On the Economics of Contribution Evasion

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Abstract

This paper considers the evasion of social security contributions, exemplified for unemployment insurance. It is established that critical differences between contribution evasion and tax evasion exist because contributions entitle to future claims. Furthermore, we derive a recommendation for the reduction of contribution evasion referring to the distinction between Bismarckian and Beverigean social security systems.

Keywords: evasion, social security, unemployment insurance, contributions

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1 Introduction

1.1 Motivation and Main Results

Fraudulent misreporting of income to reduce tax payments has been discussed extensively since the pioneering work of Allingham and Sandmo (1972) (hereafter AS). Subsequently, numerous economic studies have attended to the evasion of taxes. This stands in stark contrast to the study of the evasion of social security contributions, which attracted hardly any attention. This is astonishing for two reasons: (1) Social security contributions account for a considerable part of the tax wedge in many OECD countries (OECD, 2004a). In addition, there is evidence of the importance of this kind of evasion. Table 1 summarizes estimations on the size of the evasion rate for selected OECD countries (based on OECD (2004b)). The given rates are calculated using the ratio of actual contribution receipts to theoretical liability to compulsory employee and employer social security contributions in the non-government sector.[1] (2) There

Table 1: Non-Compliance in Selected OECD Countries

Country	Evasion rate (2000)	Country	Evasion rate (2000)
Austria	0.06	Italy	0.20
Belgium	0.14	Mexico	0.55
Czech Rep.	0.02	Poland	0.18
Finland	0.06	Portugal	0.16
France	0.07	Slovak Rep.	0.03
Germany	0.10	Sweden	0.12
Hungary	0.29	US	0.12
Ireland	0.16		

Source: OECD (2004b)

seem to be conceptual differences between the decision to evade taxes and the decision to evade

[1] The evasion rate is determined by one minus this ratio of actual contribution receipts to theoretical liability, where the theoretical liability is calculated by estimating the true contribution base on the basis of national account figures on labour costs provided by the OECD (see e.g., 2007b). Data on actual receipts of contributions rely on OECD revenue statistics (see e.g., OECD, 2006).

contributions. Unlike taxes, contributions generate potential future claims. If these benefits are income-related, this link may discourage contribution evasion, an observation which is to our knowledge mostly neglected to this day.[2]

This paper analyzes the evasion of contributions to unemployment insurance (UI) and establishes conceptual differences to the evasion of taxes. We first derive the optimal individual choice and discuss conditions under which evasion occurs. Second, we derive the comparative statics of the optimal choice. Parameters varied comprise worker characteristics as well as several policy parameters. A distinguishing feature of the analysis is the comparison of different institutional designs of the UI system. We thereby contribute further insight to the discussion termed "Beveridge versus Bismarck" and term a policy recommendation.[3] In most OECD countries UI benefits are earnings-related, with Iceland, Ireland, Poland and the United Kingdom being exceptions with benefits equal to a flat rate. In Finland benefits are calculated as a combination of a percentage of previous income and a basic benefit.[4]

For tax evasion it is known that risk averse employees will evade taxes if the expected penalty does not exceed the reduction in taxes paid. This result does not apply to contribution evasion. In a setting with heterogeneous employees and cross subsidization in unemployment insurance, we show that individuals faced with a high risk of becoming unemployed declare more income than they are supposed to if there is a close link between benefits and contributions. For low-risk agents evasion can only be observed if insurance coverage is high, whereas they do not evade contribution payments if benefits are indexed to contributions and refund only a small fraction of previous income. The economic intuition is provided by reference to insurance theory. As is well known, risk averse individuals prefer full coverage if the insurance contract is actuarially fair and prefer less than full coverage in case of actuarially unfairness. With social security systems offering pooled contracts, the latter are actuarially unfair for low-risk agents and benefit high-risk agents. Consequently, both types of agents may prefer a different insurance coverage to that offered by the UI policy. Introducing evasion generates a mechanism of affecting the coverage since the effective level of coverage is reduced by underreporting, and is increased by

[2] Although some empirical papers are aware that benefits may affect compliance decisions (Alm et al. 1990 and Alm et al. 1993), a theoretical investigation has been omitted to this date.

[3] For a distinction between a Beveridgean or Bismarckian system of unemployment insurance see also Goerke (2000) or Beissinger and Büsse (2001).

[4] In general, benefits are only proportional to previous earnings for a certain interval of earnings. If UI benefits fall below some threshold value, welfare programs may provide payments (see, OECD 2007a).

overreporting income if benefits are linked to contribution payments. In this context, dishonest behavior can be regarded as an instrument of choosing one's optimal insurance coverage.

The comparative statics of the model yield very interesting findings. For instance, if we take into account budget-balancedness for the insurance, it can be shown that an increase in low-risk types' unemployment probability may actually increase the level of benefits. Most importantly, reforming the UI-system so that the income-related part of benefits is increased which is financed by a decrease of the flat-rate part leads to an increase of income declared. This can thus be used as an indication that policy makers who intend to ameliorate evasion ought to opt for a reform which effectuates that benefits are based on actual individual contributions to a greater extent.

1.2 Related Literature

There is extensive literature on the economics of tax evasion. Since we cannot do justice to that literature, we abstain from discussing it in this section.[5]

Quite to the contrary, there are no theoretical studies on contribution evasion. Nevertheless, this topic has been the subject of several descriptive and empirical studies. Bailey and Turner (2001) specify consequences of imperfect compliance with social security obligations for the management and administration of social security systems and derive measures to reduce evasion. Related recommendations for action are deduced in McGillivray (2001). This study, as well as Manchester (1999) and Gillion et al. (2000), survey a number of empirical studies which aim to measure evasion in pension systems in several OECD countries and some developing countries of Latin America. Contribution compliance in Central and Eastern European countries is analyzed by Stanovnik (2004). A number of these countries reformed their pension schemes during the 1990s. Comparing contribution collection before and after the institutional reorganization enables Stanovnik to draw conclusions about the interaction between compliance behavior and the organization of the social protection system as well as the mechanism of contribution collection. Empirical findings suggest that noncompliance is not only a problem in developing countries, but also in developed countries. For instance, Kingston et al. (1986) and Burgess (1992) show that in the United States overpayment of UI

[5]Interesting recent surveys are provided by Andreoni et al. (1998), Alm (1999), Franzoni (2000), Slemrod and Yitzhaki (2002) and Slemrod (2007).

benefits is widespread and mainly caused by inadequate compliance of job-search regulations. Blakemore et al. (1996) estimate that employers' contribution evasion costs the UI system $ 728 million annually. More current estimates of contribution evasion in OECD countries are provided by Alm and Martinez-Vazquez (2003) and OECD (2004b), to which we referred in the previous section. A discussion about employer and employee incentives to evade contributions can be found in McGillivray (2001), Gillion et al. (2000) and Manchester (1999). Mares (2003) discusses the preferences of employers toward various social insurance policies. She points out that large firms using skill intensive technologies might support social protection and therefore do not have incentives to evade contributions. Using Chinese firm specific data, Nyland et al. (2006) examine the association between firm characteristics and evasion behavior. Yaniv (1986) provides a formal investigation of illegitimate collection of UI benefits. Based on evidence that the unemployment insurance system is often abused by individuals who are in fact employed, the fraudulent claiming behavior is analyzed. As outlined in the introduction, the focus of our paper is on the evasion of contributions, that is the revenue side of the social security system.

