Tax Evasion with Third-Party Reporting

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Preface

A big thanks to my supervisor, Tore Nilssen, to my co-supervisor, Tone Ognedal, and to Oslo Fiscal Studies for granting me their scholarship.

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Abstract

In this thesis I look at income tax evasion for freelancers and employees in small firms when there is third-party tax reporting. I use a game theoretic framework to study two things. Firstly, how the employee and the employer divide their gains from evasion if they come to an agreement, and secondly, why there is less evasion for freelancers and employees in small firms when there is third-party reporting. For the first question I use the Nash cooperative bargaining approach and adapt it to the situation the employer and the employee are facing. For the second question I find that third-party reporting reduces evasion because it makes underreporting more costly, and because uncertainty about the other person's tax morale makes both players less willing to suggest evasion.

Summary

In this thesis I attempt to give an insight into the situation faced by potential tax evaders when there is third-party reporting. I have two main objectives. The first is to give some insights into what affects how the employer and the employee divide the gains from evasion, and in which direction it affects the division of gains. The second objective is to say something about why introducing or increasing third-party reporting decreases tax evasion. My contribution towards this objective is to evaluate the situation for freelancers and employees in small firms. I also include considerations about the situation for employees in larger firms.

To gain insights into how the employer and the employee will divide their gains, I use a cooperative bargaining approach. I first set up a plain Nash bargaining model, where the employer and the employee can get an expected outcome from evasion if they agree, and get a disagreement outcome if they do not reach agreement.

By intuition, the employer and the employee seem to be rather different. I therefore look closer at what these differences are, and how they affect the bargaining outcome. I state that the most significant difference is likely to come from differences in disagreement points. I also look at how the outcome changes when we go from equal players to players with different beliefs, with full and limited information. I explore conditions for when the solution remains the same despite different beliefs, and attempt to model the situation when those conditions are not fulfilled. I also look at how the solution changes with different attitudes concerning risk, in addition to looking at several aspects of uncertainty about the feasible set and the disagreement point.

In short, I find that having a better disagreement point leads to a better outcome. I find that a sufficient (but not necessary) condition for the solution not to change when there are different beliefs is that the disagreement point is $(0,0)$, and that each player's mapping of their feasible set is a radial contraction/expansion of the other. I also create a model in the appendix wherein I attempt to illustrate the situation when this condition is not fulfilled, where I get the result that it pays be pessimistic, in the sense that the smaller you think the cake is, the larger a share you will require in order to be better off than you would be from disagreement. The employee gains from his assumed higher degree of risk aversion, for the same reason as above. If we assume that the employee is also more uncertain about the outcome, then he benefits from this too, under certain assumptions - though this might be an additional source of bargaining friction. In sum I believe that this section captures the most relevant aspects of how the employer and the employee divide their gains when they evade.

For my second objective - explaining the decrease in evasion for freelancers and em-

ployees in small firms when there is third-party reporting, I introduce two new possible contributors. The first is that introducing and increasing third-party reporting increases the transaction costs of underreporting with acceptably low traceability/discoverability. The reason is that you have to coordinate with someone, and arrange transfers with this person. This means that the possible gains from evasion decrease.

The second is the concept of proposer risk. In essence, this is a screening game, in which uncertainty about the other player's tax morale acts as a constraint for suggesting evasion. From this follows a constraint which must be fulfilled for the bargaining to even commence. To provide a more complete picture of tax evasion, I also introduce some theories for why income tax evasion decreases for employees in larger firms when third-party reporting is introduced.

I discuss the benefits of being registered, where I state that the sum of the cost of being registered, which depends on the tax rates and the minimum believable report, must be less than the benefits of being registered for the employer-employee pair to want to register the employee. This also implies that increasing the minimum believable/acceptable report - for example by increasing the minimum wage, will, in isolation, lead to fewer people getting registered.

I extend the model by allowing the auditors to be corruptible, and look at how this changes the tax evasion problem. We see that introducing corruptible auditors increases the level of evasion, as it decreases the expected punishment. It also shifts the Northeast frontier of the feasible set in the bargaining game outwards.

Lastly, I apply the theory introduced in the paper to study the tax evasion decision, and the potential division of gains, for an Airbnb host. I find that when there is third-party reporting, the host needs to collude with or against Airbnb to evade taxation, and that collusion *with* Airbnb is not likely to occur. I find that there nonetheless will be a bargaining problem in this case - between the host and the guest. When Airbnb does not report host's earnings to the authorities, and the host does not expect Airbnb to do so in the future, the tax evasion decision simply becomes the Allingham-Sandmo-Yitzhaki condition.

In the appendix, I introduce some of the relevant laws which concerns tax evasion and bribery in Norway, as well as some parameter sizes where available. I also attempt to simulate some of the conditions presented in the paper, given the size of the parameters in Norway.

Contents

1 Introduction

The purpose of this paper is to study two aspects of income tax evasion with third-party tax reporting. The first is how the employer and the employee divide their gains from evasion if they agree to perform it. The second is to find some possible reasons for why there is less tax evasion when there is third-party reporting.

Income tax evasion is the act of underreporting your income to the authorities, with the intention of paying less taxes than if you reported your true income. The term covers both intentional and unintentional underreporting, but the focus of this paper is on intentional tax evasion. The tax evasion I am studying is illegal, and is thus distinct from its relative, tax *avoidance*, which is characterized by using legal or grey-zone tools to minimize one's tax burden.

The income tax has a long history. Similar arrangements were common in both ancient China and ancient Egypt. Among the first instances of an income tax somewhat similar to the form it has today was one introduced by Henry II of England in 1188 AD, and was known as the Saladin Tithe (Round, 1916). The income tax in England disappeared at some point, and reappeared in 1799 through the Income Tax Act, constructed to help finance the Napoleonic wars. Interestingly, among the most important arguments used for reintroducing the income tax was to minimize tax evasion (see for example Pitt (1806), as cited by Sabine (1966), p. 27). However, the government did not trust each individual to truthfully report his earnings without any incentives to do so. A number of auditors were hired to assess the validity of the income claims. Nonetheless, evasion was widespread - as not enough auditors could be hired, and when an audit occurred, the auditors had great difficulties in assessing the subject's true income. Pitt's income tax is now considered to be somewhat of a failure, because the compliance rates remained low. However, a new income tax emerged in 1803, which proved to be more successful. The reason is that it introduces tax withholding (Soos, 1997).[1]

In Norway, taxes were occasionally levied on a combination of income and other measures of wealth, such as the size of the farm and its assumed productivity - usually based on the cadaster (Gerdrup (1998)). Something similar to the modern income tax was first introduced in 1882 as a municipality tax, and then reformed in 1892 to also help raise revenue for the government. Interestingly, Norway did not at this point use tax returns - the tax was not based on the worker's own report, but instead on an estimated income based on information from the cadaster. It was not until the tax reform of 1911 that tax returns were put to use - with the effect of significantly increasing approximated income, and thus tax revenue, despite providing a more direct opportunity to evade taxes.

The biggest driver of tax increases and tax innovation has always been wars. Such was also the case in the United States, who first introduced an income tax during the Civil War, in 1862

[1]Tax withholding, or taxation at source, had been used in England on numerous occasions in the past. The first known occurrence is on a lay subsidy from 1512 (Soos, 1997).

(Webber and Wildavsky, 1986). After the Civil War, the income tax was abolished, and was not to reappear until 1913. From this point on, the US has had an income tax in some form. The tax was reported by the individuals themselves, and was to be paid quarterly. The Second World War again made it necessary to substantially increase government revenue. With the Current Tax Payment Act of 1943, tax withholding at source was introduced. Milton Friedman was fond of telling the story about how he, when he worked at the US Treasury Department during the war, worked in the group responsible for constructing the tax withholding system which is in place in the US today (see for example Friedman and Friedman (1998)). It is true that he helped design the universal tax withholding we see today, but this was not the first trial of tax withholding in the US. Income tax withholding was introduced with the first income tax in the US, during the Civil War, but only for workers employed in the public sector, and was abolished not long after (Twight, 1995).

Tax-withholding means that the employers have to subtract taxes from the wages they paid to their employees, and forward the taxes to the government. In essence, all employers became unpaid supervisors for the tax authorities. With third-party reporting I mean in this paper, the system which started with tax withholding, where the tax authorities rely on reports from employers about the income of their employees. It does not necessarily have to include tax withholding, but it often does.

The specific setting I am looking at is one where a third party (the employer) is legally obliged to report the income of the employee. In Norway, and in most of the Western world, this is the case for everyone who is receiving wages from a registered company. That is, both employees with a regular long-term labor contract, and the group of more loosely organized labor - contractors who are hired for projects, and for freelancers. Third-party reporting is also common for capital income, but I will not go into that here.

It is difficult to measure the extent of tax evasion with any kind of accuracy. Only a few studies have been done to attempt to estimate the size of tax evasion in Norway. Klovland (1984) examines the relationship between the demand for currency and the marginal tax rate in Norway and Sweden. The theory is that when the marginal tax rate is higher, individuals will want to evade more, and since evasion is easier to perform with cash, the demand for currency will serve as a proxy for the evasion rate. However, he does not find any correlation of this kind in Norway,[2] and warns against using this approach to estimate the size of the hidden economy.

Nevertheless, the same approach is used by Schneider (1986) for Norway, Sweden, Denmark, and Germany, and by Schneider (2005) for 110 different countries. In his 2005 study, he estimates the size of the hidden economy in Norway in 2002/2003 to be 18.7% of GDP.

Isachsen and Strøm (1985), and later Goldstein et al. (2002) use survey data on tax evasion to attempt to estimate the size and development of the hidden economy in Norway. As stated by Isachsen and Strøm (1985), it is *extremely* difficult to reliably estimate the size of the hidden economy. Their best guess is that the size, as of 1981, was 4-6 percent of GDP, of which about

[2] He does find an effect for Sweden.

half was hidden labor income.

Studies have also been conducted by the tax authorities in the US, attempting to estimate the size of the tax gap. The IRS used random audits to estimate the size of the difference between the correct and the actual tax income to be about 13% of actual tax income (Internal Revenue Service, 2007).

Internationally, the use of household budget surveys has gained popularity since it was first introduced by Pissarides and Weber (1989). They assume that the self-employed correctly report food expenditure, but underreport income, while the wage- and salary-earners correctly report both. When making the reasonable assumption that food expenditure habits are largely equal between the two groups, they can estimate to which degree the self-employed underreport their income. Pissarides and Weber (1989) use data from Britain, and find that, on average, the true income of the self-employed is 1.55 times higher than what they report - suggesting that the size of the hidden economy is approximately 5.5% of GDP in Britain.

Feldman and Slemrod (2007) use the same principle, but use charitable giving instead of food expenditures. They find that, on average, a self-employed person reporting a positive income, has a true income which is 1.54 times as high as what they report, which reinforces the findings from Pissarides and Weber (1989). One weakness of these studies is that they make the assumption that there is *no* noncompliance among the wage- and salary-earners.

The numbers reported by Schneider (2005) seem to an outlier. The guess by Isachsen and Strøm (1985) seems to reflect the current consensus in countries comparable to Norway. As both Isachsen and Strøm (1985) and Skatteverket (2008) estimate that the hidden labor income constitutes about half of the total hidden economy, I will use this to indicate the size of the hidden labor income in Norway today. The estimated GDP of Norway in 2015 was 3 140 845 million NOK Statistics Norway (2016b). If we say that hidden labor income constitutes 2-3% of that, then the amount of hidden labor income in Norway is between 62.8 and 94.2 billion NOK.

The difference in reporting between income subject to third-party reporting and income not subject to it is indeed stark. An early estimation of the difference is Klepper and Nagin (1989), who estimate tax noncompliance among the wage- and salary-earners to be only 0.1% in the US. Kleven et al. (2011) analyze a large field experiment in Denmark, where a group of 20 000 taxpayers were randomly audited. They find that the tax evasion rate is below 1% across all specifications for taxpayers subject to third-party reporting, while it is 41.6% for the self-employed, *conditional on the income being self-reported*. This is important. For all income from self-employment, the evasion rate is 17.7%. The reason for this difference is that a portion of the self-employed are subject to third-party reporting, and the tax evasion rate for this group is only 0.33%.

In this paper I study some possible explanations for why there is less tax evasion when there is third-party reporting, and suggest a framework in which to analyze the problem. For the main section I use a cooperative Nash bargaining model, wherein the employer and the employee must come to an agreement about the division of the gains from evasion, or otherwise abstain from evading.

When studying the bargaining solutions for the employer and the employee in the tax evasion setting, I find the solutions where the employer and employee agree on evading taxes. However, what I am trying to show is not that third-party reporting is useless because there are ways around it. The bargaining solution should be seen as imposing an additional constraint which must be satisfied in order to successfully evade taxes - thus making tax evasion less attractive when third-party reporting is in place. As stated by Leif Johansen, with particular reference to cooperative bargaining situations with few players "*bargaining has an inherent tendency to eliminate the potential gain which is the object of the bargaining*" (Johansen, 1979). To illustrate the ways in which bargaining acts as a constraint, I use two tools. Firstly, I say that there is a "proposal risk". This means that the proposer is uncertain about what type the other player is. I state that if the other player has high moral standards, then he will reject any proposal immediately and report the proposer to the authorities. If the other player has low moral standards, he will go along with the evasion, given that they reach an agreement he is happy with. This acts as a constraint for the bargaining game to even begin. Secondly, I state that the cost of underreporting income increases significantly when there is third-party reporting of information, such that when the underreported amount $w - \overline{w}$ is paid, the recipient only recieves $(1 - k_j)(w - \overline{w})$, with $0 \leq k_j \leq 1$. In addition, I assume that the sender accrues a transaction cost of k_i, such that it costs $(1 + k_i)(w - \overline{w})$ to send it. It is reasonable to assume that it is costly to underreport income for a several reasons. For example, it is costly to keep two sets of financial records, and to arrange the practicalities with a minimum of traceable evidence. An assumption about costly bribing is common in the corruption literature, and as I see it, there is a clear parallel here. One might question whether it is appropriate to set the cost of underreporting as a share of the sum underreported. It is likely to be a convexly increasing function with some fixed costs. However, we do not lose any relevant properties through this simplification, and it makes it fit more easily in the established framework.

Corruption by tax collectors has received much attention in the corruption literature. This literature generally approaches the tax evasion problem as one where a government tax collector/auditor discovers that an individual is evading taxes, and is then bribed into not reporting the evasion. In the main part of this paper I circumvent this issue by stating that there is a certain chance that a firm will be audited, but if it is audited, this will reveal the true state of things to the tax authorities. I then look at how introducing the possibility of corruption changes the bargaining problem.

I should also justify the use of bargaining in analyzing tax evasion when there is third-party reporting. The cooperative Nash bargaining solution is applicable when two parties can obtain mutual benefit upon agreement, but lose out on this benefit if they are unable to reach an agreement. This accurately describes the situation faced by the employer and the employee when there is third-party reporting. They must coordinate their reports to the tax authorities, and if they do not, then tax evasion is not possible, and the two players are unable to reap the potential benefits. The Nash bargaining framework is especially useful in this framework for capturing and interpreting the consequences of the significant and inherent differences between the employer and the employee.

