corp.\ tax_j$	-0.3069**	-0.5256**	-0.5214**	-0.4257**	-0.3752*
	(0.1459)	(0.2327)	(0.2327)	(0.2073)	(0.1976)
$Corp.\ tax * Tax\ complex._j$	0.0586**	0.0819**	0.0820**	0.0703**	0.0601**
	(0.0282)	(0.0331)	(0.0331)	(0.0306)	(0.0297)
VAT_j	-0.0667*	-0.0598	-0.0609	-0.0589	-0.0656
	(0.0361)	(0.0383)	(0.0387)	(0.0401)	(0.0401)
GDP_j	3.0298**	3.3852**	3.4464**	2.9406**	2.8569**
	(1.4775)	(1.5409)	(1.4132)	(1.4208)	(1.3913)
$Corruption2_j$	-0.0739	-0.4514	-0.5588		
	(0.1623)	(0.3287)	(1.0102)		
$Corruption2 * Corp.\ tax_j$		0.0120	0.0114		
		(0.0104)	(0.0106)		
$Corruption2 * Tax\ complex._j$			0.0233		
			(0.1987)		
$Corruption_j$				-0.2026	0.9077
				(0.2389)	(0.7245)
$Corruption * Corp.\ tax_j$				0.0078	0.0086
				(0.0086)	(0.0090)
$Corruption * Tax\ complex._j$					-0.2057
					(0.1508)
N	118992	118992	118992	118992	118992
Affiliates	4474	4474	4474	4474	4474
Countries	27	27	27	27	27
pseudo R^2	0.1223	0.1224	0.1224	0.1223	0.1224
Log-Likelihood	-12882.06	-12880.84	-12880.83	-12881.71	-12880.17
Clusters	71	71	71	71	71
Country FE	✓	✓	✓	✓	✓
Country controls	✓	✓	✓	✓	✓

The dependent variable is y_{kj} (i.e. 0 or 1). All independent variables correspond to the year $t(k) - 1$ before the investment k takes place. Cluster-robust standard errors (regarding affiliate sector) are provided in parentheses. ***,** and * indicate significance at the 1%, 5% and 10% level. All specifications are conditional logit estimations. Country controls are the variables $Bureaucracy_j$, $Labor\ costs_j$, $Trade\ freedom_j$, $Inflation_j$, $Exch.\ rate_j$, $Country\ risk_j$, $Lending\ rate_j$ and $Invest.\ freedom_j$.

Table C.2 shows that our findings are robust when including the interactions between corruption and the corporate income tax, and corruption and tax complexity. Moreover, our findings do not change when we use an alternative measure for corruption, i.e. $Corruption2_j$. Data for this corruption measure comes from the variable "Control of corruption" of the World Bank's Worldwide Governance Indicators and was rescaled to range approximately from 0 to 10 instead of a range from -2.5 to 2.5. As for $Corruption_j$, a low value for $Corruption2_j$ means high corruption.

Specification 1 in Table C.3 shows that our findings are robust when excluding the variable $Labor\ costs_j$. The reason for this robustness check is the high correlation of

Table C.3: Estimation results

	Spec. 1	Spec. 2	Spec. 3
$Tax\ complex._j$	-2.1479**	-2.3341**	-2.6700**
	(0.8514)	(1.1203)	(1.0691)
$Corp.\ tax_j$	-0.2575**	-0.2833**	-0.3300**
	(0.1172)	(0.1417)	(0.1471)
$Corp.\ tax * Tax\ complex._j$	0.0490**	0.0541*	0.0637**
	(0.0225)	(0.0280)	(0.0287)
VAT_j	-0.0563	-0.0639	-0.0686*
	(0.0419)	(0.0405)	(0.0388)
GDP_j	2.3406*	2.9245**	3.4701**
	(1.3881)	(1.4253)	(1.5451)
N	118992	110720	99216
Affiliates	4474	4325	4134
Countries	27	26	24
pseudo R^2	0.1223	0.1277	0.1327
Log-Likelihood	-12883.06	-12232.93	-11394.29
Clusters	71	71	71
Country FE	✓	✓	✓
Country controls	✓excluding $Labor\ costs_j$	✓	✓