The stated differences between the evasion of taxes and the evasion of contributions is less pronounced if tax receipts are utilized in some way. Analyzing public good provision in the context of tax evasion, Cowell and Gordon (1988) and Falkinger (1995) explicitly take the expenditure side of the government into account. Falkinger formulates a model in which the presence of public goods creates a mechanism in which the individual internalizes his own evasion activities. Experimental studies of tax compliance indicate that individual's willingness to comply is more pronounced in the presence of public goods (cf. Alm, 1999). Another way of modeling a positive feedback of honesty is provided by Falkinger and Walther (1991). In their model taxpayers are rewarded if tax inspectors find no discrepancies.[6]

The remaining part of the paper is organized as follows. Section 2 presents the basic framework. Section 3 presents the analysis as well as the comparative statics. Concluding remarks end this study.

[6]Rewarding honesty is a common approach in the literature on optimal tax enforcement. For a survey of this topic see McCubbin (2004).

2 The Model

Consider a large number of risk-averse individuals who live two periods and whose preferences can be represented with the von Neumann-Morgenstern utility function $U[I]$, $U'[I] > 0$, $U'[0] \to \infty$, $U''[I] < 0$, where I is net income. $R_A(I) \equiv -U''[I]/U'[I]$ defines the non-increasing Arrow-Pratt measure of absolute risk aversion and $R_R(I) \equiv -IU''[I]/U'[I]$ defines the non-decreasing Arrow-Pratt measure of relative risk aversion.[7] All individuals are employed in the first period, whereas they become unemployed with an exogenous probability a_i, $i = 1, 2$, in the second period. The population consists of two types of individuals, which are homogeneous except for the unemployment probability, $a_1 < a_2$, and possibly income levels, W_i. Individuals of type i make up the share μ_i of the total population.

The social security system is compulsory and compensates income losses in the event of unemployment. Transfers are financed by contributions proportional to income and collected in the first period. Let θ be the contribution rate and assume that the legal incidence of these contributions falls on employees. The declared income, X_i, not necessarily coincides with true income, W_i. True income is not verifiable without auditing. Agents are audited with probability p, $0 < p < 1$. Audits uncover misreporting of income to the full amount and imply a penalty. The penalty takes the form

$$F_i = \widetilde{\pi}|W_i - X_i|, \tag{1}$$

where $\widetilde{\pi} = \pi[(1-\alpha)+\alpha\theta]$. The parameter π denotes the penalty rate and α is a binary variable. Analogy to AS implies $\alpha = 0$, i.e. the fine is proportional to income not reported. In this case π must be greater than θ in order for F_i to be a fine. If $\alpha = 1$, the fine is proportional to evaded contributions and π must be greater than one (Yitzhaki 1974). The penalty depends on the absolute value of $W_i - X_i$ as agents may declare more than their actual income. Overpayment increases the financial burden of other agents in the economy. We assume that overreporting is punishable like underreporting.

For both periods, there are two net income levels to be distinguished. First-period net income is either

$$I_i^{nd} = W_i - \theta X_i, \tag{2}$$

[7]These preference restrictions are proposed by Arrow (1976) and Alm (1988) and have been adopted in numerous studies (see, e.g. Isachsen and Strom 1980, Cowell and Gordon 1988, Yaniv 1992, Trandel and Snow 1999 or Snow and Warren Jr. 2005).

if there is no audit, or

$$I_i^d = W_i - \theta X_i - F_i \tag{3}$$

if there is an audit. If employed in the second period, individuals do not pay contributions and net income equals income

$$I_i^e = W_i. \tag{4}$$

If unemployed, the individual obtains UI benefits given by

$$I_i^{ue} = L + b(1-\theta)X_i, \tag{5}$$

where $0 \leq b \leq 1$ and $L \geq 0$.

For simplicity, we assume that the compulsory insurance is the only possibility to shift income into the future. Suppose further that the utility function is time-separable and that there is no discounting, so that expected lifetime utility takes the form

$$E(U_i) = (1-p)U(I_i^{nd}) + pU(I_i^d) + (1-a_i)U(I_i^e) + a_i U(I_i^{ue}). \tag{6}$$

The UI system is characterized by (i) the structure of its *benefits*, (ii) the *insurance coverage*, and (iii) its *premium calculation*. In equation (5), UI *benefits* are modeled as a function of an income-related and a flat-rate component. Depending on the values of L and b, economic literature distinguishes between the so-called Beveridgean and Bismarckian UI systems. While benefits in the former system are income-independent ($L > 0$ and $b = 0$), benefits are income-related in a (pure) Bismarckian system, denoting ($L = 0$ and) $b > 0$. With the choice of b and L, the insurer determines *the insurance coverage* ex ante

$$\widetilde{I}_i^{ue} = L + b(1-\theta)W_i, \tag{7}$$

where $\widetilde{I}_i^{ue} \leq (1-\theta)W_i$ is assumed to hold, which ensures that the official insurance coverage does not exceed full coverage. The claimant only receives benefits at the official level if he meets his payment obligations, since $I_i^{ue} \neq \widetilde{I}_i^{ue}$ if $X_i \neq W_i$. Although the system is compulsory, individuals can influence their level of protection. Concerning the *premium calculation*, we assume that the insurer cannot distinguish low-risk from high-risk types but only knows the respective unemployment probabilities as well as the share of each type in total population. This asymmetric information prevents risk-type-specific contracts with actuarially fair premiums, θ_i. Instead, one premium is calculated so that the budget of the unemployment insurance is balanced. Abstracting from administration costs and interest payments, the budget constraint is given by

$$B \equiv \theta \sum_{i=1}^{2} \mu_i X_i - \sum_{i=1}^{2} a_i \mu_i [L + b(1-\theta)X_i] = 0 \tag{8}$$

Note that a UI-system with strongly income-related benefits is not only actuarially unfair (more than fair) in absolute terms but also at the margin for low (high)-risk agents.

3 Analysis and Comparative Statics

3.1 Evasion Decision

Agents maximize their expected utility with respect to declared income, X_i. Differentiating equation (6) yields

$$E_i \equiv \frac{dE(U_i)}{dX_i} = -\theta(1-p)U'[I_i^{nd}] - (\theta - \widetilde{\pi}\delta_i)pU'[I_i^d] + a_i b(1-\theta)U'[I_i^{ue}] \tag{9}$$

where $\delta_i = 1$ ($\delta_i = -1$) for $X_i < W_i$ ($X_i > W_i$). With overreporting being sanctionable, the change in the sign of δ_i reflects the fact that a further increase in declared income, starting at a declaration above true income, increases the expected sanction. The second derivative is given by

$$\frac{d^2E(U_i)}{dX_i^2} = \theta^2(1-p)U''[I_i^{nd}] + (\theta - \widetilde{\pi}\delta_i)^2 pU''[I_i^d] + a_i b^2(1-\theta)^2 U''[I_i^{ue}] < 0 \tag{10}$$

and is negative for all values of $X_i \neq W_i$ owing to the assumption of risk aversion.[8]

Define X_i^* as the optimal amount of income declared. Let us first consider when evasion is obtained, i.e. $X_i^* \in (0, W_i)$. The individual declares positive income if

$$E_i|_{X_i=0} = -\theta(1-p)U'[W_i] - (\theta - \widetilde{\pi})pU'[(1-\widetilde{\pi})W_i] + a_i b(1-\theta)U'[L] > 0$$

which can be rearranged to

$$\widetilde{\pi}p > \theta \left[p + (1-p)\frac{U'[W_i]}{U'[(1-\widetilde{\pi})W_i]} \right] - a_i b(1-\theta)\frac{U'[L]}{U'[(1-\widetilde{\pi})W_i]} \tag{11}$$

Furthermore, agents will declare less than true income W_i if

$$E_i|_{X_i \to W_i^-} = -\theta(1-p)U'[(1-\theta)W_i] - (\theta - \widetilde{\pi})pU'[(1-\theta)W_i] + a_i b(1-\theta)U'[\widetilde{I}_i^{ue}] < 0$$

[8] E_i and E_{ii} are not well defined for $X_i = W_i$. This results from δ_i being positive (negative) for $X_i < W_i$ ($X_i > W_i$).

which occurs if

$$\widetilde{\pi}p < [\theta - a_i b(1-\theta)G_i]\,, \tag{12}$$

where $G_i \equiv U'[\widetilde{I}_i^{ue}]/U'[(1-\theta)W_i] \geq 1$.