The simplest possible setting, and the one I have in mind in the main part, is one where there is a firm with one owner and either one employee or a freelancer. There are two reasons why this is a good starting point. First of all, according to Statistics Norway (2016a), more than 20 per cent of all firms in Norway have between one and four employees.[3] Second of all, the model is easily extendable to a range of different-sized firms and different forms of employment, as I show later in this paper. Perhaps most interestingly, with reinterpretations of some of the parameters, it also captures some interesting aspects of the situation for employees in larger firms if we make the assumption that neither the employer nor the employee reports the other person to the tax authorities. This is not necessarily very unrealistic. As noted by Kleven et al. (2016), reporting someone you have a relationship with to the tax authorities has a psychological cost. When no whistleblower reward is given, there are few incentives to whistleblow.[4]

To capture some other interesting aspects of the situation when there are several employees in the firm, I also include the central theoretical models by Kleven et al. (2016). Together, the models provide a fuller picture than any of them does separately.

I also model the specific situation faced by participants in the rapidly expanding "sharing economy", and thereby give an insight into a problem which is becoming more relevant every day.

To sum up, my purpose is not to find the optimal reported income. In essence I state that either the employer-employee pair have a possible gain from evasion or they do not. When they do, they can either underreport income or not. What I am interested in are two things. Firstly, how they share their gains if they do agree to underreport income, and secondly, why there is less tax evasion when there is third-party reporting.

I find that having a better disagreement point leads to a better outcome, I find that a sufficient (but not necessary) condition for the solution not to change when there are different beliefs is that the disagreement point is $(0,0)$, and that each player's mapping of their feasible set is a radial contraction/expansion of the other. I also create a model in the appendix wherein I attempt to illustrate the situation when this condition is not fulfilled, where I get the result that it pays be pessimistic, in the sense that the smaller you think the cake is, the larger a share you will require in order to be better off than you would be from disagreement. The employee gains from his assumed higher degree of risk aversion, for the same reason as above, and if we assume that the employee is also more uncertain about the outcome, then he benefits from this too,

[3]Unfortunately, they do not have data on how many firms have exactly one employee.

[4]One possible and realistic exception is when there is a punishment reduction for whistleblowing, and you believe that there is a high probability that someone else will whistleblow.

under certain assumptions - though this might be an additional source of bargaining friction. In sum I believe that this section captures the most relevant aspects of how the employer and the employee divide their gains when they evade.

For my second objective - explaining the decrease in evasion for freelancers and employees in small firms when there is third-party reporting, I introduce two new possible contributors. The first is that introducing and increasing third-party reporting increases the transaction costs of underreporting with acceptably low traceability/discoverability. The reason is that you have to coordinate with someone, and arrange transfers with this person. This means that the possible gains from evasion decrease.

The second is the concept of proposer risk. In essence, this is a screening game, in which uncertainty about the other player's type acts as a constraint for suggesting evasion. This type could be interpreted the person having low or high tax morale. This constraint must be fulfilled for the bargaining to even commence. To provide a more complete picture of tax evasion, I also introduce some theories for why income tax evasion decreases for employees in larger firms when third-party reporting is introduced.

The rest of the thesis is structured as follows. I first introduce literature on tax evasion with third-party reporting, before I introduce the Allingham-Sandmo-Yitzhaki model (A-S-Y), which is helpful as a starting point. I will then introduce a basic 2-player Nash Bargaining model, after which I extend the model in both ends, with a proposal risk model and the possibility of tax corruption. After that I extend the Nash bargaining model to make it more relevant to our setting, before I allow multiple employees. I then apply the model to a firm in the sharing economy. I finish off by making some critical comments.

2 Literature

The theoretical literature on tax evasion is vast. Most agree that the first contribution of interest is Becker (1968), who started the imperialism of economics into the subject of criminology. He formulated a rational-choice theory of crime, in which he makes the assumption that a criminal act is rational, just like any other behavior. If the expected punishment of a crime is greater than the expected gain, then it would not be performed.

After Becker, the seminal contribution to the subject is Allingham and Sandmo (1972), which is considered to be the first modern economics paper on non-compliance in tax reporting. In their paper, Allingham and Sandmo (A&S) utilize Beckerian crimeonomics combined with portfolio theory to create a framework for understanding the tax evasion decision. I will make use of a version of this framework in this paper. The framework has been criticized on various grounds. One interesting critique is that the model lacks realism - that people have other, non-pecuniary, concerns, such as morality or social costs. However, as has been addressed by for example Allingham and Sandmo (1972) and Sandmo (2005), the original framework can be extended to include these concerns in a rather convincing way, without fundamentally changing the conclusions. Another critique, which is sometimes referred to as the Allingham-Sandmo puzzle, is that the model predicts quite high evasion rates when the probability of getting caught is low (often interpreted as a low frequency of audits), while what we in fact see is that the level of tax evasion is overall quite low. This paper formalizes one possible explanation for why that is. Sandmo (2012) provides the general explanation. When there is no third-party reporting, then tax evasion is high, while for those whose income is subject to third-party reporting, the evasion rate is low. In other words, A&S model the behavior of the self-employed, and therefore predict high evasion rates.

Kleven et al. (2011) study tax evasion in Denmark using a field experiment. They are particularly interested in the difference between income which is subject to third-party reporting, and income which is not, and develop a theoretical model to illustrate the tax evasion decision. The model is based on the Allingham-Sandmo one, and attempts to include third-party reporting by extending A&S, while assuming that there is no collusion between the employer and the employee.

Kleven et al. (2016) leave behind the assumption of Kleven et al. (2011) that there is no collusion between the employer and the employee. They explore an agency model of tax evasion with the firm as supervisor. Their model focuses on how tax evasion decreases when the size of the firm increases, due to the threat of each employee to reveal the tax evasion to the authorities, and connects this with macroeconomic growth models. I will introduce parts of their work, as I see this as an interesting approach to studying tax evasion in an N-person framework.

Yaniv (1993) is an earlier model which is similar to that used by Kleven et al. (2016). It studies the effect of tax withholding on tax compliance. Interestingly, his perspective is not why there is high compliance when tax is being withheld, but on why tax withholding has little effect on tax compliance due to the possibility of collusive behavior. This is contrary to what empirical evidence shows today.

Tonin (2011) investigates the impact of raising the minimum wage on tax evasion by using data from the substantial increase in the minimum wage in Hungary in 2001 and is able to draw some interesting conclusions. His findings suggest that there are two groups reporting the minimum wage. There are low-productivity workers whose true income is the minimum wage, and there are some high-productivity workers who declare the minimum wage, but has a true income which is higher. He finds that the minimum wage hike in fact increases compliance for some, and thereby decreases their disposable income. He then develops a theoretical model to explain this. The model is one where the employer and employee cooperatively evade taxation. However, in his analysis, Tonin treats the employer and the employee as a single utility-maximizing unit. This might be a useful simplification in applications such as his. However, it fails to incorporate important and relevant differences between the employer and the employee.

3 The Allingham-Sandmo-Yitzhaki model

3.1 Timing in the game

This thesis is built around variations of the game described below.
$t = 1$: Nature chooses actual income of the agent (w), and reveals it to the employee and the employer, but not the tax authorities. Nature also chooses whether the employer has high or low morale.
$t = 2$: The employee decides whether it is in his interest to participate in tax evasion.
$t = 3$: If the employee does want to participate in tax evasion, he decides, based on his belief about the employer's type, and the anticipated pay-off in each state, whether it is in his interest to suggest tax evasion to the employer.
$t = 4$: If he does find it to be in his interest to suggest evasion to the employer, he does this, and thereby commences the bargaining game.
$t = 5$: The employer and the employee either reaches an agreement about the pay-offs (u_1^N, u_2^N), or does not, which results in the players receiving their disagreement outcome, (d_1, d_2).
$t = 6$: The employer and the employee both send their reports about the employee's income to the tax authorities.
$t = 7$: The tax authority decides whether or not to audit the employer-employee pair, and if they do, nature chooses whether the responsible auditor is corruptible or not.
$t = 8$: If the employer-employee pair is audited, they attempt to bribe the auditor if they see it as advantageous for them
$t = 9$: The auditor decides whether or not to accept the bribe, and the resulting payments are made. This concludes the game.

3.2 The evasion decision

In this section I will introduce a version of the Allingham and Sandmo (1972) tax evasion problem, as described by Yitzhaki (1974). The difference between this version and the original A&S-model is that the punishment is levied on the amount of taxes evaded, rather than the amount of underreported income. In the original model, an increase in taxes has an ambiguous effect, as there is both a substitution and an income effect. In this model, no such ambiguity exists. In Norway, punishment for evasion is levied on evaded taxes, as in the Yitzhaki-model.

The agent gets an actual income w, but only reports $\overline{w}$, which is taxable at a rate $0 \geq \tau \geq 1$. $\theta(> \tau)$ is the punishment for discovered tax evasion, measured per krone of tax evaded.

In investigating whether or not the employee will want to evade taxes, it is necessary to weight the potential gains from tax evasion against its potential costs. We first look at the different potential states.

If the employee gets away with the tax evasion, his income would be wages minus taxes on reported income

$$Y = w - \tau\overline{w} \tag{1}$$

If the tax authorities decide to hire an external supervisor, thereby discovering the tax evasion, his income would be the above, subtracting a punishment, which depends on the size of the evasion

$$Z = w - \tau\overline{w} - \theta\tau(w - \overline{w}) \tag{2}$$

Let $0 \leq p < 1$ be the subjective probability of being caught, in other words the probability that the tax authorities hire an external, non-corruptible supervisor. If the authorities hire the external supervisor, we assume that they discover the true income of the employee, such that any unlawfulness is discovered. We assume that this is strictly less than one, which means that the government is not able to perfectly assess who is engaging in collusion - at least not at an acceptable cost.

I can then generate a function for expected utility for the employee

$$E(U) = pU(Z) + (1-p)U(Y) \tag{3}$$

or:

$$E(U) = pU(w - \tau\overline{w} - \theta\tau(w - \overline{w})) + (1-p)U(w - \tau\overline{w}) \tag{4}$$

Differentiating the expected utility-function with respect to reported income ($\overline{w}$).

$$\frac{\partial E(U)}{\partial \overline{w}} = \tau[pU'(Z)(\theta - 1) - (1-p)U'(Y)] \tag{5}$$

The extensive margin for tax evasion then becomes

$$\left.\frac{\partial E(U)}{\partial \overline{w}}\right|_{w=\overline{w}} < 0 \tag{6}$$

which gives us the extensive-margin condition of tax evasion:

$$p\theta < 1 \tag{7}$$

This means that, at no tax evasion ($w = \overline{w}$), the individual will increase his utility by decreasing the amount reported. We can say that $\overline{w}$ is the highest amount lower than or equal to w for which $p\theta < 1$ does not hold.

3.3 Comparative statics

The comparative statics of this result is well documented in the literature, so I will only introduce the results briefly, with a short discussion on empirics.

Firstly, an increase in the penalty rate, θ, and the probability of audit, p, should make it less attractive to evade income, such that evaded income decreases. This is generally supported in literature. For example, Cebula (1997) uses a dataset on the underground economy in the US from 1973-1994, and finds that both the audit rate and the punishment is negatively correlated to the size of the underground economy. However, using a very limited dataset from Germany, Feld et al. (2007) find that the results are ambiguous for punishment, while no correlation is found for audit frequency. One should interpret these results with some caution, as they for example only have audit data from a 10 year period, and do not go into detail on characteristics and possible problems with their limited dataset.

It is also a trivial observation that increasing θ is always preferable to increasing p in this model, as increasing p is costly. However, there are usually political constraints which limit the size of θ. It is common to assume that the optimal size of θ is at its maximum size given the political constraints.

Secondly, an increase in τ should according to this model lead to a decrease in tax evasion, because of the income effect - increasing taxes lowers an individual's income. According to the common assumption of decreasing risk aversion, this leads to the individual being more risk averse. When he is more risk averse, he will want to reduce the amount evaded, as this can be seen as placing your money in a risky asset. As mentioned, the original A&S-model is ambiguous on this subject, as there is an additional substitution effect, according to which an increase in the tax rate makes it relatively less attractive to pay taxes relative to evasion. In the A-S-Y model presented above, no such substitution effect exists, which means that an increase in taxes will unambiguously decrease evasion. The question has received a significant amount of empirical interest. There seems to be a consensus that, in general, the empirics go against this theory, but there is disagreement about the magnitude. The recent paper by Berger et al. (2016) is an example where they find evidence which contradicts the theory in an indirect manner by using quasiexperimental methods to study television fees and tax compliance in Austria. Gorodnichenko et al. (2007) study a tax reform in Russia, and finds that a change in tax level has a high impact on tax compliance rate.

Many attempts to resolve what has become known as the Yitzhaki puzzle - that the data does not seem to support his result - has been performed, for example by using lessons from modern behavioral economics. However, they are largely unsuccessful (see for example Piolatto and Rablen (2013)).

Kleven et al. (2011) show empirical support for the theory that an increase in expected punishment reduces evasion, but they also find that an increase in the tax rate increases evasion. In addition, they find that increasing enforcement is a more effective tool for decreasing tax evasion than decreasing the marginal tax rate is.

On a side note, it is also interesting to ask how the progressiveness of the tax schedule impacts the amount of tax evasion. Earlier literature, such as Pencavel (1979) and Koskela (1983) suggest that an increase in tax progressivity leads to a reduction in tax evasion. The more recent paper by Trandel and Snow (1999) analyzes the question in a underground economy-framework, in which workers divide their labor between the legal and the illegal sector. They find that an increase in progressivity actually increases evasion, if the workers have increasing absolute risk aversion or nondecreasing relative risk aversion.

3.4 The benefits of being registered

Let us say that the probability of being caught via random audit is zero, and also ignore all moral concern, and the concerns about other employees. Would this mean that all agents would abstain from reporting income, and thus be unregistered as employees? Though this is often assumed in literature, it is not likely to be true. The reason for this is that being registered brings some important benefits. Perhaps the most important of which is access to the judicial system. This has its benefits for all parts of a transaction or labor agreement. The seller wants to make sure that he gets paid according to the contract, and the buyer wants to make sure that the product or service provided is as agreed. If the firm goes to court, it is likely that at least any obvious unlawfulness in the company tax reporting is going to be discovered.

On a side-note, it is also likely that there will be an adverse selection concern. The act of suggesting underreporting sends a signal to the other player about the general trustworthiness of the suggester - both directly in the sense of "if they cheat on this, then they might cheat on other things", but also in the sense that part of their reason for suggesting to go off the records might be to hinder the other agent from going to the authorities in the likely case of a contractual dispute.

As a short illustration, imagine the case of a carpenter being hired to refurbish your house. Then either you or the carpenter offers the other party to take the project off the books, to the financial advantage of both parties. Then in practice you make it very costly to force completion of the contract, on either part. The carpenter may do shoddy work, or not complete the job at all, and the house owner may not complete the full payment, for example. Bear in mind that this is somewhat simplified, and that there in most countries are laws regulating the specifics of this problem in such a way that the problem may change. But the general idea remains.

For small businesses dealing with individuals or other small businesses, there may be other ways to ensure that contracts are enforced - such as threats or violence, but this also has high costs.[5]

When deciding to report an amount greater than zero, you also have to consider what the lowest believable report is - reporting just 1 NOK is quite likely to raise suspicion. We can then state that there is some minimum believable report ν, which is taxable both as income tax, τ and as payroll tax, t. This means that the minimum cost of being registered is $(\tau + t)\nu$. When we ignore the probability of being caught and the punishment, the constraint for wanting to

[5] For larger firms this type of behavior is rarely seen. The reason is probably that they have more to lose if it is discovered.

send an above-zero report is

$$(\tau + t)\nu \leq \text{benefit} \tag{8}$$

in words, that the benefits of being registered must be greater than the cost of being registered.