The dependent variable is y_{kj} (i.e. 0 or 1). All independent variables correspond to the year $t(k) - 1$ before the investment k takes place. Cluster-robust standard errors (regarding affiliate sector) are provided in parentheses. ***,** and * indicate significance at the 1%, 5% and 10% level. All specifications are conditional logit estimations. Country controls are the variables $Bureaucracy_j$, $Labor\ costs_j$, $Trade\ freedom_j$, $Corruption_j$, $Inflation_j$, $Exch.\ rate_j$, $Country\ risk_j$, $Lending\ rate_j$ and $Invest.\ freedom_j$.

this variable with GDP if the variables are demeaned by country, as shown in Table C.4. Specification 2 and 3 of Table C.3 show robustness when we vary our country sample. In Specification 2, we exclude Belgium. The reason for this robustness check is that Belgium is an outlier regarding the percentage change in tax complexity (the variable "Time" of the Doing Business database increases from 2004 to 2008 by over 150%. However, this is not completetly unrealistic since it increases from a relatively low level). In Specification 3, we exclude Ireland, Luxembourg and Switzerland. The aim is to check robustness when excluding these countries where investment decisions might be special due a very low corporate tax rate (Ireland 12.5% which is clearly the minimum in the OECD) or a dominant financial sector (Luxembourg and Switzerland).

C.2 Additional Tables and Figures

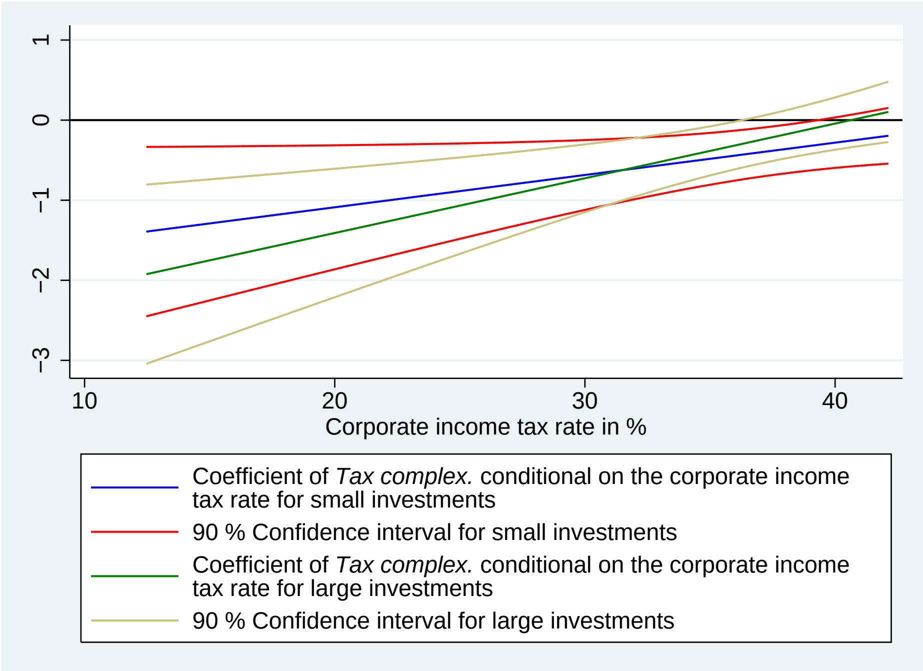


Figure C.1: The coefficient of tax complexity conditional on the corporate income tax rate (based on Table 4.4, Spec. 3)