If $b = 0$ and $L > 0$, the latter expressions on the right-hand side (*RHS*) of conditions (11) and (12) drop out and we are left with conditions known from the study of tax evasion. If benefits depend on declared income, $b > 0$, the analysis of evasion incentives becomes more complex. Due to the link between contributions and benefits, evasion now reduces income in case of unemployment. Condition (12) reveals that underreporting of income is optimal if the expected fine does not exceed the marginal return from evasion. The latter results from the difference between the rate of contribution and the weighted expected marginal return from contributions. The weight, G_i, can be interpreted as the relative appreciation of the insurance. The lower the insurance coverage (low values of $\widetilde{I}_i^{ue}$ and thus high values of G_i), the stronger agents value the negative effect of evasion on the marginal return from contributions.

Because of cross-subsidization of high-risk agents by low-risk individuals, the insurance is always actuarially unfair at the margin for low-risk agents, which implies $\theta > a_1 b(1-\theta)$. Therefore, in case of full coverage, $G_1 = 1$, the *RHS* of equation (12) is positive. Evasion will take place by these individuals as long as the value of b is low such as to assure condition (12) to hold. Further, since G_1 increases with a fall in coverage, there will be a certain level of incomplete coverage as from which the *RHS* becomes smaller than $\widetilde{\pi}p$ even for high values of b and therefore evasion does not occur. Instead, overreporting of income may become optimal, which will be discussed in a moment after looking at high-risk individuals.

For high-risk agents, the insurance may be actuarially unfair or overfair at the margin, which depends on the extent of cross-subsidization and the level of the flat rate benefit part L. In the case of the insurance being overfair for high-risk individuals, $\theta - a_2 b(1-\theta) < 0$, the *RHS* of condition (12) is negative in the case of full coverage ($G_2 = 1$) and, therefore, high-risk individuals have no incentive to underreport actual income. When insurance coverage is reduced high-risk agents still will not evade contributions as long as a sufficiently strong relationship between contributions and benefits prevails. Indeed, high-risk agents incentives to declare more than their income need to be considered.

If (12) is not fulfilled for low- and/or high-risk individuals, incentives for overreporting income to enlarge income if unemployed may exist. The feasible range of X_i^* is determined by

$(W_i, W_i/\theta)$, $i = 1, 2$. The two conditions that must be satisfied to assure an interior maximum in this range can be rewritten as

$$E_i|_{X_i \to W_i^+} > 0 \Rightarrow \theta + \widetilde{\pi} p < a_i b(1-\theta) G_i \tag{13}$$

and

$$\begin{aligned} E_i|_{X_i \to \frac{W_i}{\theta}} &= -(1-p)\theta U'[0] - p(\theta + \widetilde{\pi})U'[(1-1/\theta)\widetilde{\pi} W_i] \\ &+ a_i b(1-\theta)U'[L + b(1-\theta)W_i/\theta)] < 0. \end{aligned} \tag{14}$$

The latter condition is always satisfied owing to the assumption imposed on the utility function of $U'(0) \to \infty$. The former condition is fulfilled if the increase in contribution payments and the expected fine associated with a higher declaration of income falls short of the weighted marginal return from contributions. It can be shown that this condition may be fulfilled for a sufficiently strong relationship between contributions and benefits. For low-risk individuals this would have to be accompanied by a low level of insurance coverage. Thus, a certain range of parameter values exist in which it is optimal for agents to pay more contributions than they are supposed to do. It follows from (13) that this is more likely to be the case for high-risk individuals.

The results are consistent with insurance theory. Risk-averse individuals prefer full coverage if the insurance is actuarially fair at the margin. For high-risk individuals, the pooled contract may be more than actuarially fair at the margin. Thus, they prefer to pay more contributions than required. For low-risk agents, the contract is actuarially unfair and therefore full coverage is not optimal. Hence, in the case of full coverage, incentives to reduce the insurance coverage through evasion exist.

In summary, individuals with highest job security have the most distinctive incentives to evade. Individuals with a high unemployment probability may evade contributions in a Beveridgean system but may declare more than their actual income if a strong dependence of UI benefits and income exists. Overreporting of income by low-risk individuals may only occur with a strong dependence of benefits on contributions and a rather low level of insurance coverage.

3.2 Comparative Static Analysis

In the following, we derive how the optimal declared income changes with variations in exogenous parameters. This is important for designing the institutional features of the insurance system. In the preceding section, we have already established differences between the incentives for tax and contribution evasion. Now, we inquire whether results of respective comparative static analyses also differ. Moreover, the underlying model allows the analysis of effects on evasion due to variations of labor market conditions and changes in the structure of unemployment benefits, i.e. changes in the relation of b and L.

The complexity of the problem at hand requires further assumptions. We follow Alm's (1988) invoked preference restriction, implying $R_R(.) \leq 1$. Furthermore, we assume that insurance coverage is sufficiently high and that benefits are sufficiently strongly related to income, such that $X_1^* \in (0, W_1)$ and $X_2^* \in (W_2, W_2/\theta)$.

Below, we distinguish two cases. One, in which individuals with a high unemployment probability are able to choose their optimal amount of declaration (case i). Thus, high risk agents' compliance varies with parameter changes. In the second setting (case ii), these individuals are restricted to declaring their income, implying a corner solution. Consequently, the results reported refer to individuals with a low unemployment probability only.

The section is structured as follows: We start our analysis by neglecting the budget constraint of unemployment insurance to identify the direct effects. In Section 3.2.2 we incorporate repercussions via the budget constraint.

3.2.1 Direct Evasion Effects

The parameters we are interested in are: individual characteristics (W_i, a_i), policy variables (p and $\widetilde{\pi}$), and the elements of the UI system (θ, b and L).

Individual characteristics. Consider the effect of a change in income on the fraction of actual income declared[9]

$$\begin{aligned}\frac{\partial(X_i/W_i)}{\partial W_i} &= -\frac{1}{E_{ii}W_i^2}\left\{\theta(1-p)U'(I_i^{nd})[R_R(I_i^{nd})-R_R(I_i^d)]\right\} \\ &- \frac{1}{E_{ii}W_i^2}\left\{a_i b(1-\theta)U'(I_i^{ue})\left[R_R(I_i^d)-\frac{I_i^{ue}-L}{I_i^{ue}}R_R(I_i^{ue})\right]\right\}. \end{aligned} \tag{15}$$

The term in the first line corresponds to the effect known from tax evasion and is non-negative due to the assumption of non-decreasing relative risk-aversion. However, with benefits depending on income declared, an additional effect is observed. Since the ranking of net income in the two states, I_i^d and I_i^{ue}, is not determined, the effect cannot be unambiguously signed. The sign of the second term crucially depends on the penalty on misreporting, the level of coverage, and the flat rate part of the insurance system. However, it is possible to derive conditions which generate unambiguous results for low-risk agents under certain conditions. If the penalty rate is sufficiently small, $\pi \leq 1$ under the AS-penalty scheme or $\pi \leq 1/\theta$ under the Yitzhaki-penalty scheme, it follows that $I_1^d \geq I_1^{ue}$ has to hold in a pure Bismarckian system ($L = 0$) with full coverage, $b = 1$. In this case the second term is positive if relative risk aversion increases with income, and thus the aggregate effect is positive as well. Low-risk agents will declare relatively more income at higher income levels. In this case, the quantitative effect exceeds the one from tax evasion. If the penalty rate is relatively high, $\pi > 1$ under the AS-penalty scheme or $\pi > 1/\theta$ under the Yitzhaki-penalty scheme, the second term is negative for strictly increasing relative risk aversion. In this case, the aggregate effect on evasion is ambiguous due to the counteracting benefit effect.