A particularly interesting application for the benefits of being registered is migrant workers. In Norway, the law is such that you have to be a registered worker in order to get access to important welfare and health services (Dølvik and Friberg, 2008). Considering that chances of work-related injury are relatively high in the professions in which the guest workers are often employed, and probably in particular on the projects where grey zone labor is used, the workers have a clear incentive to insist on being registered. However, their bargaining positions are rarely very strong. The employees might have been able to convince the employer to pay them parts of their wages legally such that they can be registered, but there are strict regulations in these sectors of the labor market, including what is in practice a minimum wage[6] within the sectors where migrant workers are often employed. This means that if the employer wants to pay the employee anything legally, then he must pay the person at least the minimum wage, which then becomes the minimum report the employer can send. This means that the government raises ν while keeping the benefit constant. This will lead to an increase in non-registration. This means that the laws which are created to protect the rights of workers, may in fact keep a group of workers from achieving fundamental rights in Norway.

In this particular case, going from unregistered to registered is also likely to involve going from unlawful to lawful. This means that there will be a few additional benefits - expected punishment becomes zero, and you decrease the uncertainty regarding your income, because there is no risk of punishment, which is a benefit in itself.

[6] Allmenngjort tariff.

4 Introducing third-party reporting

In this section, I will adapt the Nash bargaining framework to a situation of potential tax evasion when there is third-party reporting. There are many ways of analyzing tax evasion with third-party reporting, for example the method used by Tonin (2011). However, I am not interested in the optimal evasion when the employer and the employee act in perfect unity. I am interested in studying how the fact that the employee now is forced to bargain with an employer in order to successfully evade may act as a constraint, and in how the employee and employer would divide the “loot”.

The situation I am studying is one where equation (7) holds, such that the employee, before introducing the employer, has an incentive to evade taxes. I use a model of cooperative bargaining to illustrate the situation the employee and the employer face. By doing this I am able to provide some additional constraints to the players’ evasion decision. In the above setting, which is the one faced by the self-employed, we see that the player only needs to concern himself with a single, simple constraint. When there is third-party reporting, the constraints are more complicated.

We know that both sides gain from the collusion, as the employee and employer are both obligated to pay taxes on reported income to the employee. The employee can, by evading taxation, save income tax, while the employer saves payroll tax. Note that we do not limit the bargaining set to this net gain - they bargain over the entire unreported amount. It might seem unintuitive that the employee should accept anything less than $(1-\tau)w$, but we should remember that the project may not be undertaken if tax is to be paid on the full amount w, such that opting out of collusion and receiving that amount is not an alternative - the disagreement point is the outcome if they do not come to an agreement.

Kleven et al. (2016) make the interesting observation that, if the financial records of the firm are observable by government, then the firm does not necessarily have an incentive to underreport wages, because this only means that the firm has to over-report profits, which is also taxable at some rate. For this reason, if we are to assume that the financial records are observable, we must assume that the profit tax is higher than the payroll tax, such that the firm has an incentive to under-report wages even when this implies over-reporting profits. For the sake of simplicity, we assume that the financial records are not observable. This could be interpreted as the firm keeping two sets of financial records - one official, and one true, and the true records being unavailable to the government.[7]

I will introduce the Nash solution for cooperative bargaining. As the outcome they are bargaining over is uncertain, I need to use a cooperative bargaining model with an uncertain feasible set. My approach will be to use the standard Nash solution for cooperative bargaining in its traditional set-up, in which the two players bargain over shares of expected utility. Then

[7] According to Norwegian law, firms above a certain size must make public certain financial records. See appendix A for details.

I will discuss how the bargaining set-up changes if the players have different perceptions about p or θ, such that a given share gives them different expected utility. I will also look at how a one-sided increase in risk changes the outcome when information is symmetric by using the results from White (2006).[8] Lastly, I look at how the solutions will change if the employer and the employee have different attitudes about risk.[9] We start with introducing the symmetric bargaining solution, where I will lean on Muthoo (1999).

I use a slightly different notation than in the previous section, in order to enrich the illustration. I add R for firm revenue under agreement, and $\overline{R}$ for revenue under disagreement, $\overline{W}$ for employee wage in alternative employment, a for the employee's share of the evaded amount - and thus $(1-a)$ as the employer's share, t for the payroll tax, and k_i for cost of underreporting for each player. Note also that the tax parameters now denote the average tax rate, rather than the marginal tax rate.

4.1 Symmetric Nash Bargaining Solution

The symmetric Nash bargaining solution was proposed by Nash (1950) as a method for finding how, under certain conditions, two players should agree on a division of their gains in a situation where the two players can gain from reaching an agreement. We will simply assume that the axioms of symmetric Nash bargaining are satisfied, as the properties of the axioms are well-discussed elsewhere and not very interesting in this context. We first look at the different potential states. For the employer, successful tax evasion gives the pay-off

$$R-(1+t)\overline{w}-(1+k_1)(w-\overline{w})+(1-a)(w-\overline{w}) = R-(1+t)\overline{w}-(k_1+a)(w-\overline{w}) \quad (9)$$

in words, he gets a revenue, R, pays reported wages, $\overline{w}$ and payroll taxes t on them. In addition, we say that he first pays the difference between the reported amount and the actual amount, and the cost of underreporting that amount, and then gets back a certain share of the difference, $(1-a)$, as payment for sending a false report. For the employee the pay-off is

$$\overline{w}(1-\tau)+(1-k_2)(w-\overline{w})-(1-a)(w-\overline{w}) = \overline{w}(1-\tau)+(a-k_2)(w-\overline{w}) \quad (10)$$

where we see that the employee receives a reported wage, and pays taxes on that, then he receives the difference between reported and actual income from the employer, subtracting his cost of underreporting income, before he sends back the employer's share of the underreported income, $(1-a)$. When we simplify the pay-offs, we see that the employer simply pays the employee his share, a.

[8] Later published as White (2008) without the section on Nash bargaining.

[9] We can not use only information about preferences over outcomes (Binmore et al., 1986) - we therefore have the choice between using preferences over time or risk. Time preferences are not very interesting in this context, so we use attitudes towards risk as the central piece of information used in addition to preferences over outcomes.

If the tax authorities decide to hire an external supervisor, thereby discovering the tax evasion, the pay-off for the employer would be

$$\begin{aligned} &R-(1+t)\overline{w}-(1+k_1)(w-\overline{w})+(1-a)(w-\overline{w})-\theta_1 t(w-\overline{w}) \\ &\quad =R-(1+t)\overline{w}-(a+k_1+\theta_1 t)(w-\overline{w}) \end{aligned} \tag{11}$$

and for the employee

$$\overline{w}(1-\tau)+(a-k_2)(w-\overline{w})-\theta_2\tau(w-\overline{w})=\overline{w}(1-\tau)+(a-k_2-\theta_2\tau)(w-\overline{w}) \tag{12}$$

We see that these pay-offs are the same as above, except that both of them must subtract a punishment, θ_i.

We should also include the players' disagreement point, as the work might not be carried out if the players are to report full income. For simplicity, we assume that this is their only possibility to evade, such that the disagreement point is not a bargaining game with different players, but a lawful situation. The utility pair which forms the disagreement point $d=(d_1,d_2)$ is, for the employer

$$d_1=U_1(\overline{R}-\overline{W}(1+t)) \tag{13}$$

where we see that the employer gets his disagreement revenue, and must pay wages and payroll taxes on them. For the employee it becomes

$$d_2=U_2(\overline{W}(1-\tau)) \tag{14}$$

in words, he receives his disagreement wage, and pays taxes on that.

We can now construct von Neumann-Morgenstern utility functions for the players. For the employer, it will be

$$A=(1-p)U_1(R-(1+t)\overline{w}-(k_1+a)(w-\overline{w}))+pU_1(R-(1+t)\overline{w}-(a+k_1+\theta_1 t)(w-\overline{w})) \tag{15}$$

while the vNM utility function for the employee becomes

$$B=(1-p)U_2(\overline{w}(1-\tau)+(a-k_2)(w-\overline{w}))+pU_2(\overline{w}(1-\tau)+(a-k_2-\theta_2\tau)(w-\overline{w})) \tag{16}$$

in words, they attach a probability to each of the possible states, from which they would receive a given utility.

We define the set of possible expected utility pairs as Ω. Muthoo (1999) uses the notational convention that u_i denotes the utility (expected utility in our case) that player i gets if the players agree - in which case he receives x_i, such that $U_i(x_i)=u_i$, and therefore $x_i=U_i^{-1}(u_i)$. For later reference we state that the bargaining framework can be formulated as (S,d), where S is the feasible set consisting of all feasible agreements x, and d is the disagreement point. The set of feasible agreements is defined as $S = \{(x_1,x_2) : 0 \leq x_1 \leq \pi \text{ and } x_2 = \pi - x_1\}$. The solution to this combination of feasible set and disagreement point is denoted as $F(S,d)$. U_i is used for other pay-offs, U_i^{-1} is the inverse of U_i and π is used for the total amount available. The utility that player j obtains when player i gets u_i can thus be expressed as:

$$g(u_1) \equiv U_2(\pi - U_1^{-1}(u_1)) \tag{17}$$

We define g as a concave function mapping the feasible set of agreements. In essence it is simply a graph of u_2, which shows the utility of the employee to depend on the employer's share of the total. We see that it is decreasing as the employer increases his share. We assume that it is differentiable. It is also reasonable to assume that any solution will be such that the agreed utility pair, (u_1,u_2) is a subset of Θ, where the set $\Theta \in \Omega$ has the properties $u_1 \geq d_1$, $u_2 \geq d_2$, $U_1(0) \leq u_1 \leq U_1(\pi)$, and $u_2 = g(u_1)$.

We can then define the symmetric Nash bargaining solution as the utility pair (u_1^N, u_2^N) which solves the following problem

$$arg\max_a \sqrt{(A - U_1(\overline{R} - \overline{W}(1+t)))(B - U_2(\overline{W}(1-\tau)))} \tag{18}$$

which we see is the square root of the product of the vNM utility function of the employer and the employee, subtracting their disagreement points. This has a unique solution because we assume that the Nash product is continuous and strictly quasiconcave, g is strictly decreasing and concave, and Θ is non-empty. We maximize with respects to a because this parameter decides the division between the players, as defined in utility-space.

The general symmetric NBS is the unique solution, in utility space, which follows from the value of a found above, as defined by the following pair of equations:

$$-g'(u_1) = \frac{u_2 - d_2}{u_1 - d_1} \tag{19}$$

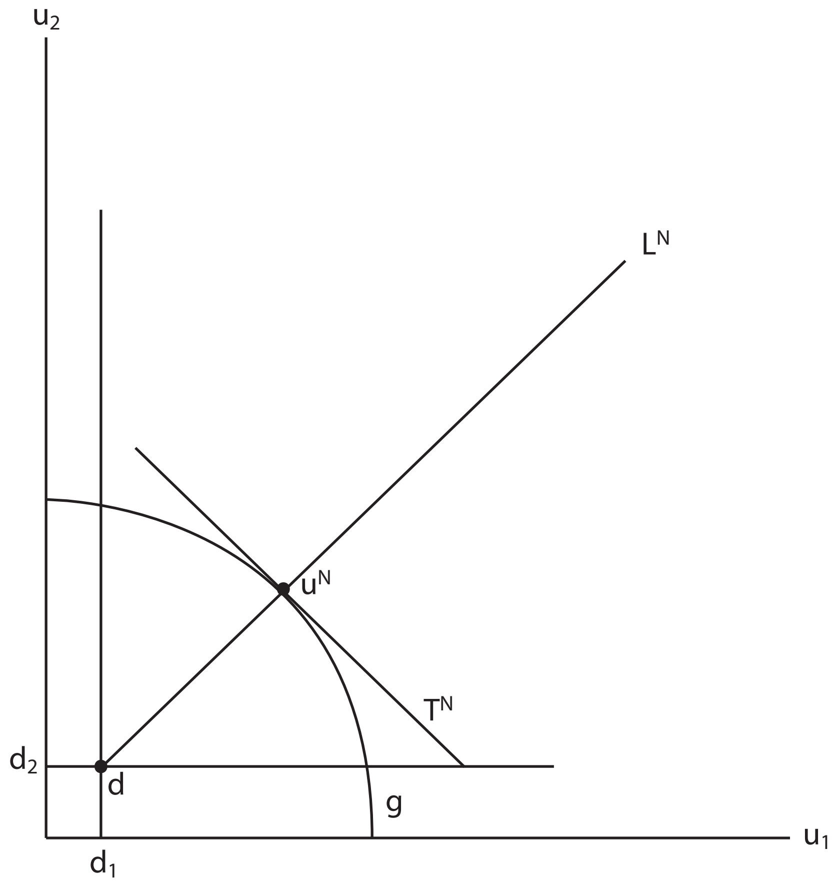
and:

$$u_2 = g(u_1) \tag{20}$$

The first equation states that the slope of the line, L^N, connecting the disagreement point d with the NBS u^N is equal to the negative of the slope of the tangent of g at u^N.[10] The second line simply states that the solution is on the line g. Figure (1) below is an illustration of the geometric characterization of the NBS.

[10] If g is not differentiable at u^N, such that there exists several tangents at u^N, then we say that one of them has this property.

Figure 1: Standard Nash bargaining solution



4.2 Asymmetric Nash Bargaining Solution

The asymmetric Nash solution is, similarly to the above

$$arg\max_{a}\ (A - U_1(\overline{R} - \overline{W}(1+t))^{\alpha}(B - U_2(\overline{W}(1-\tau)))^{1-\alpha} \tag{21}$$

where $\alpha \in (0,1)$. We interpret α as weights for bargaining strength. The bargaining strength, or bargaining power is intended to catch all effects which are not a part of the bargaining set-up, (S,d).

The asymmetric NBS is, similarly to the symmetric situation, the unique solution to the following:

$$-g'(u_1) = (\frac{\alpha}{1-\alpha})[\frac{u_2 - d_2}{u_1 - d_1}] \tag{22}$$

and:

$$u_2 = g(u_1) \tag{23}$$

4.3 The disagreement point

The Nash bargaining outcome depends on the disagreement point, which means that we can write it as $(u_1^N(d_1), u_2^N(d_2))$.[11] It is therefore interesting to look at how the division changes when the disagreement point changes. According to Muthoo (1999), the comparative statics are simple. To illustrate, we say that the demand for labour in the sector in which our employee works increases - which means that his outside wages $\overline{W}$ increase, such that $d_2' > d_2$. In our setting, an increase in $\overline{W}$ also implies a decrease in the disagreement point for the employer, $d_1' < d_1$, but even if we had $d_1' = d_1$, we would still have the following two results: $u_2(d_2') > u_2(d_2)$ and $u_1(d_1') < u_1(d_1)$.[12] In words, the player with the increased disagreement point will increase his receipt at the expense of the other player. This makes intuitive sense - when your cost of not reaching an agreement is lower, you will be comparatively less dependent on reaching an agreement.

The situation is illustrated below. To see why $L^N\prime$ is steeper than L^N, it is useful to think about the following. If we attempt to draw the line from d' to u^N, we see that the slope of $L^N\prime$ is steeper than the tangent T^N at this point. If we move to the right, we make $L^N\prime$ less steep while $T^N\prime$ gets steeper. If, on the other hand, we moved to d' and kept the same angle of L^N, the problem would be the opposite, and we should move to the left. Thus the solution is somewhere between the former point u^N and the point reached when we draw L^N from d'. An interesting point to make here is that any disagreement point along L^N will lead to the same NBS u^N. However, an equal increase in the disagreement outcomes only sustains the same NBS if L^N is 45°.

Whether the employer or the employee has a better disagreement point is likely to vary. In high-skill jobs, there are fewer available workers such that the employer will find a worker harder to replace, and the workers can be assumed to find a new job reasonably quickly. For low-skill jobs, the situation is reversed.