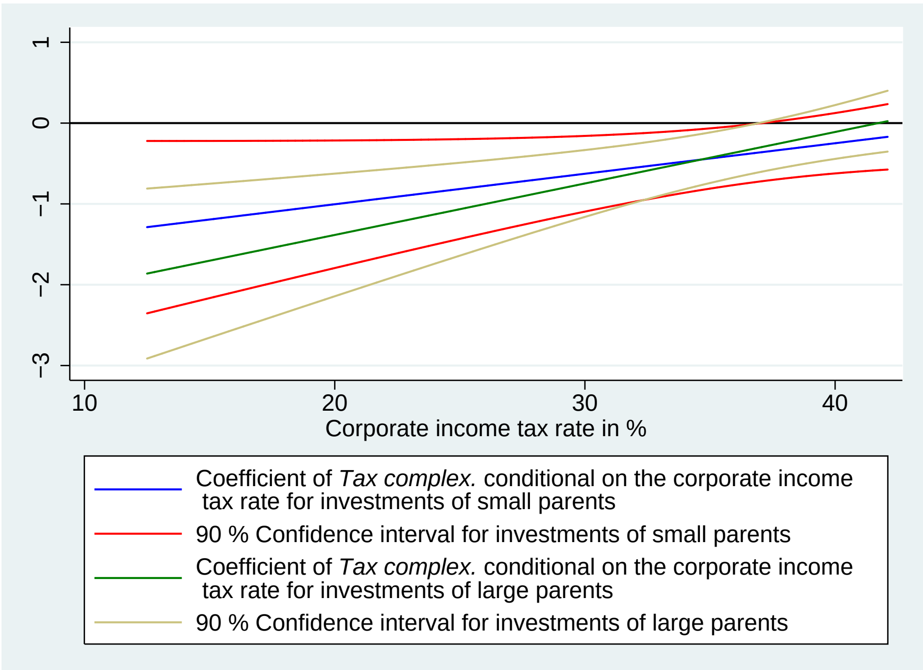


Figure C.2: The coefficient of tax complexity conditional on the corporate income tax rate (based on Table 4.4, Spec. 2)

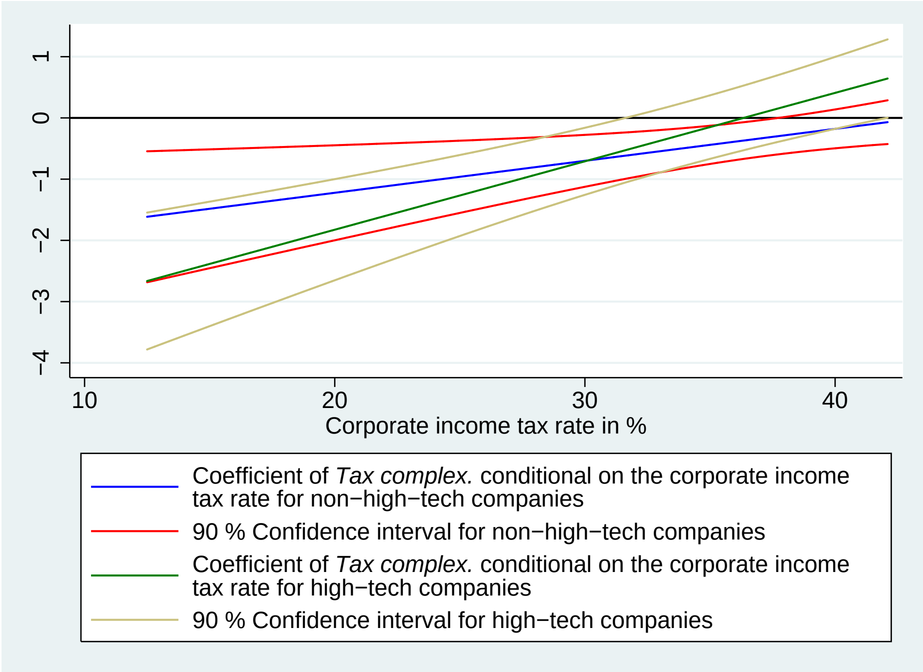


Figure C.3: The coefficient of tax complexity conditional on the corporate income tax rate (based on Table 4.5, Spec. 3)

