Memoire d'Initiation à la Recherche

Theoretical effects of ambiguity on tax evasion: is unclarity beneficial to tax compliance ?

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Abstract

This paper reviews the behavior of tax evader when they face ambiguity about the probability of audit. Therefore it uses the smooth ambiguity model of Klibanoff Marinacci & Mukerji(2005). Then it introduces inequity in this framework. Concerning ambiguity averse agents, this work reveals that ambiguity about the probability of audit appears to be efficient to reduce the evaded amount of income. Then inequity by decreasing the global wealth of agent, tends to decrease the evaded amount of taxes.Taking the behavior of agents into account, we deduce what the optimal fiscal policy is. As most of people are risk and ambiguity averse, the State should implement ambiguity around the probability of audit. Then a numerical example is derived so as to obtain more accurate and realistic conclusions.

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Contents

Introduction

"Globally, trillions are being lost to tax evasion. If countries tackled it seriously there would be no eurozone crisis."[1]

In 2010, Murphy realized a study on 145 countries for Tax Justice and Network. He estimated that the cost of tax evasion reached 98% of the global GDP, which is equivalent for each country to about 55% of healthcare spendings. Tax evasion reached a trillion euros in the European Union in 2013. The missing revenue could fill the budget deficit of 16 EU members. For some countries (e.g Italy or Greece) tax evasion has a major role in the dire state of their economy, the proportion of evaded taxes is around 30%.

Tax evaders sometimes get caught and penalized. Recently multinational firms (Amazon, Starbuck, Google...) have been denounced for how little taxes they pay[2]. But the behavior of those firms is difficult to expose: their manner often stands on the line between tax evasion and tax avoidance. *Tax avoidance* refers to "any legal activity that lowers taxes while *evasion* implies illegal means" (Alm and Torgler (2006)). For example Apple stroke a deal with the Irish fiscal administration to reduce its tax rate to 1%. So Apple was not legally evading taxation. In the end, the European court found them guilty and fined them to a 13 billion euros[3]. As for firms the fines of evading households depend on the amount evaded. A well-known story in France is that of M. Cahuzac who held a hidden account in Switzerland. He was sentenced to 3 years jail and the Swiss bank was fined 1,875 million euros[4].

According to Alm (2012), this missing fiscal revenue is a plague for the entire economy for four reasons. First, it reduces the available budget to finance public commodities. Second, it creates misallocation of resources: agents modify their behavior and implement new strategies to pay less taxes. Third it requires that the State allocates resources to cure tax evasion, and fines evaders. Fourth, evasion creates inequity: all agents are not equally able to evade in the same way. Tax evasion may also create an incentive to disrespect Law: "if others evade, why should I not".

Tax evasion is a threat to our society and even more to our welfare State. To better understand this phenomenon, we study the behavior of households and the factors that influence their decision making process. We define *tax evasion* as "illegal and intentional actions taken by individuals to reduce their legally due tax obligations". Individuals can evade by underreporting income, overstating deductions and exemptions, by failing to file appropriate tax returns or even by engaging in negotiations (Alm (2012)). We will focus on tax evasion by underreporting. We will study tax evasion behaviors in the context of an ambiguous fiscal policy. Ambiguity stems from the fact that fiscal institutions do not always announce the share of audited households. And fiscal institutions like the US Internal Revenue Service underline the advantage of keeping the audit policy secret and random. Conducting a full audit policy is very costly, so keeping the audit probability hidden from the agents is more cost effective (Snow and Warren (2005)).

The questions we seek to answer are the following: How does ambiguity on the probability of audit influence the behavior of tax evaders? Is ambiguity an effective mean to fight tax evasion?

First we review the main works on tax evasion. Section 2 describes the behavior of tax evader under ambiguity using the Klibanoff Marinacci & Mukerji's[5] theory. We add inequity to the basic framework in section 3. Then we deduce optimal rules for the State in Section 4. Before concluding, we compute a

[1] Collect the evaded tax avoid the cut, Murphy 2010, The Guardian

[2] http://www.bbc.com/news/magazine-20560359

[3] https://www.theguardian.com/business/2016/aug/30/apple-pay-back-taxes-eu-ruling-ireland-state-aid

[4] http://www.lemonde.fr/societe/article/2016/12/08/fraude-fiscale-jerome-cahuzac-condamne-a-trois-ans-de-prison-ferme_5045553_3224.html

[5] We will then refer to them by using the short form "KMM"

numerical example of this model (section 5).