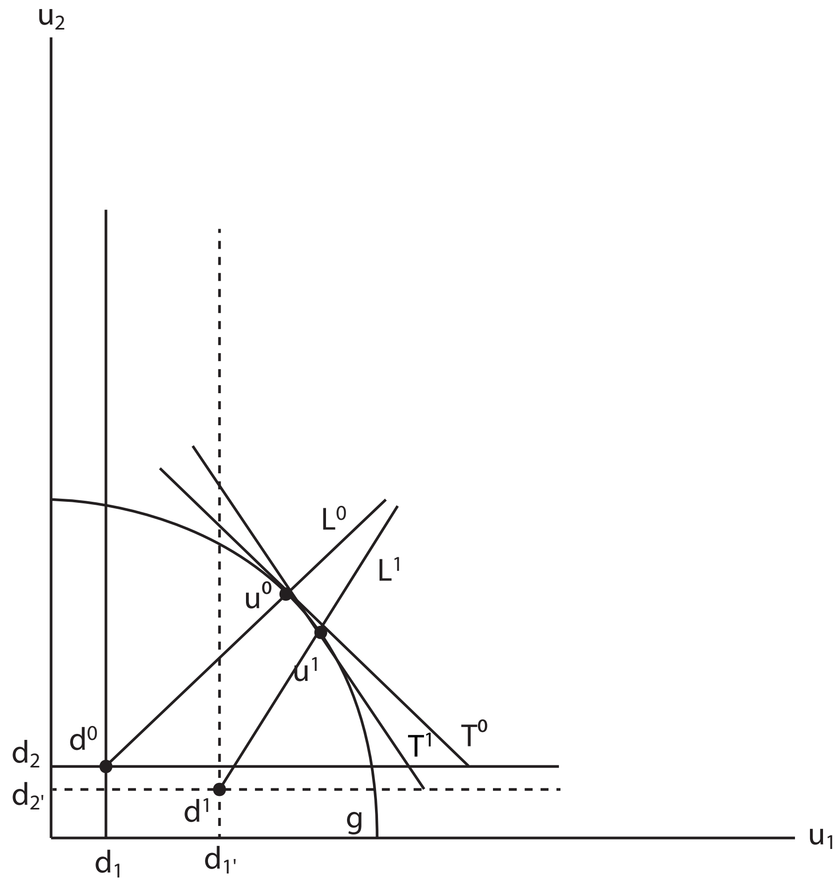
4.4 Proposer risk

A bargaining game can act as a constraint when neither player is willing to suggest even commencing it, due to uncertainty about the other player's attitude towards tax evasion. We can model this as a screening game, in which one of the players - the employer for example - has

[11] In this case, and in many other cases, the NBS is a function of both your own and the other player's disagreement point.

[12] If g is not differentiable, then the inequalities will not be strict.

Figure 2: Standard Nash bargaining solution - change in disagreement point



either high or low moral standards.[13] This information is not known to the employee, but he thinks that the probability of the employer having low moral standards is q. If the employee chooses not to suggest evasion, both players get their disagreement outcomes regardless of the employer's type. If he does suggest, then nature first decides whether the employer is of low or high moral standards. Then the employer decides whether to accept evasion, or to reject it and report the employee to the authorities - giving each player the disagreement outcome, and the employee a punishment ψ, which I interpret to be a fine which is proportional to the size

[13]It might appear strange that a non-cooperative game precedes a cooperative game between the same two players. But I believe that this is a realistic scenario - as only some types of players will be willing to engage in the cooperative game.

of the potential evasion.[14] [15] Note that ψ is a function of the exogenous parameters τ, w and $\overline{w}$. In the figure I use ψ to mean the full amount for simplicity, and not the rate, while in the equations below, it is used as rate to accommodate comparative statics. If the employer accepts, then the bargaining problem will commence, and each player will receive x_i^N. This share could have the interpretation that there is no chance of being caught evading when you are subject to third-party reporting by your employer, as is assumed by Kleven et al. (2016), such that the outcome is determined. It could also be their share of the expected outcome, which is somewhere between the outcome from successful and unsuccessful evasion. See below for more on this.

We say that this pre-bargaining game does not affect the outcome of the bargaining,[16] and that both the players know what they expect their share, x_i^N to be before they enter the bargaining game, such that it is exogenously given here. If the employer is of high moral standards, then accepting evasion will cause a moral cost, m for the employer.[17] We define a player to be of high morale when it is high enough to make him reject the proposal to evade - i.e. that $d_1 > x_1^N - m$, such that the employer prefers to evade when he has low morale, $x_1^N > d_1$. These conditions come from the subgame for each type, as illustrated in Figure (3). The employee knows the pay-offs of the other player, so for him to choose to suggest evasion, the expected outcome from doing so must be greater than his disagreement outcome. For simplicity, we assume here that the players are risk-neutral, and thus do not use utility functions. We therefore get the following condition for the employee to suggest evasion

$$qx_2^N + (1-q)(d_2 - \psi\tau(w - \overline{w})) > d_2 \tag{24}$$

which simplifies to

$$x_2^N - d_2 > \psi\tau(w - \overline{w})(\frac{1-q}{q}) \tag{25}$$

In words, the returns from evasion must be greater than the punishment if it is rejected, multiplied by the relative probability that the employer has a moral which is such that he will reject the employee's offer. The comparative statics are immediately obvious. An increase in punishment for suggesting evasion decreases your willingness to suggest evasion, as it requires a higher return. An increase in the likelihood of the employer having low morale increases the

[14] According to Ligningsloven (1980), punishment for evasion is in proportion to the *potential* gain. Furthermore, it is stated in Skatteloven (1999) that attempting to perform a crime is punishable when an action has been performed which has the purpose of initiating the act. It therefore seems that a failed attempt might be punishable under the same law as completed evasion, though perhaps with smaller punishments.

[15] The interpretation the punishment could for example also be that the tax authorities does a thorough audit of him and punishes any previous discrepancies, or it could be social sanctions by the employer, or that the employee loses his job.

[16] A possible concern is that this game changes the information at hand for the players, which might complicate the bargaining problem. Another possible concern is that the level of morale itself might change the outcome of bargaining. However, since we assume that the agent knows what he expects from the bargaining, he will also include morale in this expectation.

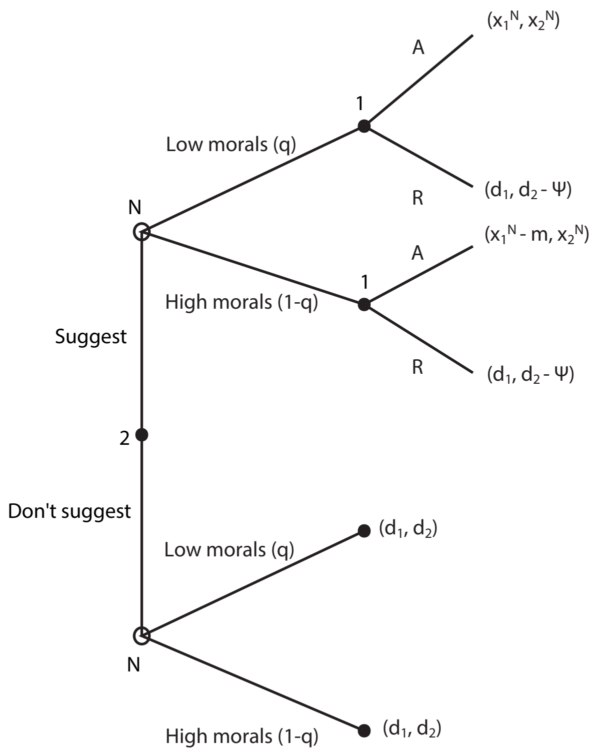
[17] I normalize the moral of the low-morale type to zero.

willingness to suggest evasion.

An interesting observation on the progressivity of the tax rate can also be made. The average tax rate, τ, appears on both sides of the equation, as it is also part of the disagreement point for the employee. It is reasonable to assume that $\overline{W} < w$, as the incentive to engage in tax evasion would not otherwise be present. If the tax system is progressive, we can therefore assume that the tax rate on $\overline{W}$ is less than that on $w - \overline{w}$. Furthermore, an increase in progressiveness, which holds tax on $\overline{W}$ constant, and increases the tax rate on $w - \overline{w}$ increases the required return, and thereby in fact decreases the desirability of suggesting evasion, which again decreases evasion. Of course, tax progressivity influences the tax evasion decision in other ways, so we cannot state from this that increased progressivity leads to less evasion, but only that this effect pushes in that direction.

Note that $x_2^N - d_2$ can exceed the size of $w - \overline{w}$ if $(1 - \tau)\overline{w} > d_2$.

Figure 3: Screening game



See Appendix C for some simulations on the size of the required returns to evasion based on the parameter size in Norway.

4.5 Corruptible auditors

An interesting extension to the model is to remove the assumption that the external auditor is non-corruptible. In a country such as Norway, good institutional design ensures that this type of corruption is rare. However, in countries with weaker institutions, corrupt tax collectors and auditors is a major concern. I will present a simple model - inspired by Aidt (2003). His interpretation of the model is that there is a tax collector responsible for the collection of taxes - the tax authorities do not rely on self-reported information. In its direct interpretation this seems to be an old-fashioned system, and not quite how modern tax agencies work. It might, however be that this is the system in some of the countries in which tax corruption is widespread. In addition, the model can be applied to the system we have in Norway if we use a slightly different interpretation. We reinterpret the tax collector as a tax auditor - the person who performs the “random” audits.[18] In this section we assume that the firm and the employee act in union. For convenience, I refer to this union of the employer and the employee as the firm. Note that the bribe is not annulled if an accepted bribe is discovered.

We first state that the audited firm has either performed evasion or not. If it has performed evasion, then some punishment is to be paid to the tax authorities, unless the firm is able to bribe the tax auditor into not doing so. There is a probability that the tax authorities discovers that the tax auditor has taken a bribe - we use ξ for this purpose. If the tax auditor is caught taking a bribe, then he will both lose his job and get a penalty, f_1. The firm will get the tax evasion penalty, $\theta_1 + \theta_2$. In addition, he will get the punishment f_2 for bribing an official. We also assume that there are transaction costs, k, which means that the tax auditor only receives a share $(1-k)$ of what the firm gives. The firm evades income taxation, and the evaded amount is $w - \overline{w}$, of which the firm would otherwise be liable $(\tau + t)(w - \overline{w})$ in taxes. Note that both punishments depend on the amount underreported.[19] The auditor gets I working as a tax auditor, and can get I_0 in a different job. The size of the bribe (as received by the auditor), b, is therefore, assuming as Aidt does that the auditor has a completely superior bargaining position

$$b = max\{(1-k)(t(1-\xi(\theta_1 + f_2)) + \tau(1-\xi(\theta_2 + f_2)))(w - \overline{w}), 0\} \tag{26}$$

The explanation is that the bribe will be equal to the firm’s expected gain. The amount saved from escaping taxation is $(\tau + t)(w - \overline{w})$, and the expected punishment is $\xi(\theta_1 t + \theta_2 \tau + (t + \tau) f_2)(w - \overline{w})$. Subtracting the second from the first gives us the size of the bribe as paid by the firm. Multiplying this by k gives us the amount received by the auditor. The tax auditor will

[18] Modern tax collection agencies rarely perform completely random audits. Instead they use predictive analytics to target those who are most likely to evade. See (Hashimzade et al., 2016) and Foss et al. (2015)

[19] According to Norwegian law, the punishment for bribing a public official (Straffeloven (2005), paragraph 387, 388 or 389), depends on the size of the corruption - in this case the amount evaded. See appendix B for details.

accept the bribe iff

$$(1-\xi)b+\xi(I_0-I+b-f_1(t+\tau)(w-\overline{w}))>0 \tag{27}$$

This means that getting audited when engaging in corruption may not necessarily imply that you have to pay the punishment, θ, but it does mean that you will at least have to pay a bribe, b, which, when you evade, will be equal to $(t(1-\xi(\theta_1+f_2))+\tau(1-\xi(\theta_2+f_2)))(w-\overline{w})$, which we assume is lower than θ.[20] This means that the expected punishment in the original model will decrease - which again implies that there will be more tax evasion when there is corruption.

We could also include the possibility of corruption in the main set-up. If we say that a certain share, $\gamma\in[0,1]$, of tax auditors are corruptible, and that they will always accept the bribe b, while the rest is incorruptible, the A-S-Y condition becomes

$$\xi(\gamma b+(1-\gamma)\theta)<1 \tag{28}$$

where γ is likely to be close to zero in countries such as Norway, which means that the condition above approaches that of A-S-Y. In the bargaining situation, we can easily see how the vNM's change. For the employer

$$\begin{aligned} A=&(1-p)U_1(R-(1+t)\overline{w}-(k_1+a)(w-\overline{w}))\\ &+pU_1(R-(1+t)\overline{w}-(a+k_1+(\gamma nb+(1-\gamma)\theta_1)t))(w-\overline{w})) \end{aligned} \tag{29}$$

while the vNM utility function for the employee becomes

$$\begin{aligned} B=&(1-p)U_2(\overline{w}(1-\tau)+(a-k_2)(w-\overline{w}))\\ &+pU_2(\overline{w}(1-\tau)+(a-k_2-(\gamma(1-n)b+(1-\gamma)\theta_2)\tau)(w-\overline{w})) \end{aligned} \tag{30}$$

where n is the share of the bribe paid by the employer.

One could also create a proposal risk-model for the corruption setting, but I will not do that here.

4.5.1 Comparative statics

In this set-up, the authorities can affect the prevalence of corruption in a number of ways. It can change ξ, f_1 or I, and thus directly affect the corruption decision of the auditor - Equation (27). It can also impact the decision indirectly by changing the expected gain from corruption, and thus the size of the bribe, by changing k, θ_1, θ_2, f_2, t or τ. If the size of the bribe is lower, then it is less attractive for the auditor to accept it.

[20] A possible interpretation of the model is that all auditors are corruptible, but that their required bribe to do so differs. A portion of the auditors could then be said to have a required bribe which is higher than θ, in which situation the evaders prefer the punishment.

The idea of increasing the wage for the corruption-prone was first introduced by Becker (1968), and is often referred to as giving them *efficiency wages*. The idea is that when you increase their wages, thus increasing the wage difference between their job as a tax auditor and alternative employment, it makes it more costly to be discovered - in which case they would lose their jobs. In this model, that is certainly true, but it also has some downsides. Firstly, it is a very costly policy, and secondly, it may cause a misallocation of workers between the government agencies using the efficiency wage on the one hand, and both the government agencies not using it and the private sector on the other (Aidt, 2003). It might also be difficult to sell politically - you are in effect giving a subsidy to suspected criminals in the hope that they will not commit crimes. One could also attempt to decrease their wages in alternative employment by making sure that the corruption cases are very public, such that their labor-market value decreases. Corruption cases are often very public, but whether the government pushes for this, and whether the above is part of the consideration is not known. The media attention has a cost in itself, but it is more reasonable to label this to be a part of the punishment for getting caught, f.

The comparative statics for probability of getting caught, ξ, and the punishments for corruption, f_i are simple. If we differentiate the left hand side of the inequality in Equation (27) with respects to ξ, we get

$$I_0 - I - f_1(t+\tau)(w-\overline{w}) < 0 \tag{31}$$

since we assume that the auditor makes more at his current job than in alternative employment (at least when we consider search costs etc.), $I_0 - I$ is negative. We also assume that the firm never overreports wages, and that the fine and the taxes are non-negative, such that $f_1(t+\tau)(w-\overline{w})$ is always positive, and the entire expression is always negative. We also see here and in most of the other results that the effect increases with the size of the evasion.