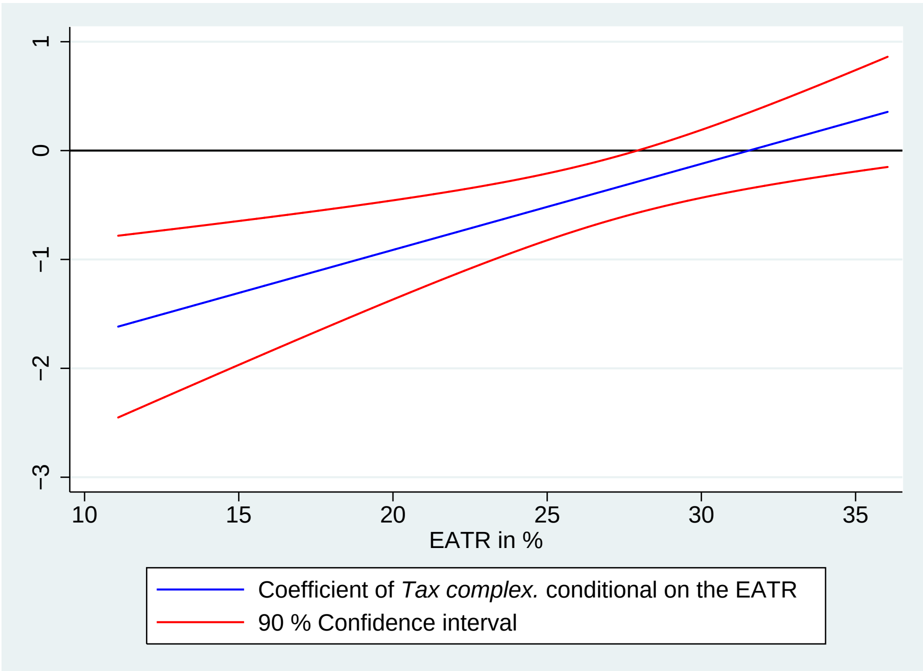
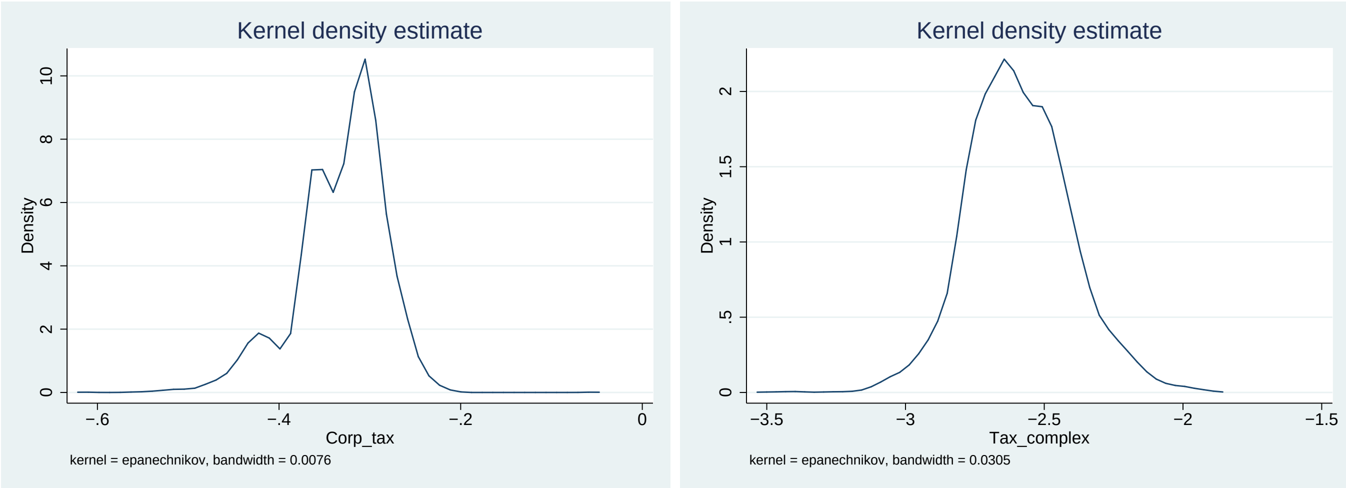