1 Literature review

1.1 Related works

Observing the non-compliance of agents to tax rules, economists started to develop models so as to understand the behavior of agents. According to Alm (2012), Allingham and Sandmo (1972) are the first authors to model tax evasion by using the utility maximization design and the von Neuman and Morgenstern expected utility. This work assumes that agents maximize their expected utility by choosing not to declare a part of their wage. In the best case for the agents, they evade and are not caught. In the worst case they are caught and are required to pay a penalty. This model gives some intuitions of the factors that affect tax evasion: tax rates, probability of being caught and penalty rates. An agent declares his revenues because he is afraid of getting caught and of paying penalties. This theoretical model also predicts that people will evade less when the tax rate increases. It is mainly because of two effects: substitution and revenue effects. The substitution effect arises when the tax rate increases: as the tax rate increases, the marginal gain of evading is higher so the agent should evade more. A revenue effect also appears: when the tax rate increases the agent is globally poorer, therefore he evades less because he would be even poorer in the case that he is caught. Yitzhaki (1974) has shown that the substitution effect disappears when the penalty is proportional to the amount evaded. Agents are ultimately poorer when taxes increase, they will evade less if they have a decreasing absolute risk aversion. The basic framework of Allingham and Sandmo (1972) has often been used to develop more complete models. Our work builds on and extends these works.

One of the earliest study based on the 1969 Tax Compliance Measurement Program also reached similar conclusions: the elasticity of reporting with respect to the marginal tax rate is positive and varying from 0.5 to 3 (Clotfelter (1983)).Alm et al. (1990) have observed that tax compliance increases when tax rates decrease or payroll benefits increase. Tax evasion is higher when the probability of being caught is more certain. Alm and Torgler (2005) analyzed tax morale[6] of individuals according to their cultural features. They compared the willingness of agents from America and Europe to pay taxes. They noted that an individual's occupation has strong influence on his tax moral. By using a worldwide investigation of socio-cultural and political features, they conclude that United States and Switzerland have the highest tax compliance. The Northern European countries tend to have bigger fiscal law compliances. Nevertheless empirical results must be considered with caution, since tax evasion is by definition difficult to quantify. Tax evasion being illegal, agents are reluctant to reveal their actual behavior.

The work of Allingham and Sandmo (1972) opened new research directions. Sandmo (1981) distinguishes different markets in which it is possible to evade and others in which it is impossible. In one market the employer reports all salaries while in the other the employee reports his income by himself. Sandmo goes further by studying how the State should set the rate of audit and the penalty. Sandmo (2005) introduces the presence of a black market, but had difficulties in concluding. He could not say what is the effect of a marginal tax rate increase on the amount of tax evaded and on the proportion of moonlighting. The repartition of free time between leisure and black market labor remains unclear when taxes increase. In this extension he assumes that evasion is equal to the amount of black market earnings. Our work does not address market types, but it could be a further path of development.

[6]Tax morale is "the agent's intrinsic willingness to pay taxes".

Models were also improved by adding human characteristics. Bordignon (1993) introduces fairness (aversion to inequity) in the model: before evading agents take into account the behavior of other agents and evaluate if the exchange rate between the taxes paid to the State and the available public goods per agent is fair. If the agent believes that he is treated unfairly compared to the others, or/and that the quantity and the quality of public commodities provided by the State is too low, he is likely to declare less revenue. Therefore Bordignnon uses the Kantian rule. It emphasizes that "an economic agent considers that it is fair to pay as much as he would wish other individuals to pay". The model concludes that for a given level of public spending, an increase of tax, if considered unfair, induces an increase of tax evasion to compensate the equity. Cowell (1992) adds to the basic framework of tax evasion a degree of inequity, which depends on the level of taxation and the perceived share of public goods available. Contrary to Bordignon, he found that evasion decreases when inequity increases. We take Cowell's view of inequity in this work. So we will develop a bit more this modeling afterwards.

Tax polices often change, and tax laws are sometimes hard to understand for agents. The number of audit realized by the fiscal administration is not clear. To take this idea into account, Alm et al. (1990) introduce ambiguity at two levels: the tax base may change and so does the tax rate. The uncertainty concerning the tax rate is likely to foster tax evasion and always make individuals worse-off. Nevertheless uncertainty around the tax base seems to be an effective way to increase government revenues and might be welfare enhancing if government decreases taxes at the same time. Snow and Warren (2005) introduce ambiguity on the probability of audit: there is a systematic bias on the probability. They introduce second order probability, which is parameterized by a degree of aversion. They use the cumulative prospect theory that I will develop later on. The introduction of ambiguity improves tax compliance of ambiguity averse agents. But empirical experiments reveal that for small probability of audit, most of people are ambiguity loving. Therefore Snow & al. conclude that ambiguity on audit probability is not a good way to increase tax compliance. Otherwise this could be welfare enhancing if most people are ambiguity averse, the state would be able to reduce tax rates, as people would evade less because of ambiguity. This article is our starting point, as we will reproduce a similar model by using another ambiguity theory and going further. Nevertheless most of our hypothesis are similar.