Considering high-risk agents, $I_2^d < I_2^{ue}$ applies if $L = 0$ and $b = 1$, irrespective of the penalty rate. Therefore we should observe a further increase in overreporting.

Looking at the risk of unemployment, we find

$$\frac{\partial X_i}{\partial a_i} = -\frac{E_{ia_i}}{E_{ii}} = -\frac{1}{E_{ii}}[b(1-\theta)U'(I_i^{ue})] > 0, \tag{16}$$

An increase in the unemployment probability increases reported income. While the marginal return from non-declaration remains unchanged, the marginal costs of non-declaration increase due to an increase in the expected payoff from insurance.

[9] A detailed derivation is added in Appendix A.1.

Enforcement parameters. We find

$$\frac{\partial X_i}{\partial p} = -\frac{E_{ip}}{E_{ii}} = -\frac{1}{E_{ii}}[\theta U'(I_i^{nd}) - (\theta - \delta_i \widetilde{\pi})U'(I_i^d)] \left\{ \begin{array}{c} > \\ < \end{array} \right\} 0 \quad \text{if} \quad i = \left\{ \begin{array}{c} 1 \\ 2 \end{array} \right. , \tag{17}$$

$$\frac{\partial X_i}{\partial \widetilde{\pi}} = -\frac{E_{i\widetilde{\pi}}}{E_{ii}} = -\frac{\delta_i}{E_{ii}}[pU'(I_i^d) + (\theta - \delta_i \widetilde{\pi})(W_i - X_i)U''(I_i^d)] \left\{ \begin{array}{c} > \\ < \end{array} \right\} 0 \quad \text{if} \quad i = \left\{ \begin{array}{c} 1 \\ 2 \end{array} \right. . \tag{18}$$

An increase in the penalty rate or the probability of detection discourages evasion by low-risk individuals as well as overreporting of income by high-risk individuals. Note that a decrease in income reported by high-risk agents is tantamount to an increase in honesty. These effects are therefore in line with the model of tax evasion.

Unemployment insurance system. We start by analyzing how agents' behavior depends on the contribution rate. In the context of tax evasion, the penalty scheme, i.e. whether α is equal to one or zero, has a crucial impact on evasion. Hence, we will, first, derive the result for the AS-penalty and, next, for the Yitzhaki-penalty scheme. We obtain

$$\left.\frac{\partial X_i}{\partial \theta}\right|_{\alpha=0} = -\left.\frac{E_{i\theta}}{E_{ii}}\right|_{\alpha=0} = \frac{1}{\left.E_{ii}\right|_{\alpha=0}} \left\{(1-p)U'(I_i^{nd}) + pU'(I_i^d) + a_i b U'(I_i^{ue})\right\} \tag{19}$$

$$+\frac{X_i}{\left.E_{ii}\right|_{\alpha=0}} \left\{\theta(1-p)U'(I_i^{nd})[R_A(I_i^{nd}) - R_A(I_i^d)] + a_i b(1-\theta)U'(I_i^{ue})[R_A(I_i^d) - bR_A(I_i^{ue})]\right\}.$$

As in models of tax evasion when changing the tax rate, we observe a substitution and an income effect. The former one, which is due to evasion becoming relatively more attractive and represented by the upper term, unambiguously affects income declared negatively. The income effect, represented by the lower term, is positive for low-risk agents in case of $b = 1$ and $\pi \leq 1$ under decreasing absolute risk aversion. However, the second term of the income effect may become positive if the insurance does not offer full coverage and, consequently, the aggregate income effect can not be identified. If $\pi > 1$, the substitution effect and the second term of the income effect alter income declared negatively. The first term of the income effect remains positive. It is not possible to specify conditions which ensure unambiguous results for high-risk agents.

Under the Yitzhaki-penalty scheme, the aforementioned substitution effect is not present because the increase in the marginal benefit of evasion is offset by an increase in the marginal costs as the fine increases as well. This result established in the literature on tax evasion also holds in our setting. We find[10]

$$\left.\frac{\partial X_i}{\partial \theta}\right|_{\alpha=1} = -\left.\frac{E_{i\theta}}{E_{ii}}\right|_{\alpha=1} = \frac{1}{E_{ii}|_{\alpha=1}}\left\{\frac{a_i b}{\theta}U'(I_i^{ue}) - (1-\delta_i\pi)\delta_i\pi\theta p U''(I_i^d)(W_i - X_i)\right.$$
$$\left. + X_i[\theta(1-p)U'(I_i^{nd})[R_A(I_i^{nd}) - R_A(I_i^d)] + a_i b(1-\theta)[R_A(I_i^d) - bR_A(I_i^{ue})]]\right\}. \qquad (19')$$

In contrast to tax evasion, however, there still is an additional effect which might also be labeled a substitution effect. This is expressed by the first term in the upper row of equation (19'). The intuition is as follows: In addition to the mutually neutralizing change of the penalty and contribution rate, benefits change due to a variation of net income. An increase in θ therefore reduces net income as well as unemployment benefits, making it less worthwhile to discharge contributions at the margin and thus stimulates declaring less income. Therefore, the substitution effect alters the honesty of both agents in opposite directions. While low-risk agents' dishonest behavior is reinforced, high-risk agents meet their obligatory payments more accurately.

The above has established that the sign of the change in declared income as a response to a change in the contribution rate is ambiguous. Yet, we can show that an increase in the contribution rate unambiguously encourages honesty to a greater extent under the Yitzhaki-penalty than under the AS-penalty scheme if dishonest behavior is penalized to the same extent in both systems.[11] This can best be seen by sequentially comparing the income and substitution effects for both agents. Contrasting the latter effects, yields

$$(1-p)U'(I_i^{nd}) + pU'(I_i^d) + a_i b U'(I_i^{ue}) =$$
$$\frac{1}{\theta}[\delta_i\pi p U'(I_i^d) + a_i b U'(I_i^{ue})]\left\{\begin{matrix} > \\ < \end{matrix}\right\}\frac{a_i b}{\theta}U'(I_i^{ue}) \quad \text{if} \quad i = \left\{\begin{matrix} 1 \\ 2 \end{matrix}\right. . \qquad (20)$$

Thus, the declaration depressing substitution effect is greater for low-risk agents under AS-penalty than Yitzhaki-penalty. For high-risk agents it is smaller. But since a decrease in income reported implies an increase in honesty, a smaller substitution effect is tantamount to less honesty. The income effect affects honesty more positively under the Yitzhaki-penalty, since the second term in the upper row of (19') does not appear in (19). This term stimulates (reduces)

[10] A detailed derivation is added in Appendix A.2.

[11] This is the case if $\theta\ \pi|_{\alpha=1} = \pi|_{\alpha=0}$.

the amount of declared income for low-risk (high-risk) agents. Thus, both effects encourage compliance more if the penalty is proportional to contributions instead of misreported income.

To summarize: in the case of tax evasion a variation in the tax rate generates no substitution effect under the Yitzhaki-penalty as the tax rate and the penalty rate increase proportionally. There is a substitution effect in the context of contribution evasion as changes in θ affect future benefits. Nevertheless, as in the case of tax evasion, an increase in the contribution rate encourages honest behavior to a larger extent under the Yitzhaki-penalty.