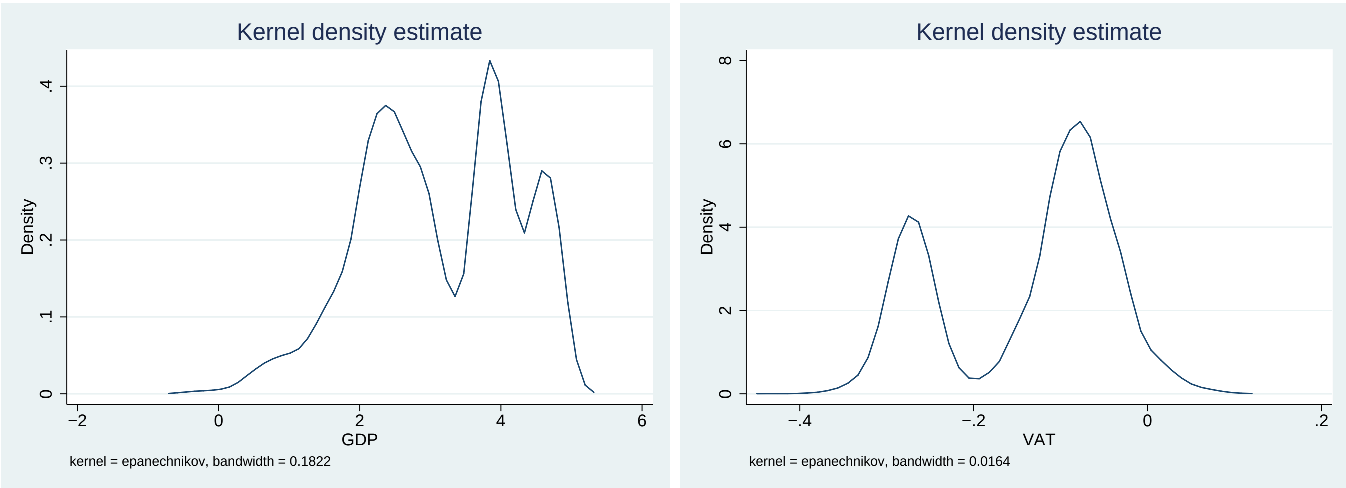
Figure C.4: The coefficient of tax complexity conditional on the effective average tax rate (based on Table 4.3, Spec. 3)



(a) Kernel density estimate for the coefficient of $Corp.\ tax_j$ in Table 4.3, Spec. 2

(b) Kernel density estimate for the coefficient of $Tax\ complex._j$ in Table 4.3, Spec. 2

Figure C.5: Kernel density estimates



(a) Kernel density estimate for the coefficient of GDP_j in Table 4.3, Spec. 2

(b) Kernel density estimate for the coefficient of VAT_j in Table 4.3, Spec. 2

Figure C.6: Kernel density estimates[1]

[1] An explanation for the multiple peaks in Figure C.6 a) would be that there are several categories of FDI projects which depend on GDP to a different extent. For example, holding companies might be less depending on GDP than manufacturing firms.
An explanation for the two humps in Figure C.6 b) could be horizontal FDI and vertical FDI, since for the latter VAT is expected to have a smaller effect.