The same logic applies to both f_1 and f_2, which each changes respectively, the corruption decision, and the size of the bribe equally

$$-\xi(t+\tau)(w-\overline{w}) < 0 \tag{32}$$

The main difference between the two tools is that increasing the probability of getting caught is resource-costly, while this is not necessarily the case for increasing the penalty.[21]

The tax evasion punishments, θ_i, has the same sign as the above punishments. For θ_1, it is

$$-\tau\xi(w-\overline{w}) \tag{33}$$

and for θ_2

[21] A fine has minimal costs, but the punishment may also include a prison sentence, which is costly. Note that court costs are always costly, but that increasing the punishment is not likely to increase these costs.

$$t\xi(w-\overline{w}) \tag{34}$$

Changing the taxes on the employer and the employee changes both the bribe size, the corruption decision, in addition to changing the amount evaded, as described in Section 3.3. The tax rate changes the size of the bribe by both increasing the gains from evasion, and the size of the punishment, because this is proportional to the size of the evaded amount. For the size of the bribe, we have, when we differentiate with respects to the taxes

$$(1-\xi(\theta_i+f_2)(w-\overline{w}) \tag{35}$$

where $i=1$ for the payroll tax, and $i=2$ for the income tax. We see that this is negative when $\xi(\theta_i+f_2)>1$, and positive if is less than one, and zero if it is equal. The effect of changing the tax is therefore inconclusive for the size of the bribe.

For the corruption decision, the taxes influence the condition by changing the size of the punishment. The effect is therefore clear, when we differentiate the corruption decision for either of the taxes, we get

$$-\xi f_1(w-\overline{w}) \tag{36}$$

For both of these results we should have in mind that, because the taxes may change the amount evaded, this may either strengthen or counteract the effect, depending on what effect the taxes have on evasion.

Lastly, the authorities may increase the transaction cost of paying the bribe, by making the practicalities of paying the bribe without being discovered more difficult. One example of a way to do this is by increasing the traceability of cash, or even by eliminating cash, as cash is more difficult to trace than electronic transactions. Also, increasing effort against tax havens, in which traceability is lower, would have the same effect. This will impact the corruption decision by lowering the received bribe. Differentiating the corruption decision with respects to b, we get

$$(1-\xi)+\xi=1 \tag{37}$$

such that lowering the size of the bribe by increasing k has a negative effect on the willingness to accept the bribe which is exactly proportional to the size of the decrease of the bribe. If we assumed the size of the bribe to also depend on the size of the evasion, then this would counteract the effect. However, this does not seem to be the practice in Norwegian law. See Appendix B for details.

5 Bargaining with differences between the players

In this section I will look closer at some determinants of how the employer and the employee would divide their gains from tax evasion - what is likely to push their bargaining positions in which direction. This is not only interesting because we get closer to reality by doing it, but also because it affects the decision of whether to evade in the first place, through the proposer risk pre-game. If, for example the employee expects his outcome from evasion to be only slightly higher than the disagreement point, then he will only want to suggest evasion if he is very certain that the employer is of such morale that he will accept the employees suggestion.

A bargaining situation between an employer and an employee is not a bargaining situation between equals. The differences between an employer and an employee are many and fundamental, but even if we ignore their roles as employer and employee, it would be difficult to find two people with the same beliefs and preferences if you tried. One question is then whether it is appropriate to use the symmetric or the asymmetric Nash Bargaining Solution. According to Binmore et al. (1986) it is not appropriate to use the asymmetric solution when the asymmetry is found only in different preferences and disagreement points. It is likely to be here that the greatest differences are to be found between the employer and the employee. The employee would not like to lose his job, because this would mean that he has to search for a new job, which is costly, and then take a job which is likely to be inferior to the previous one. It is usually less costly for the employer than the employee when the employee leaves his job - as it is likely to be less costly to find a replacement - especially in unskilled employment. This last point is interesting. Evasion is more common in the sectors where the employer has a superior bargaining position. It would be interesting to investigate this correlation more closely. Is it the case that unskilled workers are more willing to accept evasion relative to skilled workers because their cost of disagreement is higher? Going into detail on this question is unfortunately outside the scope and focus of this paper.

Different perceptions of p and the degree of uncertainty might be seen as a form of asymmetry, but it is not obvious that it should be. According to Binmore et al. (1986), asymmetries exist when there are differences between the players that are not captured by (S,d). Different perceptions about uncertainty fulfills this, as it does not influence any of the parameters or the expected values. However, the way we have set it up, p is captured in (S,d), even if it differs between players. I therefore conclude that the asymmetric solution is only appropriate for differences in uncertainty.

It should be noted that, as far as I know, no theory supports the idea that these are typical differences between the employer and the employee, which means that the differences can go either way.

5.1 Uncertainty

In this section I will look at some aspects of uncertainty in bargaining. First, I will look at an interesting special case when there is uncertainty about the feasible set, before I look at how uncertainty about the disagreement point might change the conclusion. I conclude the section with introducing a one-sided increase in uncertainty about the feasible set.

Chun (1988) studies Nash bargaining situations in which the two players are uncertain about which of two states will be realized. His main conclusion is that when

$$\begin{aligned} F(S^1,d) &= F(S^2,d) \\ &\equiv x \end{aligned} \tag{38}$$

then we will also have

$$F(pS^1 + (1-p)S^2, d) = x \tag{39}$$

with $p \in [0,1]$. In words, if the two states separately imply the same NBS, then the same NBS will hold when the players are bargaining over a feasible set anywhere between the two possible states. That means that if the employer and the employee bargain separately over the feasible set defined by successful evasion and unsuccessful evasion and reach the same NBS, then, given that they have equal perceptions about the size of the penalty and the probability of getting caught, we can state that the same NBS will prevail under any probability of getting caught.

He does not say anything about (1) when it is the case that the NBS will be the same in the two different states, or (2) how the conclusions change if there is limited information between two different players. I will later attempt to give some insight into these questions. The motivation for having a closer look at (2) is that it seems reasonable that this is closer to reality than the full information case. An extension of the analysis also makes it possible to analyze the outcome when the two players have different beliefs about the size of π.

Chun and Thomson (1990) study how the bargaining problem changes when the players are certain about the feasible set, but uncertain about the disagreement point. They construct an axiom they call *Restricted disagreement point linearity*, which they claim is reasonable, and find that under this axiom, we will have that

$$\begin{aligned} pF(S,d^1) + (1-p)F(S,d^2) &= F(S, pd^1 + (1-p)d^2) \\ &= x^N \end{aligned} \tag{40}$$

if x is along the Pareto-optimal border of S and S is smooth at both solution points. As we know, $F(S,d^i)$ is the solution when we know that the disagreement point d^i will be realized. We can therefore say that the left side is a point between the two solutions which is obtained in a bargaining game with either of the disagreement points. We find the solutions given two different disagreement points, and find a point between them, the distance from each solution defined by p. They then claim that this is equal to the solution which would materialize when we are uncertain about which of the two disagreement points will materialize, but deem the probability of one state to be realized to be p - when we use an expected disagreement point to find a unique solution.

It is easy to see how this is relevant to our case. The employee is unlikely to be certain about what the outside wages are, and the employer might be uncertain about what revenue they would obtain if they used a different employee.

I will now look at how a change in uncertainty about the feasible set changes the conclusions from the original model, utilizing the method of White (2006).

We introduce a random mean-preserving additive change in uncertainty $z \in Z$, following Rothschild and Stiglitz (1970). It is not immediately obvious how a one-sided uncertainty-increasing Mean Preserving Spread (MPS) of this kind would manifest itself in my framework. The MPS changes the probability distribution function by flattening it - by symmetrically increasing the thickness of the tails, and reducing the frequency of the mean while maintaining it as the mean. We have to get rid of a previous assumption to be able to interpret this properly.

Until now, we have assumed that if an employer-employee-pair is the subject of an audit, then the auditor discovers the true income of the employee. This implies that if an agreement is reached, only two states can materialize - successful evasion (as in Equations (9) and (10)), and unsuccessful evasion (as in Equations (11) and (12)). This gives us a probability distribution which is completely dominated by the two extremes, with no probability mass between them. We now employ the more realistic assumption,[22] used by Tonin (2011), that if an evader is audited, then the auditor discovers an income $\hat{w}$, which is randomly distributed with support $[0, w]$. If we assume that the mean is the same, then this implies that getting rid of this assumption is in fact a negative Mean Preserving Spread - it is a decrease in uncertainty. However, simply removing this assumption decreases uncertainty symmetrically, and is thus not relevant in itself in this case. What makes it interesting in this context, is that we can combine it with the lessons from White (2006) to investigate what happens if the employer and the employee have different evaluations of this probability distribution.

White (2006) claims that a one-sided additive increase in uncertainty (which may well only be subjective) is going to increase this player's receipt, under certain conditions. That means that if, for example, the employee thinks that this distribution is flatter than what the employer thinks, then, even if they think the mean is the same, the employee, all else being equal, gets a higher share than the employer. Specifically, she requires the relevant player's Bernoulli utility function[23] to satisfy the following ($\forall z \in [a, b]$):

[22] Tonin (2011) cites Feinstein (1991) and Erard (1997) as empirical evidence supporting this claim.

[23] Sometimes called the cardinal utility function, or the felicity function.

$$\frac{U_i(x+z)}{U_i(x)} - \frac{U_i'(x+z)}{U_i'(x)} \leq z[\frac{U_i'(x)}{U_i(x)} - \frac{U_i''(x)}{U_i'(x)}] \tag{41}$$

or, for a small increase in risk:

$$\frac{-U_i'''}{U_i''} > \frac{-U_i'}{U_i} \tag{42}$$

where either $i = 1$ or $i = 2$, but not for both at the same time.

To give the expressions some meaning, it is useful to briefly introduce some terminology. We first define the concept of *boldness*. The concept was first introduced by Aumann and Kurz (1977), and thoroughly discussed by Roth (1989). For a pay-off of x, and assuming that the utility of nothing is zero, we define boldness as:

$$\begin{aligned} b(x) &= \frac{U'(x)}{U(x) - U(0)} \\ &= \frac{U'(x)}{U(x)} \end{aligned} \tag{43}$$

In words, the boldness is the maximum probability of losing x that the player is willing to accept for the possibility to gain some incremental amount.

Prudence is useful in our context because of its predictions about how the marginal utility of consumption for a player changes following an increase in risk, and, correspondingly, how consumption changes. The theory is that increasing uncertainty about the future raises the expected marginal utility of future consumption - thus leading the consumer to consume less today and more in the next period. This implies that the player will be more patient in bargaining compared to the situation with no/less uncertainty, since the marginal utility of the future pay-off will be higher. Since time is not a factor here, the savings application of prudence is not as relevant. However, the same result holds in our application. We say that an individual is prudent if $U''' > 0$. If this holds, then we also know that marginal utility is convex, such that an increase in uncertainty increases the marginal expected utility. The formula often used to quantify this effect is the coefficient of absolute prudence, due to Kimball (1987):

$$\frac{-U'''}{U''} \tag{44}$$

We can therefore state that if, for example, the employee experiences a small increase in one-sided risk, then he can increase his share when his coefficient of absolute prudence is greater than the negative of his boldness.

An interesting application of this theory is in wage bargaining. If for example the employees are more uncertain about the inflation rate than the employers, and they have equal bargaining power, then we expect that, if the conditions above are satisfied, the employees increases their receipt at the cost of the employers. Note, however, that we should be careful to interpret higher uncertainty as according to the definition of Rothschild and Stiglitz (1970), and not according to its everyday usage, which often implies a more negative outlook and a lower expected value.

A friction may arise from this. Since the employer can be assumed to have more resources at hand than the employer, it is not unreasonable to assume that he uses some of those resources to obtain better information, to be able to make better decisions about evasion. We might also assume that the employer can not transfer this knowledge in such a way that the employee is fully convinced, such that his uncertainty is at least marginally higher than that of the employer. In that case, the employer will have an informational advantage over the employee in the bargaining situation. From the above, we have seen that this, under certain conditions, would lead to the employee demanding a higher share. But if the employer is hesitant about rewarding the employee's ignorance, then agreement may not be reached.

To sum up the section on uncertainty, we have seen that the increase in subjective one-sided risk, or one of the players experiencing the uncertainty about the feasible set to be greater, then this will increase the share of the total that this player receives - given some plausible assumptions about his utility function - relative to the situation with symmetric perception of uncertainty. We can interpret this as an asymmetry in bargaining. This implies that under the conditions above, a one-sided increase in uncertainty would lead to that player having a higher bargaining strength, α or $(1-\alpha)$.

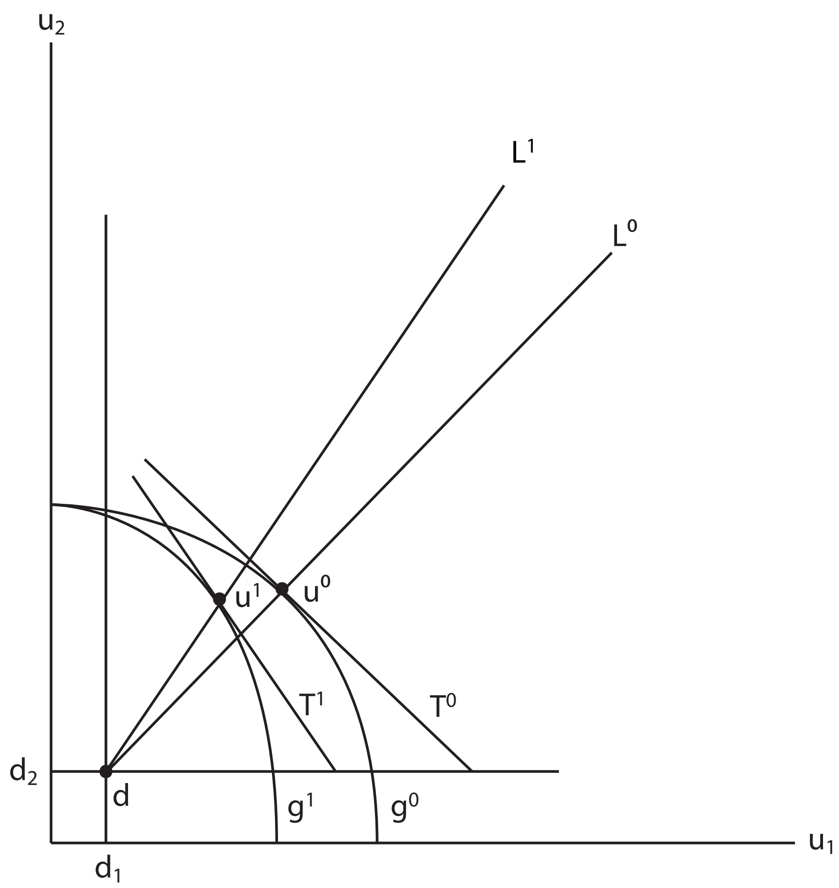
It would be interesting to see a characterization of the NBS with an uncertain disagreement point when the disagreement point is randomly distributed according to a probability density function, and then to look at how the solution might change if the uncertainty increases. To my knowledge, no such analysis has been done. Doing one, however, is outside the scope of this paper.