Finally, we analyze the effects of a change in L and b, given by

$$\frac{\partial X_i}{\partial L} = -\frac{E_{iL}}{E_{ii}} = -\frac{1}{E_{ii}} a_i b(1-\theta)U''(I_i^{ue}) < 0 \tag{21}$$

$$\frac{\partial X_i}{\partial b} = -\frac{E_{ib}}{E_{ii}} = -\frac{1}{E_{ii}} a_i(1-\theta)U'(I_i^{ue}) \left[1 - \frac{I_i^{ue} - L}{I_i^{ue}} R_R(I_i^{ue})\right] \geq 0. \tag{22}$$

A rise in the flat-rate component L raises the expected disposable income in the state of unemployment. For $b > 0$ the marginal benefits from paying contributions declines, resulting in a decrease in reported income for both types of agents.

In addition to this income effect, an increase in b evokes a substitution effect. Due to the closer link between contributions and benefits, the substitution effect depresses non-declaration of income. All in all, assuming $R_R(I_i^{ue}) \leq 1$, a stronger relationship between benefits and contributions causes agents to declare more income.[12]

3.2.2 Balanced Budget

So far we neglected budget-balancedness. Since a change in compliance affects insurer's revenue and therefore requires an adjustment of UI benefits,[13] we now extend the partial analysis and take the insurance budget-constraint into account. To operationalize case (i) and (ii) introduced at the beginning of Section 3.2, we formulate the Kuhn-Tucker condition

$$E_2(W_2 - X_2) = 0. \tag{23}$$

[12]This outcome is consistent with empiric findings. Alm et al. (1990) estimates the effect of various factors like the marginal income tax rate, penalty rate and tax-related benefits on tax compliance behavior in Jamaica. The estimation suggests that individuals increase tax compliance significantly if benefits are increased.

[13]Because of the ambiguous effect resulting from a variation in θ, the contribution rate is not an appropriate instrument to balance an insurer's budget in the underlying model.

Totally differentiating the budget constraint $B = 0$, equation (8), and the first-order conditions (9) and (23) with respect to the endogenous parameters X_1, X_2 and a catch-all insurance variable ϕ, $\phi = b, L$, and the exogenous parameter a_1, a_2, μ_1 and a catch-all enforcement parameter τ, $\tau = p, \widetilde{\pi}$, yields:

$$\begin{bmatrix} E_{11} & 0 & E_{1\phi} \\ 0 & (W_2 - X_2)E_{22} - E_2 & (W_2 - X_2)E_{2\phi} \\ B_1 & B_2 & B_\phi \end{bmatrix} \begin{bmatrix} dX_1 \\ dX_2 \\ d\phi \end{bmatrix} =$$

$$- \begin{bmatrix} E_{1a_1} & 0 & 0 & E_{1\tau} \\ 0 & (W_2 - X_2)E_{2a_2} & 0 & (W_2 - X_2)E_{2\tau} \\ B_{a_1} & B_{a_2} & B_{\mu_1} & 0 \end{bmatrix} \begin{bmatrix} da_1 \\ da_2 \\ d\mu_1 \\ d\tau \end{bmatrix}, \tag{24}$$

where $E_{ij} = E_{ia_j} = E_{i\mu_j} = E_2 \frac{\partial X_2}{\partial a_2} = E_2 \frac{\partial X_2}{\partial \phi} = B_\tau = 0$, for $i, j = 1, 2$ and $i \neq j$. The methodology of the comparative analysis is as follows: We discuss the effect on benefits, b or L, and the effects on evasion due to a change in one of the parameters. Since a change in b and L affects the behavior of individuals differently, the total evasion effect also depends on which insurance parameter is adjusted. Therefore, we discuss the effects on evasion first if the insurer balances its budget via a variation of b and then via a variation of L.[14]

Labor Market Conditions. Consider, first, the effect on benefits, b or L, resulting from a change in the unemployment probability of group 1, a_1, given by

$$\frac{d\phi}{da_1} = -\frac{1}{J_\phi} B_1 E_{11} E_{22} \left[\frac{\partial X_1}{\partial a_1} - \underbrace{\frac{L + b(1-\theta)X_1}{\theta - a_1 b(1-\theta)}}_{= \frac{B_{a_1}}{B_1}} \right], \quad \phi = b, L, \tag{25}$$

where $J_\phi < 0$, as well as the derivatives are summarized and signed in Appendix A.3 and A.4. The variation in a_1 generates ambiguous effects. On the one hand, a rise in a_1 increases the expected expenditure of the insurer directly and therefore exerts downward pressure on

[14] Since most results do not depend on the underlying assumption of whether overreporting is possible or not, the following issues are derived for case (i), $E_1 = E_2 = 0$. The effects for case (ii), $E_1 = 0, W_2 = X_2$, are listed in Appendix A.5 and are discussed in the main text if the results are sensitive to this assumption.

benefits. On the other hand, from (16) we know that the direct evasion effect of an increase in a_1 on X_1 is positive. Since the insurance contract is actuarially unfair at the margin for type 1 individuals, this releases the insurer's budget. Since the multiplier of the bracket in equation (25) is positive, the deterioration of labor-market conditions results in higher (lower/constant) benefits if the direct increase in income declared by agents of type 1 exceeds (falls below/is equal to) the required budget balancing change. Therefore, contrary to intuition, an increase in low-risk type's unemployment probability may result in higher unemployment benefits. The following example shows that a more pronounced heterogeneity among both groups makes this outcome more likely.

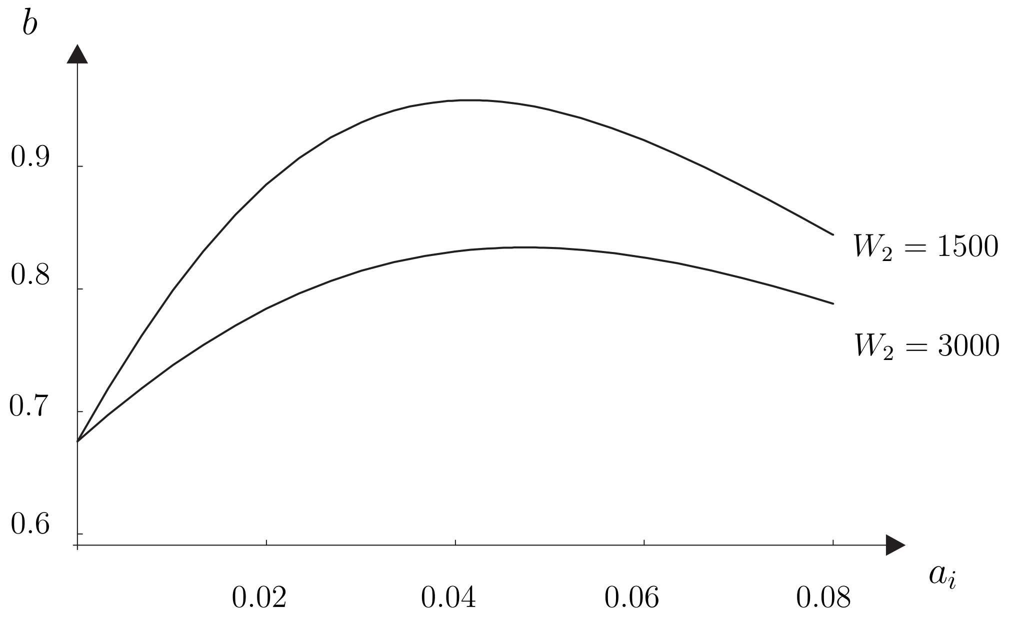

Figure 1: Effect of Low-risk Agent's Unemployment Probability on Benefits

Example 1. Suppose preferences are given by $U = ln(I)$. This utility function exhibits decreasing absolute and constant relative risk aversion. Let $a_2 = 0.12$, $\theta = 0.075$, $L = 0$, $W_1 = 3000$, $W_2 = 1500$ (or 3000), $\mu_1 = 0.5$ and $p = 0.02$. The penalty structure follows the Yitzhaki-scheme with $\pi = 2$. Based on this specification it is possible to solve the first-order conditions of both types and the budget constraint for $X_i^*(a_1)$ and $b(a_1)$, where $a_1 \in [0, 0.0778]$ as $a_1 > 0.0778$ would imply $X_1^* > 3000$. From Figure 3.2.2, it is apparent that for small values of a_1, benefits increase with a_1. This result is robust with respect to actual income of agent 2 and is consistent with our results. The smaller the unemployment probability of group 1 and therefore the more distinct the two groups are, the more pronounced is the effect of a change in a_1 on b.