Table C.4: Summary statistics and correlations

	$Tax\ complex._j$	$Corp.\ tax_j$	VAT_j	GDP_j	$Bureau\text{-}cracy_j$	$Labor\ costs_j$	$Trade\ freedom_j$	$Cor\text{-}ruption_j$	$Infla\text{-}tion_j$	$Exch.\ rate_j$	$Country\ risk_j$	$Lending\ rate_j$	$Invest.\ freedom_j$	$Cor\text{-}ruption2_j$	$EATR_j$	$EMTR_j$	$Tax\text{-}payments_j$	$Enforce\text{-}ment_j$
N	133	133	133	133	133	133	133	133	133	133	133	133	133	133	133	133	133	27
Mean	5.27	28.36	16.83	26.98	2.67	3.12	82.58	7.12	2.72	100.72	0.35	6.13	71.28	7.72	24.85	15.33	2.48	0.30
Std. Dev.	0.66	6.76	6.5	1.25	0.87	0.67	4.83	1.92	1.42	5.95	0.8	2.84	12.82	1.63	6.18	6.39	0.62	0.68
Min.	4.06	12.5	0	24.48	0	1.55	57.4	3.3	-0.3	82.28	0	0.37	50	4.42	11.09	-3.39	0.69	-1.61
Max.	6.84	42.1	25	30.3	4.74	4.04	89.2	9.7	7.9	128.61	3	14.48	90	10.11	36.04	26.97	3.69	1.49
$Tax\ complex._j$	1.00																	
$Corp.\ tax_j$	0.29	1.00																
VAT_j	0.04	0.01	1.00															
GDP_j	-0.20	-0.49	-0.15	1.00														
$Bureaucracy_j$	-0.16	0.24	0.03	-0.42	1.00													
$Labor\ costs_j$	-0.20	-0.46	-0.18	0.97	-0.46	1.00												
$Trade\ freedom_j$	-0.07	-0.33	-0.28	0.55	-0.42	0.50	1.00											
$Corruption_j$	-0.11	0.00	-0.19	0.18	0.03	0.23	0.10	1.00										
$Inflation_j$	-0.13	-0.25	-0.06	0.45	-0.20	0.42	0.14	-0.02	1.00									
$Exch.\ rate_j$	-0.13	-0.12	-0.18	0.60	-0.21	0.67	0.19	0.36	0.10	1.00								
$Country\ risk_j$	0.18	0.22	-0.08	-0.29	0.07	-0.30	-0.21	-0.26	0.08	-0.39	1.00							
$Lending\ rate_j$	-0.05	-0.37	0.22	0.43	-0.27	0.43	0.06	-0.08	0.23	0.12	-0.01	1.00						
$Invest.\ freedom_j$	-0.09	-0.14	-0.20	0.34	-0.13	0.33	0.21	0.04	0.13	0.18	0.09	0.10	1.00					
$Corruption2_j$	0.10	0.19	0.02	-0.12	0.21	-0.14	-0.14	0.20	-0.04	-0.01	0.05	-0.12	-0.04	1.00				
$EATR_j$	0.27	0.93	-0.08	-0.42	0.09	-0.36	-0.20	0.03	-0.19	-0.07	0.26	-0.35	-0.11	0.10	1.00			
$EMTR_j$	0.12	0.61	-0.07	-0.18	-0.04	-0.07	-0.04	0.16	-0.19	0.14	0.01	-0.23	-0.12	-0.02	0.80	1.00		
$Tax\ payments_j$	0.20	0.42	0.06	-0.35	0.09	-0.32	-0.22	-0.01	-0.19	-0.10	0.16	-0.31	-0.03	0.01	0.41	0.32	1.00	

For the correlation matrix, all variables are demeaned by country. The reason is that in an analysis with country fixed effects only within-country variation matters. The 133 observations consist of 27 countries over a time span of 5 years (2004-2008) with two years missing for Luxembourg. $Enforcement_j$ is only available for the year 2005.

Eidesstattliche Erklärung

Hiermit erkläre ich, die vorliegende Dissertation selbständig angefertigt und mich keiner anderen als der in ihr angegebenen Hilfsmittel bedient zu haben. Insbesondere sind sämtliche Zitate aus anderen Quellen als solche gekennzeichnet und mit Quellenangaben versehen.

Mannheim, den 26. Mai 2014

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