Experimental findings tend to support theoretical results. Spicer and Thomas (1982) conducted an experiment in which they gave different information about the probability of audit to individuals. The authors found that well-informed people reduce the amount evaded when the probability of audit increases. For those who had no written information, no correlation was revealed. Friedland et al. (1978) realized a game simulation of tax evasion and found that a high penalty is really more effective than frequent audits. To obtain those results they experimented on students and gave them clear information on tax, audit rate and also on the magnitude of fines. The fine depends on the total amount evaded. Bott et al. (2014) show that rather than using fiscal tools, policy makers could improve tax revenue by implementing a moral appeal on tax form. The effects are different: increasing the probability of audit increases the number of people who declares income (while they did not before); whereas a moral appeal tends to increase the amount declared by agents that already used to declare income. They realized this field experiment by adding a moral appeal enclosed on the foreign revenue tax form.

Besides detailing how individuals should behave when they evade taxes, authors have tried to find the best reply of the state. For Slemrod and Yitzhaki (1985), the objective function of the state is to maximize the expected utility of households. They show that the social cost of tax evasion can be summarized by the excess burden of tax evasion. The excess burden of tax evasion is the difference between the utility of paying taxes without evading and the expected utility of evading. The State should minimize the excess tax burden. Contrary to Slemrod and Yitzhaki (1985), the following authors focus on tax revenue rather than welfare of individuals. According to Kolm (1973) the only real constraint on the optimization of the State is the fact that the probability of audit must lie between 0 and 1 (by definition). In the expected utility classical framework Kolm shows that at the optimum there is a balance between utilities of public and private goods. Andreoni et al. (1998) argue that a way to maximize the audit revenue when the State commits to an audit rule is to apply a "cut-off" rule. A cut-off rule consists in defining a threshold of revenue under which all agents will be audited with a probability p. Above this threshold any agent will be audited. In the standard framework of utility maximizer agents, the optimal probability should equal $\frac{1}{1+\theta}$ where θ is the penalty rate. If the State is unable to commit to an audit rule, the situation is similar to sequential game. The State follows a mixed strategy. One of the remaining debate concerning welfare maximization is: should we include evader's utility in the welfare function maximized by the State (Andreoni et al. (1998)) ?

Polinsky and Shavell (1979) summarize what the optimal fines and probabilities of audit are according to agents characteristics (degree of risk aversion). In particular they criticize Becker's argument that optimal fine should be equal to individual's wealth. They use the basic framework and add en external cost due to tax evasion. They find that for risk neutral agents, the optimal probability of audit should equal the threshold probability. In their work, the threshold probability is the probability at which agents are indifferent between evading or not. The fine should be as high as possible. Then if we assume that the cost of catching evaders is very low and that agents are risk-averse, the optimal probability of audit equals 1 and the fine should equal the gain of evaders. Thus the penalty must not always be equal to the agent's wealth. In opposite, Sandmo(1981) with his dual market finds results that acknowledge Becker's idea. As probability of audit and penalties work together, for risk averse agents the State should increase the probability and diminish the penalty. And the State should do the opposite for risk neutral agents. Similarly to Polinsky and Shavell (1979), we will try to develop some advice to policy makers so as to lead an optimal fiscal policy.

Now that we have a general overview of the topic, we quickly discuss the several theories that enable to formalize ambiguity in the economic thought.

1.2 Microeconomic formulations of ambiguity

1.2.1 Definition

Ellsberg (1963) first described the presence of ambiguity in decision. He describes an experiment called the two urn experiment: there are two urns, one containing fifty black balls and fifty white; the other urn contains 100 balls but we do not know the proportions of white and black balls. In this situation agents do not respect the Sure thing principle described by Savage's work[7]. Indeed by observing individuals' choices it is impossible to infer logical probability. And none of the classical decision making patterns can describe their behavior ("minimaxing", using Hurwicz criterion). Ellsberg justify this observation by explaining that this experiment does not create a situation of risk nor of ignorance. This is a situation of ambiguity: we know the possible outcomes, but we cannot properly define the probabilities of occurrence; the information is conflicting; agents have widely different expectations. Therefore agents are willing to choose the experiment where the probabilities are well known rather than a situation in which they are ambiguous. After Ellsberg several definitions of ambiguity were proposed. Here are the most relevant:

- Ambiguity is the quality depending on the amount, type, reliability, and "unanimity" of information (Ellsberg, 1961)

[7]This result can also be supported by the three-color experiment.