5.2 Different beliefs

In this section I will look at how the solution changes when there is complete information and the two players have different beliefs about the size of the punishment, or the probability of getting caught. As we know, the players bargain over the set of Pareto-optimal solutions given that the evasion is successful. Then each player determines the utility from each share, given their preferences, and beliefs about the punishment and probability of getting caught. When the players have equal beliefs and preferences, an equal pay-off will also give them an equal utility. This situation is illustrated in Figure (1). When for example the employer thinks the probability of getting caught is higher than what the employee thinks, his utility will be lower at any share x_1, because his expected utility is lower. This situation is illustrated in Figure (4). We see that the employer has a clear decrease in utility, while the effect on the employee is more ambiguous.

An interesting extension of Chun (1988) is when the two players have different beliefs about the size of the punishment, or the probability of getting caught, and information about

Figure 4: Nash bargaining with different beliefs



the other player is incomplete. We assume that each player believes the other player to have the same perceptions as himself. In essence, I will look at how the solution might change if the employee has a different evaluation than the employer of what the feasible set is, such that they in effect are "playing different games". What we are interested in finding then is

$$F_1((1-p_1)S^1 + p_1S^2, d) \tag{45}$$

which is the solution from the employer's perspective, and

$$F_2((1-p_2)S^1 + p_2S^3, d) \tag{46}$$

which is the solution from the employee's perspective, and how they relate to each other and to $F(S,d)$.

As mentioned earlier, we can define the feasible set as $S = \{(x_1, x_2) : 0 \leq x_1 \leq \pi$ and $x_2 =$

$\pi - x_1\}$. Such that an increase in π is an expansion of the feasible set S. Furthermore, through the common axiom of Pareto-Optimality, we assume that the solution, F, is on the Pareto-frontier of S. We can therefore evaluate the effects of facing different feasible sets S indirectly through the function g having different values of π.

We start by rewriting equation (16) to

$$g_2(u_1) \equiv U_2(\pi_2 - U_1^{-1}(u_1)) \tag{47}$$

where $\pi_2 \neq \pi$ is the employee's view of the size of π.

To evaluate how the NBS changes, we rewrite Equation (19), and note that the employee sees the NBS as

$$-g'(u_1) = \frac{U_2(\pi_2 - x_1) - d_2}{u_1 - d_1} \tag{48}$$

which is to equal Equation (19) - the employer's view of the NBS - if and only if both (a) Equation (40) is a radial contraction/expansion of Equation (19) - that is, if g is homothetic with respects to π and (b) $(d_1, d_2) = (0,0)$ - the disagreement points are zero. The reason for this is that when these properties hold, the line from the disagreement point to the solution point has the same slope as the tangent of g at the solution point for any size of π. It is not strictly necessary that the disagreement point is zero. But when it is non-zero, other conditions apply, which I will not go into here.

The situation where both conditions are fulfilled is illustrated in Figure (5). The line L^N is drawn from the disagreement point to u^N, where the slope of the tangent, T^N, is the same as the slope of L^N. The line L^N continues to g^r, which is a radial expansion of g. We see that the slope of $T^N\prime$ is equal to the slope of T^N.

For an attempt to illustrate the situation when the condition is not satisfied, see appendix A.

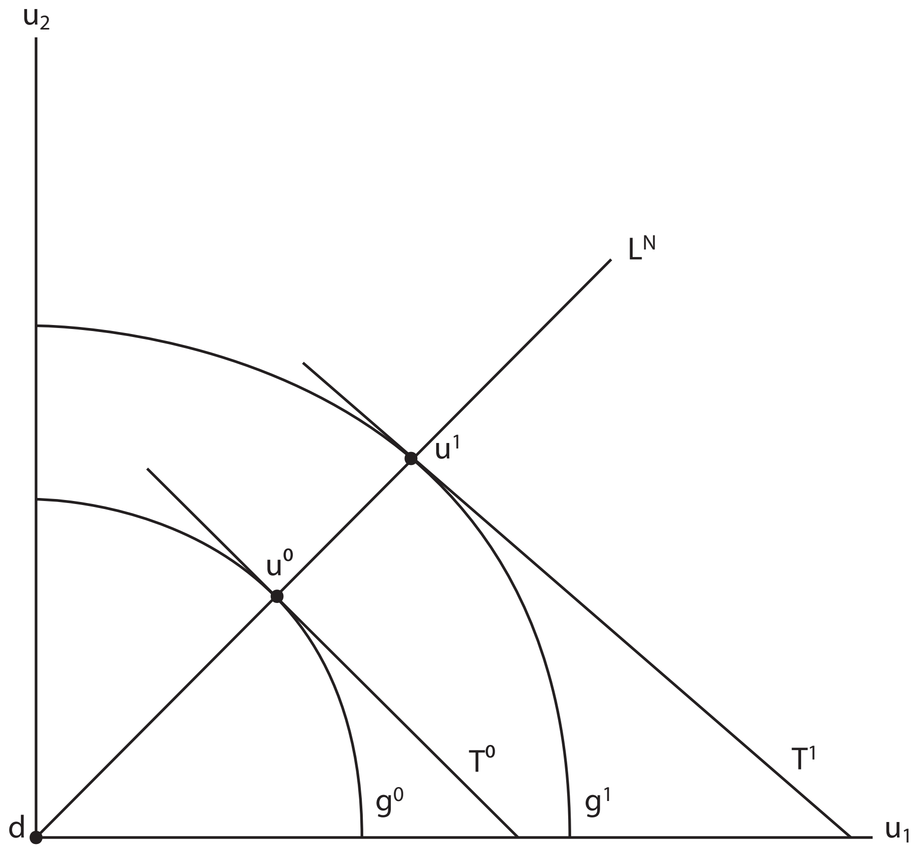
5.3 Different preferences toward risk

I will now look at how a difference in risk preferences changes the NBS, as compared to the situation with equal risk preferences. This is particularly interesting in this setting because economists often assume individuals to be risk averse, and firms to be risk neutral.

Roth and Murninghan (1982) find that risk aversion is generally a disadvantage when bargaining over risky outcomes. However, when there is a positive probability of an outcome which is below the disagreement point, the opposite is true. When this is the case, the more risk averse player requires a greater compensation for the same amount of risk as the other player. This result was confirmed in an experimental setting by Murninghan et al. (1988).

Two things are worth noting about this result. The first is that the employee should receive a compensation for his assumed higher degree of risk aversion. The second is that this may be an additional explanation for why the employer and employee are unable to extract a potential

Figure 5: NBS with different perceptions about π



gain from tax evasion when the size of the potential gain is not big enough - that either the employer or the employee is highly risk averse, requiring significant compensation for this. When the compensation required is higher than what the other player is willing to give, then no tax evasion will take place.

6 More than two players: bigger firms

The models used by Kleven et al. (2016) provide some alternative explanations for why tax evasion is less frequent when there is third-party reporting. Their models also utilize the basic framework of Allingham and Sandmo (1972), and extend it to an N-player setting, where N is the number of employees in the firm. I will introduce the different models they use to create a more complete illustration of the problem. One central assumption they use in their models is that there are no outside possibilities of getting caught. In other words, the government does not perform random audits. Notice that these games take place after the extensive-margin decision has been made, and give some reasons for why a tax evasion coalition of N employees and an employer is likely to be unstable.

6.1 Random Shock/Trembling Hand

Kleven et al. (2016) state that a random shock may reveal tax evasion to the authorities. The random shock may come in several different forms. Firstly, a newly hired employee may have moral concerns about the evasion, and decide to report it to the authorities. Secondly, the employee may have a conflict with the employer, which makes him report the employer to the authorities. Thirdly, the employer or employee may simply reveal the evasion by mistake.

The income of the employee would be the same as in equation (1), except that we extend it to the N-person framework

$$w_n - \tau \cdot \overline{w}_n \tag{49}$$

We then claim that the probability of getting away with tax evasion is $(1-\varepsilon)^N$, where ε $[0,1]$ is the probability of a random shock which reveals tax evasion to the authorities. This has its clear parallel in the equivalent in the original model, $1-p$, except that we now by raising it to the power of N give it the desired property of being decreasing when the size of N increases.

Putting these two elements together with an essentially slightly reworked version of equation (2), we get the pay-off for each employee

$$y_n = w_n - \tau \cdot \overline{w}_n - (1-(1-\varepsilon)^N) \cdot \tau \cdot (1+\theta) \cdot (w_n - \overline{w}_n) \tag{50}$$

We define $Y = \sum_n y_n$, and differentiate with respects to reported wage, $\overline{w}$

$$\frac{\partial Y}{\partial \overline{w}} = \tau[-1 + (1+\theta)(1-(1-\varepsilon)^N)] \tag{51}$$

which implies that there is no tax evasion when $(1-\varepsilon)^N \leq \frac{\theta}{(1+\theta)}$, that there is full tax evasion when $(1-\varepsilon)^N = \frac{\theta}{(1+\theta)}$, and that for any positive θ and ε, there exists a number of employees N such that there is no evasion.

The last point to make is that when information about the financial records are private, such that each person only has knowledge about his own reported and actual income, it can be optimal to evade taxation for one group of employees, while not for others. They state that there is a trade-off for the firm for each employee between the potential gains from colluding with the person to evade taxation and the increase in probability of a random shock revealing the evasion. Since the potential gains are highest for the highest paid employees, they state that they will be the first to evade.

6.2 Rational Whistleblowing

We now introduce a reward for whistleblowing - for the employee telling the tax authorities that the firm is engaging in tax evasion.

The set-up is the following. There are N employees who have already decided whether or not to engage in tax evasion. The tax authorities offer a reward of δ to anyone who gives information to the tax authorities which leads to the discovery of tax evasion. The reward, δ, is a share of the total discovered evasion which the information has led to. If more than one employee denounces the employer at the same time, then the reward is shared between them.

Kleven et al. (2016) find that an employee will find it to be in his interest *not* to whistleblow, assuming no one else does, if

$$\delta \leq \frac{(w_n - \overline{w}_n)}{\sum\limits_{n'}(w_{n'} - \overline{w}_{n'})} \tag{52}$$

where $\sum\limits_{n'}(w_{n'} - \overline{w}_{n'})$ is the sum of all evasion in the firm. In words,the condition says that the potential gain from whistleblowing is less than the gains from evasion. If anyone else is whistleblowing, then it will always be advantageous to whistleblow yourself. Kleven et al. (2016) also provide some conditions relating the size of the reward to the size of the firm, and when tax evasion will take place. They state that when $N > \frac{1}{\delta}$, there will be no evasion at all, and that when $N \leq \frac{1}{\delta}$, there is room for some evasion. Which this condition, the simplicity of the model becomes obvious. According to Kleven et al. (2016), the reward can be up to 30 per cent in the US. That would imply that no firms with more than 3 employees would ever evade taxation. This is not likely to hold. As pointed out by Kleven et al. (2016), the model assumes that there are no costs of whistleblowing. However, there is likely to be substantial costs - both psychological costs and search costs of finding a new job.

The basic idea is that an employee will denounce his employer if this is advantageous for him. However, what makes it interesting is that an employee will want to avoid a situation in which he chooses not to denounce, while someone else does. In this case, not only will they be fined for any evasion they have performed, they will also lose out on a share of the reward. This makes a high-evasion equilibrium unstable - an instability which increases with N. It is clear to see that the employer has a strong incentive to minimize the informational flow on this matter within the firm. They will therefore make great effort to hide the true financial records, and to make sure that an employee only knows whether he evades himself, and not whether other people does.

7 The sharing economy

7.1 Introduction and some economic aspects

The sharing economy is the sector where private individuals charge strangers for borrowing or sharing something which is yours, or for providing services to them - usually through the internet. *Sharing* is often emphasized as an important part of the concept - that people share their apartment, their car, their food, or anything else. Though this rhetoric may attract the creative types who have been important in the spread of these services, it is probably more fruitful to think about the sharing economy as a rather common sector of the market economy.

What has happened the last few years is that technologies have been created that facilitates smaller transactions in an efficient way. One could for example rent an apartment or a room for a shorter period of time through the internet before Airbnb, using services such as Craigslist (USA), Finn.no (Norway), or even through holiday home providers such as Novasol. It is interesting to look closer at Airbnb, as they have received much tax-related focus.

What separates the former from Airbnb is that they do not have the technology which makes it convenient - that transaction costs are high, and that it does not have the same insurance or payment system that Airbnb provides, which gives the hosts safety.

Perhaps the main difference from more traditional holiday home providers is that the branding is different, and that it aims at a different market. There are some additional advantages for Airbnb hosts. It is simpler, and its fees are seemingly significantly lower. Using Novasol as an example of holiday home providers, we see that, according to NOVASOL (2008), Novasol hosts (ignoring taxes) are left with 65% of the amount paid by the guest. With Airbnb, they charge 3% directly from the pay-out to the host - such that it is part of the listing price. In addition, they charge a variable tax to the guests on top of the listing price - typically, but not limited to, 6-12%. This variable tax is interesting, and is probably used as a price discrimination tool, using the details of the reservation to evaluate whether the person has a high or low willingness to pay. Not including the bulk of the fees in the listing price indicates that they have knowledge about tax salience - that users underreact to taxes/fees when they are not included in the listing price (see for example Chetty et al. (2009)). If we say that the guests are charged 12%, then the Airbnb hosts are left with 85% - 20% more than the Novasol hosts.

Another interesting aspect, which has been the source of some criticism towards the sharing economy, is that the firms circumvent some sector-specific regulations and taxes - such that they do not compete on the same grounds as their competitors in the non-sharing economy. For example, strict regulations regarding fire safety for hotels do not apply for Airbnb, nor does Airbnb pay taxes in Norway on the money they make in Norway. This is likely to lead to the consumers paying a lower price for sharing economy services than they would if the firms were regulated equally to non-sharing economy firms.

The aspects mentioned above is likely to explain much of the enormous rise that the sharing economy has experienced over the past few years.

7.2 Modelling tax evasion in the sharing economy

Airbnb is not only one of the largest and most successful firms to emerge from the sharing economy, it also has some distinguishing features which are typical for the sharing economy. I will therefore let Airbnb represent the sharing economy here as well.

The tax authorities in Norway are trying to get Airbnb to disclose their pay-outs to hosts (NRK.no, 2016). There are good reasons for doing this - as I show in this paper, it is a simple and efficient way of reducing evasion. However, this is not yet in place in Norway, and certainly not everywhere that Airbnb operates. I will therefore draw on the models introduced in this paper and model the situation both with and without third-party reporting.

7.2.1 With government reporting

If we assume that Airbnb must report the pay-outs to all their hosts to the tax authorities in the relevant country, then the hosts have two options if they want to evade taxation. The first is to try to convince Airbnb to underreport their pay-outs. The lessons from Kleven et al. (2016) are particularly relevant in explaining why this is unlikely. We could interpret the hosts as being employed by Airbnb. We might say that the hosts only have actual knowledge about whether they evade, and not about whether anyone else does. However, it is not likely that Airbnb will willfully collude with only one of their hosts and no one else. The hosts know this, and can therefore be quite certain that if Airbnb is colluding with them, then they are also colluding with others. We can therefore analyze Airbnb as an employer with a very high number of employees, N, which, as we know, means that an evasion equilibrium is likely to be unstable. An alternative way of explaining it is by noting that each collusive agreement is likely to give a relatively small pay-off for AirBnb, while the marginal increase in risk, in combination with the large consequences, makes the expected costs rather high.

So what form is it that the tax evasion may take? We know that evasive collusion between the host and Airbnb is unlikely due to the size of Airbnb, so let us assume that it does not occur. That means that we can view Airbnb as the prolonged arm of the tax authorities.[24] Interestingly, that does not mean that tax evasion will never take place - because there is another collusion problem to consider.

Because a report to Airbnb now in practice is a report to the government, we have a lower-level collusion problem - between the host and the guest.