Consider now the variation in declared income in response to a change in the unemployment probability if the insurer balances its budget via a variation of L, given by

$$\left.\frac{dX_1}{da_1}\right|_{db=0} = \frac{\partial X_1}{\partial a_1} + \frac{\partial X_1}{\partial L}\frac{dL}{da_1} = \frac{1}{J_L}[B_{a_1}E_{1L}E_{22} - E_{1a_1}D_1] > 0, \tag{26}$$

$$\left.\frac{dX_2}{da_1}\right|_{db=0} = \frac{\partial X_2}{\partial L}\frac{dL}{da_1}, \tag{27}$$

where

$$\begin{aligned} D_1 = B_L E_{22} - B_2 E_{2L} = B_L[\theta^2(1-p)U''(I_2^{nd}) + (\theta - \delta_i\widetilde{\pi})^2 pU''(I_2^d)] \\ -a_2 b(1-\theta)[a_1 b(1-\theta)\mu_1 + \theta\mu_2]U''(I_2^{ue}) > 0. \end{aligned} \tag{28}$$

The effect on the declaration of high-risk individuals is entirely determined by the change in benefits and the corresponding direct evasion effect (21). Thus, an increase in low-risk type's unemployment probability increases (decreases/does not alter) high-risk type's declared income if the flat-rate part decreases (increases/stays constant). Furthermore, (26) states that low-risk agent's declared income increases irrespective of the change in unemployment benefits. Thus the direct evasion effect is strong since it is dominant even if L increases, which principally provokes evasion.

If the insurer adjusts the income-related component, b, we obtain the following effects

$$\left.\frac{dX_1}{da_1}\right|_{dL=0} = \frac{1}{J_b}D_2, \tag{29}$$

if $E_1 = 0$; $W_2 = X_2$, and

$$\left.\frac{dX_1}{da_1}\right|_{dL=0} = \frac{1}{J_b}[B_2 E_{1a_1}E_{2b} - E_{22}D_2], \tag{29'}$$

$$\left.\frac{dX_2}{da_1}\right|_{dL=0} = \frac{\partial X_2}{\partial b}\frac{db}{da_1}, \tag{30}$$

if $E_1 = E_2 = 0$, where

$$\begin{aligned} D_2 &= B_b E_{1a_1} - B_{a_1}E_{1b} \\ &= (1-\theta)\left\{[L(a_1\mu_1 + a_2\mu_2) - a_2\mu_2 I_2^{ue}]U'(I_1^{ue}) + \mu_1 a_1 b(1-\theta)X_1 I_1^{ue}U''(I_1^{ue})\right\}. \end{aligned} \tag{31}$$

First, consider the evasion effect when type 2 individuals are restricted, (29). From (31) it is obvious that $D_2 < 0$ if L is sufficiently low. Accordingly, if benefits do not include a flat-rate part, low-risk agent's declared income increases. If we now allow contribution over-payment, we obtain an additional repressing evasion effect, denoted by the first term in (29'). So, $sign(-D_2) = sign\left(\left.\frac{dX_1}{da_1}\right|_{dL=0}\right)$ no longer necessarily applies and type 1 individuals may declare more income even if L is large. The effect on high-risk type's declared income is conceptually the same as if the insurer were to adjust benefits via L. Since the direct evasion effect of an increase in b is positive, declared income increases (decreases/stays constant) if benefits increase (decrease/stay constant).

Consider now the effect of a change in the unemployment probability of agents from group 2, a_2, given by

$$\frac{d\phi}{da_2} = -\frac{1}{J_\phi}B_2E_{11}E_{22}\left[\frac{\partial X_2}{\partial a_2}\underbrace{-\frac{L+b(1-\theta)X_1}{\theta-a_1b(1-\theta)}}_{=\frac{B_{a_2}}{B_2}}\right] < 0 \ , \quad \phi = b, L. \tag{32}$$

If the budget is adjusted via a variation in L, the effects on declared income are determined by

$$\left.\frac{dX_1}{da_2}\right|_{db=0} = \frac{\partial X_1}{\partial L}\frac{dL}{da_2} > 0, \tag{33}$$

$$\left.\frac{dX_2}{da_2}\right|_{db=0} = \frac{1}{J_L}[B_1E_{1L}E_{2a_2} + B_{a_2}E_{11}E_{2L} - B_LE_{11}E_{2a_2}] > 0. \tag{34}$$

An increase in high-risk type's unemployment probability forces the insurer to lower unemployment benefits. Unlike the preceding analysis, the direct evasion effect of high-risk types deteriorates the insurer's budget because the insurance is actuarially overfair at the margin for this type. As a decrease in L encourages declaring more income, low-risk types become more honest, while high-risk agents cheat more.

The effects on agents' behavior in the case of a variation of b, are given by:

$$\left.\frac{dX_1}{da_2}\right|_{dL=0} = \frac{\partial X_1}{\partial b}\frac{db}{da_2} \leq 0, \tag{35}$$

$$\left.\frac{dX_2}{da_2}\right|_{dL=0} = \frac{1}{J_b}[B_1E_{1b}E_{2a_2} + B_{a_2}E_{11}E_{2b} - B_bE_{11}E_{2a_2}]. \tag{36}$$

While low-risk types will evade more contributions, the effect on high-risk agents is undetermined. This ambiguity follows from the direct evasion effect and the fall in b, which operate in opposite directions.

Enforcement Policy. We briefly summarize the changes in evasion if the insurer alters the enforcement parameters, $\tau = p, \widetilde{\pi}$. The direct effect of an increase in one of the enforcement parameters is to induce more honesty. In accordance, if overreporting of income by high-risk individuals is not possible (case ii), an increase in one of the enforcement parameters yields a surplus in the budget of the unemployment insurance, which allows for an increase in benefits

$$\frac{d\phi}{d\tau} = -\frac{1}{J_\phi} B_1 E_{1\tau} > 0. \tag{37}$$

for $E_1 = 0$; $W_2 = X_2$. In this case, the direct effect on the evasion decision of low-risk individuals predestinates the sign of the change in income declared

$$\frac{dX_1}{d\tau} = \frac{1}{J_\phi} B_\phi E_{1\tau} > 0, \tag{38}$$

for $E_1 = 0$; $W_2 = X_2$.

If we allow for overreporting of income by high-risk individuals (case i) we still find that benefits can be increased

$$\frac{d\phi}{d\tau} = \frac{1}{J_\phi} E_{11} E_{22} \left[B_1 \frac{E_{1\tau}}{E_{11}} + B_2 \frac{E_{2\tau}}{E_{22}} \right] > 0, \tag{39}$$

for $E_1 = E_2 = 0$. However, the sign of the change in income declared by the two types may now be ambiguous and depending on whether a balanced budget is achieved by a variation in b or L. Income declared of individuals of type 1 (2) unambiguously increases (decreases) if b (L) is used to adjust the budget because then the direct evasion effect and the benefits changing effect operate in the same direction. Instead, we find ambiguous results for low-risk (high-risk) agents if the insurer adjusts its budget via L (b), since the direct and benefits changing effect operate in opposite directions.