- Ambiguity represents a situation in which no probabilistic information is available to the decision maker. (Etner et al. (2012))
- Ambiguity uncertainty about probability, created by missing information that is relevant and could be known (Camerer and Weber (1992)
- Ambiguity is the subjective experience of missing information relevant to a prediction. (Frisch and Baron (1988))

We notice that ambiguity induces a lack of information for the agents, which makes them unable to well predict the occurence of an event.

1.2.2 The subjective expected utility

The subjective expected utility (Savage Leonard (1954)) shows that when there is uncertainty, agents take their decision by defining some subjective probabilities and then by maximizing their expected utility. Thus taking decision under uncertainty is in this case similar to taking decision under risk (we only replace the probability by subjective ones).

$$SEU = \int_S u(f(s))\,\mathrm{d}\mu(s)$$

$\mu(s)$ is a subjective probability and $u(.)$ is a utility function. S is all the possibilities that are faced by the agent.

Savage's work is still considered as a key theory in decision theory, but the subjective expected utility has limits. First we do not know how the subjective probability are determined, how they are defined. Second the theory of the subjective probability does not fit with the presence of ambiguity. Indeed the result of Ellsberg's experiment shows that the decision process is different. The sure thing principle is not intuitive for agents. The sure thing principle assumes that there is no need to compare decisions in different states of the world when they produce the same result. When there is a lack of information agents tend not to follow the sure thing principle anymore. Third the Ellsberg experiment shows that the SEU of Savage is inefficient in an ambiguous situation. It is impossible to characterize reaction to ambiguity under such model (Etner et al. (2012)).

Simpler models can also be used to capture the behavior of agents. The maximin theory use a pessimistic approach to do so.

1.2.3 Maximin theory

- **The standard maximin theory:**

The maximin theory was first introduce by Wald. It is a pessimistic criterion. Since agents only focus on the worst outcomes. Agents choose the solution that has the highest utility among the worst outcomes of all the possibilities. Arrow (1954) added the fact that agents also take into account the best outcome. Therefore, an agent solves:

$$\max_{x,z} \alpha u(x) + (1-\alpha)u(z)$$

α is the pessimistic degree of the agent, x the worst outcome, and z the best one. In this model, we can assimilate α to the degree of ambiguity aversion. Nevertheless it is complicated to compare two agents with different utility functions. Another limitation is that according to Hayashi and Wada (2010) individuals are sensitive not only to the worst and best outcomes, but also to the definition of the set of probabilities.

The Maximin model was improved by replacing utility with expected utility.

- **Maximin expected utility:**

According to Gilboa and Schmeidler (1989), a decision F is preferred to a decision G if and only if :[8]

$$\max_{p \in C} E_p u(f) \geq \min_{p \in C} E_p u(g)$$

Since the agent has no clear information, he compares the minimum of the expected utility. This implies that the agent is ambiguity averse. This model is based on an axiom that introduces ambiguity but there is no way to measure ambiguity aversion. And again there is no objective reference for the set of priors. A more general maximin criteria, is the maximin with Choquet expected utility as it does not impose a degree of ambiguity aversion. For v a convex capacity set[9]

$$\int_{Ch} u(f) \, \mathrm{d}v = \min_{p \in coreV} E_p u(f)$$

The maximin theory can be improved in several ways. Now we left aside the maximin optimization, and go on other models that retain the expected utility as the model key element.

1.2.4 Cumulative prospect theory (Kahneman and Tversky (1979))

This theory is similar to Choquet's expected utility. It generalizes it using a distinction between gains and losses, there are treated differently. One issue is that this model implies a reference point in order to distinguish gains and losses. Let $S = \{s_1, s_2, ..., s_n\}$ the set of events, and $f(s_i) = x_i$ the corresponding gain or loss associated to this event. For $i \in \{1, ..., k\}, x_i$ are losses, and for $i > k, x_i$ are gains. v are still capacities, one is for negative outcomes and the other for positive outcomes. and the function f is defined by the following function:

$$V(f) = \sum_{i=1}^{k} v^-(\cup_{j=i} k s_j)\Big(u(x_i) - u(x_{i-1})\Big) + \sum_{i=k=1}^{n} v^+(\cup_{j=i}^{n} s_j)\Big(u(x_i) - u(x_{i-1})\Big)$$

Then, Rieger and Bui (2010) show that this model is unable to describe the choice of very risk averse agents facing a simple lottery. By conducting a finite mixture regression, Bruhin et al. (2010) conclude that about 80% of individuals do not fit with the probability weighting function used in the cumulative prospect theory. However this theory was used by Snow and Warren to implement ambiguity in their model of tax evasion. Due to those limitations and the potential advantages of the next model, we use a different model: the smooth ambiguity model.