We could assume that the government knows that tax evasion is low when there is third-party reporting and that there therefore is little, or negligible, auditing here - as done in Kleven et al. (2016). However, it is more realistic to assume that there is a certain probability of being discovered by the tax authorities. We can also say that there is a certain probability

[24] In this context, I should note.

that Airbnb discovers the underreporting of price. Airbnb is unlikely to have any effective sanctions available other than reporting the cheaters to the tax authorities, after which the likely punishment is the tax-related ones, but we could also assume that the host has to pay some sum of money to Airbnb - this only increases the size of θ. We use f_h for host fees for using Airbnb - this is subtracted from the amount they receive, while f_g is the guest Airbnb fee, which is added to the price.

The scenario here is that the host makes a profile on Airbnb, and has a listing price x. Then a potential guest contacts the host. Either the host or the guest suggests that they instead report a price $\bar{x}$, and then find a way to divide the difference, $x-\bar{x}$. This problem is pretty much the same as in the section on bargaining. Note that $\bar{x}$ can be zero - which means that they do not register the transaction in the Airbnb system at all. The disagreement outcome for the host would be some amount $\overline{X_h}(1-f_h-\tau)$, which could be interpreted as his alternative price for the dates in question if he rented out to somebody else. If the apartment for rent is unattractive, and the dates are outside of season, his disagreement point is likely to be low, or even zero. If the apartment is attractive, or the dates are in the middle of the busiest season, his disagreement point is likely to be high, as there is likely to be significant demand from other potential guests. We can also define a disagreement outcome for the guest, $\overline{V}-\overline{X_g}(1+f_g)$, which is to be interpreted as the value of the second-most preferred accommodation, subtracting its price. Its value will be negatively correlated with the host's disagreement point. In the high season there is likely to be relatively few available accommodations, while for the low season the opposite will be true. We assume that the punishments are calculated according to the size of the fee and tax evaded, as I have done in the rest of the paper.

The utility of the guest if he gets away with underreporting is

$$U_g(V-(1+f_g)\bar{x}-(k_g+a)(x-\bar{x})) \tag{53}$$

If they are discovered, the utility becomes

$$U_g(V-(1+f_g)\bar{x}-(a+k_g+\theta_g f_g)(x-\bar{x})) \tag{54}$$

For the host, it is

$$U_h(\bar{x}(1-(\tau+f_h))+(a-k_h)(x-\bar{x})) \tag{55}$$

and

$$U_h(\bar{x}(1-(\tau+f_h))+(a-k_h-\theta_h(\tau+f_h))(x-\bar{x})) \tag{56}$$

Thefore their expected von Neumann-Morgenstern utility functions are

$$G = (1-p)U_g(V-(1+f_g)\bar{x}-(k_g+a)(x-\bar{x})) + pU_g(V-(1+f_g)\bar{x}-(a+k_g+\theta_g f_g)(x-\bar{x})) \tag{57}$$

and

$$H = (1-p)U_h(\bar{x}(1-(\tau+f_h))+(a-k_h)(x-\bar{x})) + pU_h(\bar{x}(1-(\tau+f_h))+(a-k_h-\theta_h(\tau+f_h)(\tau+f_h))(x-\bar{x})) \tag{58}$$

We can therefore state that the solution to this Nash bargaining problem is

$$arg\max_a \sqrt{(G-U_g(\overline{V}-\overline{X_g}(1+f_g)))(H-U_h(\overline{X_h}(1-f_h-\tau))} \tag{59}$$

It might well be the case that reporting $\bar{x}=0$ makes it more difficult for Airbnb to spot the cheaters. So why should the cheaters report anything at all? The answer is that they want to get access to the benefits that Airbnb provides.

There are several costs connected to going outside the Airbnb system. Firstly, you lose access to the insurances provided by Airbnb, which for example refunds any destruction of property up to a certain limit. Secondly, you lose access to the payment system, which ensures that payment is received. Thirdly, going outside the system is likely to incur an increase in administration- and transaction costs. Lastly, there is likely to be an adverse selection of types of people offering to go outside the system.

When considering the above, it seems reasonable that the amount of transactions going outside of the system should be limited. There should therefore be more underreported than unreported transactions, even if this might be easier for Airbnb to spot by using predictive analytics.

7.2.2 Without government reporting

When we remove third-party reporting from the problem, the hosts have less of an incentive to underreport to Airbnb, as they do not need to underreport to do this to evade taxation. By underreporting to Airbnb, they can only evade their fees. This means that there is less to gain from host-guest collusion, and will lower its prevalence. The problem of interest is then reduced to the standard A-S-Y condition, with a higher share of hosts reporting the correct amount to Airbnb. Note, however, that this is a static environment. If the hosts are forward-looking and believe that there is some chance that the government will gain access to their pay-out data at some point, then they will adjust their behavior accordingly, and we will see more underreporting in the Airbnb system.

The fact that introducing third-party reporting might induce hosts to cheat Airbnb to a greater degree should be of interest to Airbnb. In fact, it might explain why Airbnb for a while was, and to some degree still is, unwilling to report the host's earnings to the national tax authorities.

8 Critique: The metaphysics of cake size

In this paper I look at tax evasion with third-party reporting. I also attempt to give an explanation to why tax evasion is less prevalent when there is third-party reporting. Part of this drop might have a very simple explanation. A&S gives us a simple framework in which to analyze things. We may use a more general version of their argument, and state that the employee will want to evade taxation if the expected benefit from doing so is greater than the expected punishment. This means that if there is evasion, then the employee has some surplus of benefit, which is greater or equal to zero. When we introduce third-party reporting, we also introduce another agent who needs to have this condition satisfied. If this is not satisfied from the outset, then the employee might have to bribe the employer (he might have to do this anyway) - thus reducing his benefit surplus. If the employer's benefit deficit is larger than the employee's benefit surplus, then no evasion will take place. We know that the payroll tax is often lower than the income tax, and reasonably assume that the punishment is greater - not necessarily in terms of θ, but certainly in terms of reputation. This means that the employer's gain from income tax evasion is lower than for the employee, and the punishment is greater. From this it seems reasonable that introducing third-party reporting will significantly reduce this type of evasion, because it introduces a person who will often need to be bribed. This would reduce the surplus benefit of the employee, potentially below zero for a share of employees - which would imply that no evasion takes place for those employees, and total tax evasion is reduced.

An additional explanation for why firms evade less when they grow is that (in Norway at least), the smallest firms are not required to have an external auditor. In addition, small firms can often get by without an accountant. Both of these are likely to get knowledge about any tax evasion. They therefore need to be bribed as well, as they might also face a risk of prosecution. This has a very simple implication - more people have to share a cake which has not increased in size. This should lead to less evasion. In fact, one should see a clear kink in the evasion rate between firms just above and below the number of employees which lead to a requirement to have an external auditor. This could be tested empirically through a simple regression discontinuity design if you had good data on tax evasion.

9 Conclusions

In this thesis I have looked closer at one possible way of analysing tax evasion when there is third-party reporting. When there is one employer and one employee, the division of gains can be found using the Nash bargaining solution. I have found how the division of gains is likely to change if we introduce some realistic differences between the employer and the employee. I have also given two possible explanations for why tax evasion is less widespread when there is third-party reporting. The first is that it is risky to propose tax evasion when you have limited information about the other player's type. The second is that using third-party reporting greatly increases the cost of underreporting.

I have also formalized the bargaining problem for an Airbnb host with and without third-party reporting. It is interesting to speculate in how the growth of the sharing economy will influence the tax take in the future if the exponential growth continues.

We know that those who are subject to little or no third-party reporting have a significantly higher evasion rate compared to those who are subject to significant third-party reporting. This seems to imply that, as long as the firms in the sharing economy do not report information to the Norwegian tax authorities, a shift in employment from the regular economy to the sharing economy implies an increase in tax evasion.

That is not the full picture, however. First of all, more transactions are electronic, which means they are traceable in a completely different way than cash. In fact, to my knowledge none of the major sharing economy firms encourage or even allow cash transactions. One major reason is that cash transactions make it easier to trick the sharing economy firms. For the tax authorities it is a convenient side-effect that the abolishment of cash transactions also helps them collect the correct amount of taxes. In addition, though there is less third-party reporting for the sharing economy firms than for employees in the regular economy today, forward-looking users anticipate firms giving user data to the authorities, in which case their tax evasion would be discovered. This is likely to make the sharing-economy agents evade less than their regular-economy counterparts who do not anticipate that data concerning their current transactions might be handed over to the tax authorities at a later time.

Third-party reporting has some costs for the firms,[25] but it also has two major advantages. Firstly, third-party reporting significantly decreases tax evasion, as I show in this paper. Secondly, when using pre-populated tax returns, it decreases administration cost for the employees. In sum, it is likely that the use and continued expansion of third-party reporting is the most cost-effective tool to reduce tax evasion.

Bearing this in mind, we should ask why it is the case that not all countries use extensive third-party reporting, especially developing countries with a dire need for government revenue. One explanation is given by Carrillo et al. (2014). They use a natural experiment to show that when there are poor institutions, an increase in probability in getting caught increases revenue

[25] According to Finansdepartementet (2009), the costs for firms amount to 3.5 billion NOK.

reported by firms, but also increases reported costs, which in developing countries are very hard to verify. They study data from Ecuador, and find that firms increase their reported costs by 96 cents to every dollar in increased reported revenue, such that the increase in tax take is rather small. This serves to decrease the attractiveness of third-party reporting, at least when we restrict our analysis to the profit tax for firms.

The problem that using third-party reporting shifts evasion towards overclaiming deductions seems to be known in Norway as well, where the tax authorities concentrate much of their efforts on those who claim high deductions Foss et al. (2015). To keep this problem in check, the authorities introduce a number of regulations to maintain a minimum of traceability, with ever-increasing administration costs.

Are there alternatives to this? A trust-based policy would certainly decrease administration costs. However, it seems that a number of people evade if they can, and this would increase the number of people who can.

An alternative policy is to simply eliminate cash, or at least high denomination notes. As argued by Sands (2016), the high denomination notes are mostly used by criminals, and eliminating them would reduce crime and have few costs for society. He also states that the completely cash-less society is unattractive because cash is frequently used for smaller transactions, and removing it would therefore be quite costly. Wright et al. (2014) study the local effects on crime of reducing the cash in circulation among low-income households by paying out benefits on debit cards, rather than giving paper checks. They find that this reduced local crime by almost 10%. This policy can easily be interpreted in my framework as increasing the cost of underrepporting, k_i, and the cost of bribing k without being discovered. It would almost certainly decrease tax evasion, even though one counteracting effect may be that non-traceable electronic currencies, such as Bitcoin, will gain popularity.

For further research, it would be interesting to look closer at the connection between skill-level and evasion, and whether this could be explained by differences in bargaining positions. It would also be interesting to look at how the bargaining solution changes when uncertainty about the disagreement point changes for one of the players.

To make some final comments, I think I have shown a few interesting things in this thesis. I have shown that bargaining theory can be used to study some interesting aspects of tax evasion. It should certainly not be seen as a replacements for the methods used by others, as they study different aspects of the problem. It should rather be seen as a complementing approach from which we can draw some interesting conclusions. Other methods may reach more important conclusions than I do here, but I would argue that the insights found here are not without worth either.

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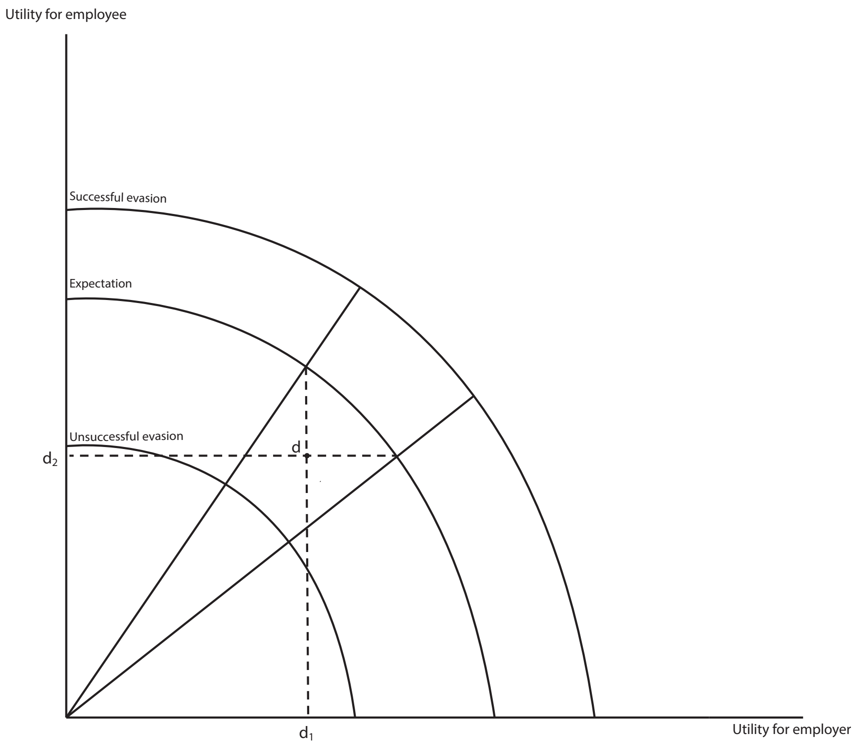
Appendices

A A graphical non-Nash approach

In this section I suggest an alternative approach to analyzing the bargaining situation when there are differences in the understanding of some central variables which affect the perception of the bargaining set, and we assume that information is limited between the players, and that each player assumes the other player to be equal to himself. Our only requirement is that the bargaining outcome (u_1, u_2) is in Θ. Figure A.1 illustrates the situation with symmetric beliefs and attitudes towards risk. We see there that the two players share the same Expected Utility-line. The disagreement point is denoted d. We know that none of the players would accept a deal which they expect to get less from than not accepting the deal. The disagreement point therefore gives us the minimum share each player is willing to accept - indicated by the dotted lines. We know from this that the division they will agree on in this setting is somewhere between or along those two lines. Notice that they bargain over shares, such that they in fact bargain over the angle of the line S, and not concrete points. This is not important here, as knowing the angle of the line gives an exact point on the expected utility-curve, but it becomes important for the next section.

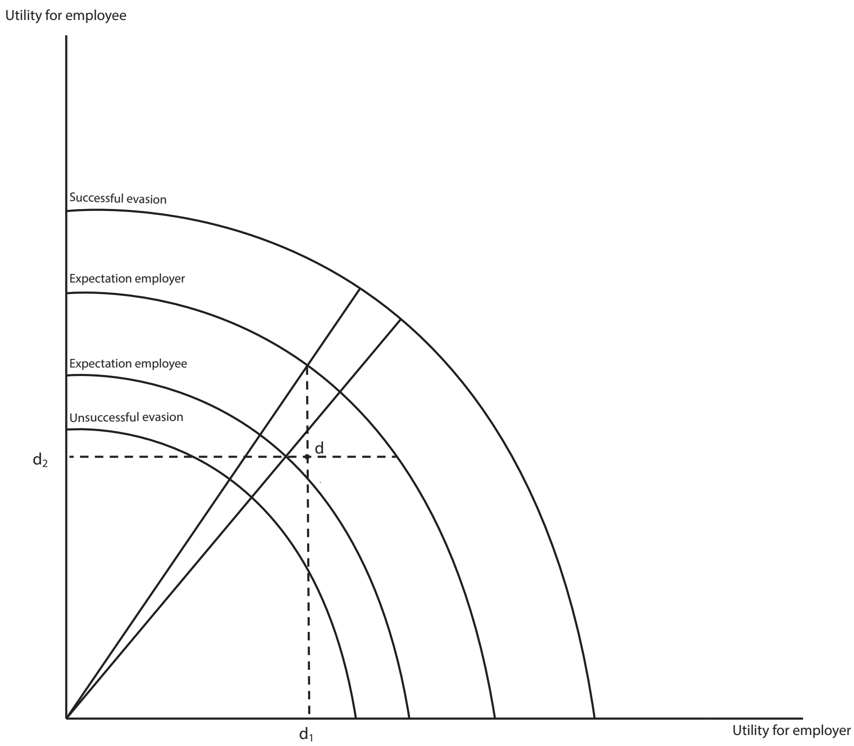
Figure A.1: Bargaining with equal beliefs/preferences towards risk



In Figure A.2, we allow for differences between the two players, which gives them different curves for expected utility. The differences could for example be in subjective understanding and preferences for risk. Again, we know that none of the players will accept the deal (a deal is a line from the origin) if it gives them a lower expected utility than the disagreement point. When we have differences, the two players have different beliefs about what utility they will get from agreeing to a line from the origin. This means that each player will only accept a line if it intersects with their expected utility curve at a point which is above their disagreement point.