Reform of the UI-System. Consider now the effect of a change in the structure of unemployment benefits on income declared. We analyse the case of an increase in L financed by a decrease in b. Consequently, the system is made less "Bismarckian". For this purpose, let L be the exogenous and b the endogenous variable of the system (24). From this modified system we obtain the following effects

$$\frac{dX_1}{dL} = \frac{1}{J_L} [B_b E_{1L} - B_L E_{1b}] < 0, \tag{40}$$

when $E_1 = 0$; $W_2 = X_2$, and

$$\frac{dX_1}{dL} = \frac{1}{J_L}\left\{ B_2 E_{1L} E_{2b} - B_b E_{1L} E_{22} + B_2 E_{1b} E_{22} \left[\frac{\partial X_2}{\partial L} \underbrace{- \frac{a_1\mu_1 + a_2\mu_2}{[\theta - a_2 b(1-\theta)]\mu_2}}_{= \frac{B_L}{B_2}} \right] \right\}, \qquad (40')$$

$$\frac{dX_2}{dL} = \frac{1}{J_L}\left\{ B_1 E_{2L} E_{1b} - B_b E_{2b} E_{11} + B_1 E_{2b} E_{11} \left[\frac{\partial X_1}{\partial L} \underbrace{- \frac{a_1\mu_1 + a_2\mu_2}{[\theta - a_1 b(1-\theta)]\mu_1}}_{= -\frac{B_L}{B_1}} \right] \right\} < 0, \qquad (41)$$

when $E_1 = E_2 = 0$. Equation (41) reveals that high-risk agents will declare less income and therefore become more honest if benefits are less income-dependent. Equation (40) shows that low-risk type's evasion increases in case (ii) if L is increased, financed by a decrease in b. But this change implies ambiguous effects for evasion by low-risk individuals in case (i), if high-risk agents can declare more than actual income. The first two terms in curly brackets and the weight of the inner bracket of (40') are positive. So type 1 agents will evade more contributions if the inner bracket is positive. This is the case if the direct evasion effect does not exceed the (partial) budget balancing effect, denoted by the second term.

The intuition behind this is the following: All else equal, an increase in L increases the expenditure of the insurer. This could be equalized by a fall in X_2, since the insurance contract is actuarially overfair at the margin for agents of type 2. From equation (21) we know that the direct effect of an increase in L is negative. If this direct effect is larger than the amount required, there will be a surplus which would lead to an increase in the Bismarckian parameter. But increasing b causes low-risk agents to increase declared income. However, from a theoretical point of view, an increase in the income related part of the UI benefits due to an increase in L is not possible if we reasonably assume that an increase in L deteriorates the budget of the social insurance institution (see Appendix A.4). Again, an example may support the result that relaxing the contribution-benefit link decreases the fraction of declared income.

Example 2. Using the specification of Example 1 and letting $a_1 = 0.06$, $W_2 = 1500$ and $\mu_1 = 0.25$ or $\mu_1 = 0.5$, we have numerically computed the solution of X_1^*, X_2^* and b for different values of L. Table 2 summarizes the results. The overall effect of an increase in L on income declared is negative. Moreover, the relative change in X_i^* is more pronounced for the high value of μ_2 (low value of μ_1).

Table 2: Effects on Income Declared due to a Reform of UI Benefits

L	b		X_1		X_2	
	$\mu_1 = 0.25$	$\mu_1 = 0.5$	$\mu_1 = 0.25$	$\mu_1 = 0.5$	$\mu_1 = 0.25$	$\mu_1 = 0.5$
0	0,78	0,92	2354,58 (n/a)	2354,58 (n/a)	2061,84 (n/a)	2061,84 (n/a)
50	0,76	0,90	2287,59 (-2,8)	2297,94 (-2,4)	1998,7 (-3,1)	2008,46 (-2,6)
100	0,73	0,87	2215,44 (-3,2)	2237,81 (-2,6)	1930,68 (-3,4)	1951,78 (-3,1)
150	0,70	0,84	2136,79 (-3,6)	2173,49 (-2,9)	1856,53 (-3,8)	1891,14 (-3,5)
200	0,67	0,81	2049,63 (-4,1)	2104,01 (-3,2)	1774,33 (-4,4)	1825,62 (-4,0)
250	0,63	0,78	1950,61 (-4,8)	2027,97 (-3,6)	1680,91 (-5,3)	1753,89 (-4,6)
300	0,58	0,74	1833,33 (-6,0)	1943,15 (-4,2)	1570,24 (-6,6)	1673,88 (-5,5)

Figures in brackets denote relative changes in per cent.

The results of this section are very interesting for policy analysis. Although the results are partly ambiguous, there seems to be strong support for that a stronger relationship between contributions and benefits encourages the declaration of income. Therefore, as long as higher income declarations are seen as desirable, this finding gives support for a Bismarckian system if compared with a Beveridgean one.

3.3 Review of Comparative Static Results

Table 3 summarizes the effects on benefits and income declared due to an increase in the exogenous parameters of the model. Most effects are unambiguously signed. If the unemployment probability of low-risk agents increases, we can only conclude that benefits tend to increase when employment probabilities differ substantially. The effects on declared income crucially depend on which part of benefits is adjusted. Assuming that the insurer is interested in both agents being honest, he should adjust benefits via L if enforcement is strengthened or if an increase in a_1 requires a supplement of benefits. The remaining results refer to no preferable action, since the effects on income declared is symmetric among both agents. The insurer has to weigh the quantitative changes in income declared by both groups, which depend on agents' utility function and the population structure.

Table 3: Effects on Benefits and Income Declared due to an Increase in a Parameter

Effect on	Parameter change								
	a_1				a_2		τ		L
ϕ	?				-		+		-
Adjustment via	L↑	b↑	L↓	b↓	L	b	L	b	b
X_1	+	?	+	?	+	-	?(+)	+	?(-)
X_2	-	+	+	-	+	?	-	?	-

Signs in brackets refer to case (ii).

4 Conclusion

This paper is the first to contribute to a theoretical foundation for the economics of contribution evasion. The analysis establishes that the design of unemployment insurance has a crucial impact on incentives to evade contributions and on the way individuals adapt their behavior in the face of changing circumstances. We show that the declared income increases if the system hinges benefits more on contributions paid. Consequently, the results support the hypothesis that a Bismarckian system stimulates the truthful declaration of income more than a Beveridgean system. However, we also show that a Bismarckian system does not erase evasion entirely because this system is at a disadvantage for the group of low-risks. Thus, the Bismarckian system itself constitutes evasion incentives for parts of the population. This effect has been neglected until now and might contribute to a better understanding of the effects of reforming social security systems on evasion behavior.

Our inquiry unearthes some interesting findings. For instance, an increase in low-risk types' unemployment probability tends to increase benefits if differences in unemployment probabilities are fairly distinct. This is because the deterioration of the insurers budget due to an increase in the expected expenditure is dominated by higher receipts from low-risk agents in this case. Moreover, it is delineated that in a Bismarckian system high-risk agents may pay more contributions than they are supposed to due to the subsidization by low-risk agents.

The study at hand spearheads the theoretical analysis of contribution evasion. In order to illuminate aspects, a number of simplifying assumptions are made. Undoubtedly, future research needs to dive into the sensitivity of findings with respect to these presumptions.

A Mathematical Appendix

A.1 The Effect of a Variation in Income on Income Declared

The variation of the fraction of income declared due to an increase in income is given by

$$\frac{\partial(X_i/W_i)}{\partial W_i} = \frac{1}{W_i^2}\left[\frac{\partial X_i}{\partial W_i}W_i - X_i\right]. \tag{42}$$

The absolute income effect is given by

$$\frac{\partial X_i}{\partial W_i} = \frac{1}{E_{ii}}[\theta(1-p)U''(I_i^{nd}) + p(\theta - \delta_i\widetilde{\pi})(1-\delta_i\widetilde{\pi})U''(I_i^d)]. \tag{43}$$

Substitution of equation (43) in (42) yields

$$\begin{aligned}\frac{\partial X_i/W_i}{\partial W_i} &= \frac{1}{E_{ii}W_i^2}[\theta(1-p)U''(I_i^{nd})W_i + (\theta - \delta_i\widetilde{\pi})(1-\delta_i\widetilde{\pi})pU''(I_i^d)W_i \\ &-\theta^2(1-p)U''(I_i^{nd})X_i - (\theta-\delta_i\widetilde{\pi})^2pU''(I_i^d)X_i - a_ib^2(1-\theta)^2U''(I_i^{ue})X_i] \\ &= \frac{1}{E_{ii}W_i^2}[\theta(1-p)U''(I_i^{nd})I_i^{nd} + p(\theta-\delta_i\widetilde{\pi})U''(I_i^d)I_i^d - a_ib^2(1-\theta)^2U''(I_i^{ue})X_i].\end{aligned} \tag{44}$$

Substituting (9) and collecting terms we get equation (15).

A.2 Variation of the Rate of Contribution under the Yitzhaki-Penalty Scheme

The first order condition under the Yitzhaki-penalty scheme has the form

$$E_i|_{\alpha=1} = -\theta(1-p)U'[I_i^{nd}] - (1-\delta_i\pi)\theta pU'[I_i^d] + a_ib(1-\theta)U'[I_i^{ue}] = 0. \tag{9'}$$

Differentiating (9') with respect to θ yields

$$\begin{aligned}\left.\frac{\partial X_i}{\partial\theta}\right|_{\alpha=1} &= \frac{1}{E_{ii}|_{\alpha=1}}\big[(1-p)U'(I_i^{nd}) + (1-\delta_i\pi)pU'(I_i^d) + a_ibU'(I_i^{ue}) \\ &- \theta(1-p)U''(I_i^{nd})X_i - (1-\delta_i\pi)\theta pU''(I_i^d)(X_i + \delta_i\pi(W_i - X_i)) + a_ib^2(1-\theta)U''(I_i^{ue})X_i\big]\end{aligned}$$

Substituting (9') we can rewrite this as

$$\begin{aligned}\left.\frac{\partial X_i}{\partial\theta}\right|_{\alpha=1} &= \frac{1}{E_{ii}|_{\alpha=1}}\left[\frac{a_ib(1-\theta)}{\theta}U'(I_i^{ue}) + a_ibU'(I_i^{ue}) - (1-\delta_i\pi)\delta_i\pi\theta pU''(I_i^d)(W_i - X_i)\right] \\ &-\frac{X_i}{E_{ii}|_{\alpha=1}}\big[\theta(1-p)U''(I_i^{nd}) + [\theta(1-p)U'(I_i^{nd}) - a_ib(1-\theta)U'(I_i^{ue})]R_A(I_i^d) \\ &-a_ib^2(1-\theta)U''(I_i^{ue})\big]\end{aligned}$$

Collecting terms yields equation (19').

A.3 Derivatives

$$B_i = [\theta - a_i b(1-\theta)]\mu_i \left\{ \begin{array}{c} > \\ \\ < \end{array} \right\} 0 \quad \text{if} \quad i = \left\{ \begin{array}{l} 1 \\ \\ 2 \end{array} \right. \tag{45}$$

$$B_b = -(1-\theta)[a_1\mu_1 X_1 + a_2\mu_2 X_2] < 0 \tag{46}$$

$$B_L = -[a_1\mu_1 + a_2\mu_2] < 0 \tag{47}$$

$$B_{a_i} = -I_i^{ue}\mu_i < 0 \tag{48}$$

$$B_{\mu_1} = [\theta X_1 - a_1 I_1^{ue}] - [\theta X_2 - a_2 I_2^{ue}] > 0 \tag{49}$$

$$E_{ia_i} = b(1-\theta)U'(I_i^{ue}) > 0 \tag{50}$$

$$E_{ib} = a_i(1-\theta)U'(I_i^{ue})\left[1 - \frac{I_i^{ue} - L}{I_i^{ue}} R_R(I_i^{ue})\right] \geq 0 \tag{51}$$

$$E_{iL} = a_i b(1-\theta)U''(I_i^{ue}) < 0 \tag{52}$$

$$E_{ip} = [\theta U'(I_i^{nd}) - (\theta - \delta_i\widetilde{\pi})U'(I_i^d)] \left\{ \begin{array}{c} > \\ \\ < \end{array} \right\} 0 \quad \text{if} \quad i = \left\{ \begin{array}{l} 1 \\ \\ 2 \end{array} \right. \tag{53}$$

$$E_{i\widetilde{\pi}} = \delta_i[pU'(I_i^d) + (\theta - \delta_i\widetilde{\pi})(W_i - X_i)U''(I_i^d)] \left\{ \begin{array}{c} > \\ \\ < \end{array} \right\} 0 \quad \text{if} \quad i = \left\{ \begin{array}{l} 1 \\ \\ 2 \end{array} \right. \tag{54}$$

A.4 Sign of Determinant J_ϕ

The determinant of the matrix on the left-hand side of (24) is given by:

$$\widetilde{J_\phi} = (W_2 - X_2)[B_\phi E_{11} E_{22} - B_1 E_{1\phi} E_{22} - B_2 E_{11} E_{2\phi}] \equiv (W_2 - X_2) J_\phi, \tag{55}$$

when $E_1 = E_2 = 0$,

$$\widetilde{J_\phi} = E_2[B_1 E_{1\phi} - B_\phi E_{11}] \equiv E_2 J_\phi, \tag{56}$$

when $E_1 = 0$; $W_2 = X_2$.

It is possible to demonstrate that $J_\phi < 0$ as long as an increase in the Bismarckian parameter b or in the flat-rate part L leads to a deterioration of the insurer's budget. Total differentiation (8) with respect to ϕ, yields:

$$\frac{dB}{d\phi} = -B_1 \frac{E_{1\phi}}{E_{11}} - B_2 \frac{E_{2\phi}}{E_{22}} + B_\phi = \frac{J_\phi}{E_{11}E_{22}}, \tag{57}$$

when $E_1 = E_2 = 0$,

$$\frac{dB}{d\phi} = -B_1 \frac{E_{1\phi}}{E_{11}} + B_\phi = -\frac{J_\phi}{E_{11}}, \tag{58}$$

when $E_1 = 0$; $W_2 = X_2$.

As $sign(J_\phi) = sign(\frac{dB}{d\phi})$, J_ϕ is negative if we assume that the budget of the insurer is decreasing in ϕ.

This assumption is based on plausibility. For the purpose of a concluding assessment this assumption would need to be tested empirically. A similar argumentation can be found in the respective literature (e.g. Baumann and Stähler, 2006, 448).

A.5 Case (ii): Comparative Static Results

$$\frac{d\phi}{da_1} = \frac{1}{J_\phi} B_1 E_{11} \left[\frac{B_{a_1}}{B_1} - \frac{E_{1a_1}}{E_{11}} \right] \quad , \quad \phi = b, L \tag{25'}$$

$$\left. \frac{dX_1}{da_1} \right|_{db=0} = \frac{1}{J_L} [B_L E_{1a_1} - E_{1L} B_{a_1}] > 0 \tag{26'}$$

$$\frac{d\phi}{da_2} = \frac{1}{J_\phi} B_{a_2} E_{11} < 0 \tag{32'}$$

$$\left. \frac{dX_1}{da_2} \right|_{db=0} = \frac{\partial X_1}{\partial L} \frac{dL}{da_2} > 0 \tag{33'}$$

$$\left. \frac{dX_1}{da_2} \right|_{dL=0} = \frac{\partial X_1}{\partial b} \frac{db}{da_2} < 0 \tag{35'}$$

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