What we see is that the set of possible divisions shrinks, with only the deals giving player 2 a high share remaining. We can therefore conclude that, with this set-up, it pays off to be pessimistic. We should notice that, although we have found that there exists some deals which are acceptable to both players, the lack of information about the other player is likely to cause friction here as well.

Figure A.2: Bargaining with different beliefs/preferences towards risk



B Norwegian law and procedure

All Norwegian firms above a certain size are required to hire an external auditor (revisor). The duty of the external auditor is to make sure that the firm keeps a financial statement in accordance to the law. One of the main purposes with the external auditor is to prevent economic crime (Finansdepartementet, 2009). According to Revisorloven (1999), a firm is legally obligated to hire an external auditor if:

- The revenue is greater than 5 million NOK
- The total assets has a greater value than 20 million NOK
- The average amount of man-hours exceeds 10

To prevent non-reporting of employees, Norwegian accounting regulation (Bokføringsforskriften, 2005) requires that employers of some groups of employees keep lists of all their employees, which are then subject to random checks. If a check is performed and a person not on the list is working, then the firm will be punished. The punishment is 10 “court fees” (rettsgebyr) - which per 2016 is 10 250 NOK. If a firm is found to repeat the offence within 12 months, then the punishment is 20 “court fees” - 20 500 NOK. The professions where the employer is required to keep lists are:

- Restaurants, cafés and pubs
- Hairdressers
- Beauty parlors
- Garages
- Other car services (Car washes etc.)

These jobs have in common that they are low-skill jobs with significant evasion.

B.1 Parameter size

We find tax regulations in Skatteloven (1999), chapter 7, and updated rates in Statsbudsjettet (2016). The tax on income from Airbnb, τ_s, is 25%, when it is not exempt from taxation. It is exempt if the rental is a part of your apartment and the part you are renting out is, in terms of value, less than half of the full apartment. If it is a larger part than that, or the full apartment, the income is exempt from taxation up to 20 000 NOK. If it is a holiday home (fritidsbolig), the income is exempt from taxation up to 10 000 NOK.

The regular marginal income tax is also 25% Finansdepartementet (2015). The income tax is progressive. If you make less than 50 000 NOK in a year, the income is exempt from taxation. There are four kinks in tax schedule. The highest effective marginal tax rate is 46.8%. The average tax rate is therefore somewhere between 0% and 46.8%.

The payroll tax, t is different depending on where in Norway the firm is registered and operating. It is used to stimulate business in rural areas. For the northernmost parts of Norway, the rate is 0%, while for the more central areas it is higher, and up to 14.1%, which is the highest rate.

Punishment for employee non-compliance is given in Ligningsloven (1980), paragraph 10-2 through 10-5. The regular punishment is 30% of the evaded taxation. If the information is correctly reported by a third-party, the punishment is reduced to 10%. However, if the under-reporting is done with clear intent, an additional punishment of either 15% or 30% of the tax evaded is added, such that $\theta_2 \in [1.25\tau, 1.6\tau]$. If the offence is to be considered tax fraud, they are punishable under Straffeloven (2005), paragraph 387, 388 or 389, depending on the seriousness of the crime. It is then punishable with a fine or prison for up to 2 or 6 years. It is not quite clear when tax evasion is punishable under which offence, but as the punishments under Straffeloven (2005) are clearly more severe, we can assume that they require a higher degree of seriousness. If the If a third-party wrongly reports data with intent, his punishment, θ_1, is a fine or prison for up to 2 years. The size of the fine is not specified, but it is reasonable to assume that it is an increasing function of amount evaded.

Bribing a public official, and accepting a bribe *as* a public official are punishable by the same law - Straffeloven (2005), paragraph 387, 388 or 389, depending on the seriousness of the crime. The actual punishment received depends on a number of factors, but to illustrate the approximate size of the punishment, I refer to some previous court decisions based on this law. Norges Høyesterett - dom (2012) found that the punishment for active corruption including a public official of about 200 000 NOK should be one year and six months in prison. Norges Høyesterett - dom (2010) found the appropriate punishment for an amount of 100 000 NOK to be 8 months in prison. Note that the sentences did not depend on the size of the bribe, but on the size of the resulting gain.[26]

The minimum wage, ν, is stated per hour, and varies according to the profession. The professions in question, and their minimum wage per hour, is given by individual regulation, and is set by the Tariff Tribunal (Tariffnemnda). Arbeidstilsynet (2016) gives an updated overview of the regulations. I also add how much this implies on a yearly basis.[27] The list is as follows[28]

[26] See for example Borgarting lagmannsrett - dom (2016), where no bribe was paid.

[27] I assume that the worker is employed full-time, and that they are unable to escape the regulation by reporting a lower amount of hours. I multiply the numbers by 1 750, which is used by the Statistics Norway labor market survey as the baseline for full-time employment in construction and services.

[28] Where there are several different minimum wages, I state the minimum wage for adult, skilled workers.

Industry	Minimum hourly wage	Annually
Construction	187.8 NOK	328 650 NOK
Shipping and warf industry	160.15 NOK	280 263 NOK
Agriculture	141.05 NOK	246 838 NOK
Cleaning	169.37 NOK	296 398 NOK
Fishing industry	177.7 NOK	310 975 NOK
Electrical work	201.97 NOK	353 448 NOK
Freight transport	158.32 NOK	277 060 NOK
Personal transport (bus etc)	150 NOK	262 500 NOK

The probability of audit also varies quite a bit depending on your characteristics. Considering that the Norwegian tax authorities use predictive analytics, it is very difficult to assess the true probability of audit for a certain firm. Given that the tax authorities use predictive analytics, the frequency of audits will be a poor indicator, as it is likely to be significantly higher for an evading firm.

B.2 Tax procedure

In Norway, tax data on individuals and firms are collected from a wide array of third-parties when available. For individuals, the data is used to create pre-populated tax returns. The individual is then presented with the data, and gets the opportunity to change incorrect information. According to Foss et al. (2015), 70% of all pre-populated tax returns are left unchanged. The remaining 30% change something. When they do change something, it is often because they want to add deductions. It is also here that most of the tax evasion in Norway takes place. The reason for this is that tax deductions are rarely subject to third-party reporting, and is in general more difficult to discover. Foss et al. (2015) finds that 35% of tax returns with three different deductions have errors, while the error rate is 60% for those who use five different deductions. They therefore focus much of their efforts on auditing those with many deductions. This is a break from previous methods, where they often targeted those who claimed the most difficult-to-track deductions.

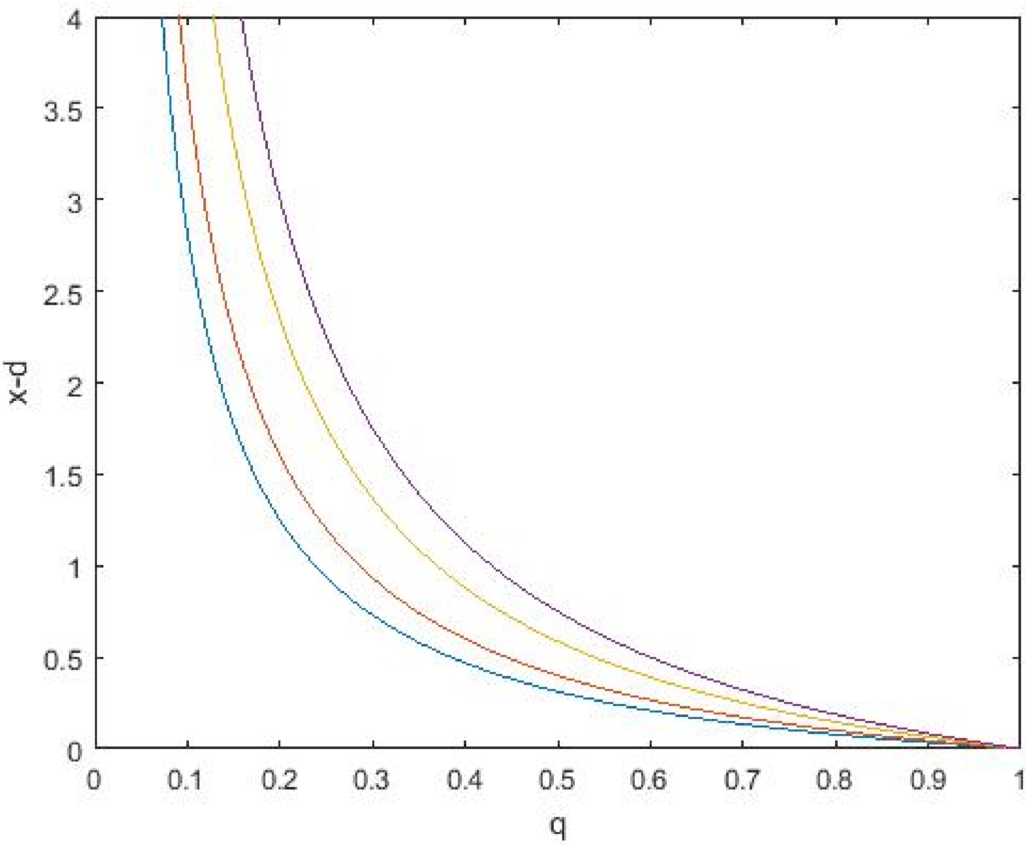
C Simulations

C.1 Proposal risk

Figure C.1 illustrates the relation between the minimum required size of the difference between x_2^N and d_2 in units of $w - \overline{w}$ on the y-axis and the belief about the employer's morale on the x-axis. The equation I am modelling is Equation 25. I normalize $w - \overline{w}$ to 1. This means that when we have 0.5 on the y-axis, the size of the employee's gain from evasion must be at least equal to half of the evaded amount. As previously noted, $x_2^N - d_2$ can only exceed 1 when $\overline{w} > d_2$. I assume that the evasion is punishable through Ligningsloven (1980), paragraph 10-2 through 10-5.

The inner line is constructed with $\psi = 1.25\tau$, and $\tau = 0.25$. The next one with $\psi = 1.6\tau$, and $\tau = 0.25$. The third one with $\psi = 1.25\tau$, and $\tau = 0.468$, and the outermost one with $\psi = 1.6\tau$, and $\tau = 0.468$. See the previous appendix for details on these numbers. We also see that the required return tends 0 as q tends to 1, and to infinity as q tends to 0, and finally that the rate is undefined at $q = 0$.

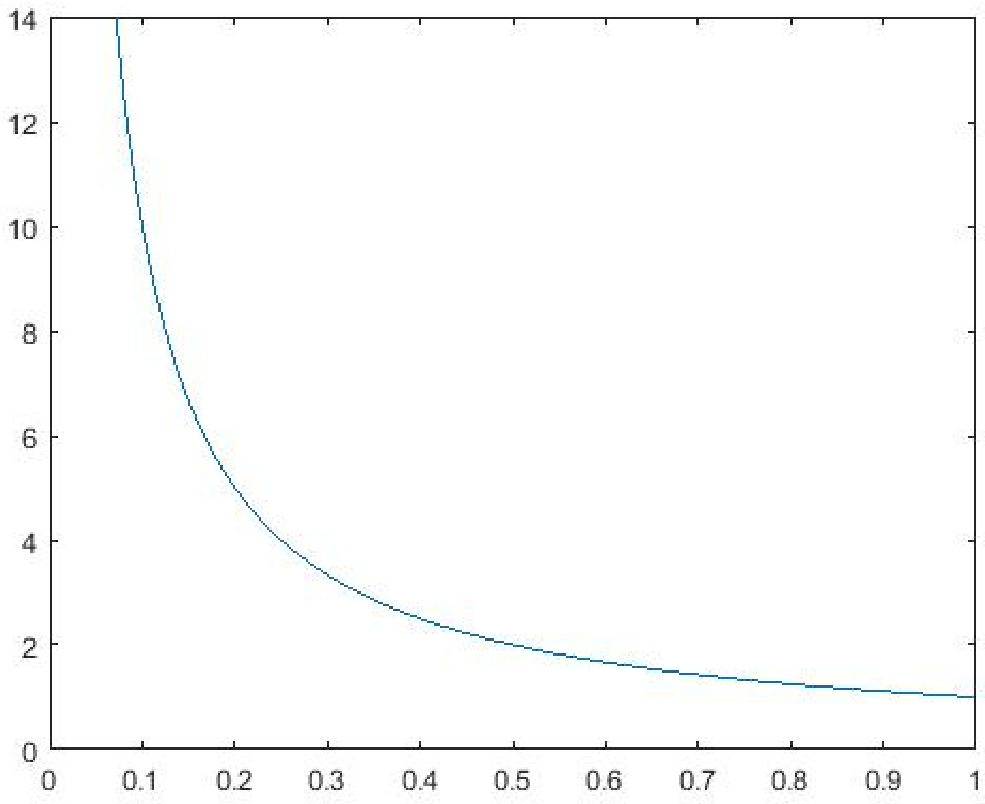
Figure C.1: Simulation of proposal risk



C.2 Allingham-Sandmo-Yitzhaki

In Figure C.2 I illustrate the Allingham-Sandmo-Yitzhaki condition, with punishment, θ on the y-axis (which, as we know, is proportional to the gain), and the probability of getting caught on the x-axis. At the line, the individual is indifferent between evading and not evading. If the probability of getting caught is, for example, 50%, then he is indifferent if the punishment is twice the size of the potential gain, and will not want to evade is the punishment is higher, and will want to evade if it is lower. Of course, models of this kind are a bit simplistic, and should perhaps predominately be used for comparative statics. But it is nonetheless interesting to see its actual predictions. We also see that the required punishment size tends to infinity as the probability of getting caught tends to zero, and that it tends to 1 as the probability tends to 1.

Figure C.2: Simulation of the Allingham-Sandmo-Yitzhaki condition



C.3 Benefit of being registered

The following list contains the required size of the benefit of being registered to want to do so, given taxes and minimum wages. I also assume that the payroll tax is 14.1%.

Industry	Annually	Average income tax + payroll tax	Required annual benefit
Construction	328 650 NOK	40.1%	131 788 NOK
Shipping and warf industry	280 263 NOK	38.1%	106 780 NOK
Agriculture	246 838 NOK	36.1%	89 108 NOK
Cleaning	296 398 NOK	39.1%	115 891 NOK
Fishing industry	310 975 NOK	40.1%	124 700 NOK
Electrical work	353 448 NOK	41.1%	145 267 NOK
Freight transport	277 060 NOK	38.1%	105 559 NOK
Personal transport (bus etc)	262 500 NOK	37.1%	97 387 NOK