1.2.5 Smooth ambiguity model (Klibanoff Marinacci and Mukerji(2005))

This model enables to easily distinguish risk aversion and ambiguity aversion. First the agent maximizes his expected utility (EU) with a subjective set of probability. Then he finds out the optimal level of evasion in the presence of ambiguity by considering this transformed expected utility:

$$E_F[\Phi(EU(x, \pi))] = \int_{\underline{\pi}}^{\overline{\pi}} \phi(EU(x, \pi)) \, \mathrm{d}F(\pi, p)$$

[8]p is the probability and C the set of prior.

[9]The capacity gives "the smallest probability of each outcome if this decision is chosen", for more details see Etner et al. (2012).

x is the variable of interest, $F(.)$ is a cumulative function; π is the probability belief, and it varies in an interval $[\underline{\pi};\bar{\pi}]$. The shape of the transformed expected utility depends on ϕ, which describes the agent's degree of aversion to ambiguity.

The sign of the second derivative of Φ drives the behavior of agent facing ambiguity:

- an agent is ambiguity neutral if: $\Phi''(.) = 0$
- an agent is ambiguity loving if: $\Phi''(.) > 0$
- an agent is ambiguity averse if: $\Phi''(.) < 0$

This model has two key advantages. First without restriction on the range of ambiguity attitude, we can distinguish ambiguity as a characteristic and the attitude of the agent toward this feature.[10] Second, we obtain smooth utility curve. One can hold the timeless feature against this model, but in 2009, KMM found a way to extend the smooth ambiguity model to dynamic problem.

2 Our model

After having reviewed the key papers on the topics of interest: tax evasion, ambiguity and the optimal fiscal policy, we will now details our work. We build a model of tax evasion in an ambiguous context about the probability of audit. Therefore we use the basic framework of Allingham & Sandmo(1972), and assume Snow & Warren hypothesis to be true. We introduce ambiguity by implementing the model of Klibanoff et al. (2005). We go further than Snow and Warren (2005) by looking at the consequences of an agent's inequity aversion. In this way we will be able to conclude whether this modeling better reflects the empirical and experimental findings as this type of ambiguity has until today never been used in the tax evasion framework.

Now we derive the behavior of agents in order to observe whether this different specification of ambiguity changes completly the outcomes.

2.1 Hypothesis

We assume that: the taxpayer has a fixed income: ω. He is taxed at a rate $t \in [0;1]$. The amount of undeclared income is x. The penalty rate is $\theta > 1$. So the agent's budget constraint is:

- $W_N = \omega(1-t) + tx$ if he is not audited;
- $W_A = \omega(1-t) + tx(1-\theta)$ if he is audited;

The utility of taxpayer depends on his net income: $U(W_i), i = \{N; A\}$.

- the agent is risk loving if his utility function is convex $(U''(.) > 0)$
- the agent is risk neutral if his utility function is linear $(U''(.) = 0)$
- the agent is risk averse if his utility is concave $(U''(.) < 0)$

[10]For more details, see Tallon, Jelena and Entner (2012)

- The probability of being caught

The objective probability of being audited is $p \in [0,1]$. The subjective probability of being audited is π. π has a cumulative distribution: $F(\pi, p)$ with $F(0,p) = 0$. Beliefs are unbiased, which means that: $E_F(\pi) = p$ or $\int_0^1 \pi \, \mathrm{d}F(\pi, p) = p$

2.2 Modeling ambiguity

We use the smooth model of ambiguity described in the previous section.

The transformed expected utility of a taxpayer is:

$$E_F[\Phi(EU(x,\pi))] = \int_{\underline{\pi}}^{\bar{\pi}} \phi(EU(x,\pi)) \, \mathrm{d}F(\pi, p)$$

2.3 The initial model

2.3.1 Risk neutral agents

A risk neutral agent has a linear utility function: $U'(.) > 0$ and $U''(.) = 0$.

- No ambiguity:

The expected utility of the economic agent is :

$$EU(x,p) = (1-p)U(W_N) + pU(W_A) \tag{1}$$

To choose the optimal level of undeclared income, the agent maximizes his expected utility according to x:

$$\max_x EU(x,p) \tag{2}$$

As the agent is risk neutral, $U'(W_N) = U'(W_A)$. So we can rewrite the first order condition as:

$$\frac{\partial EU(x,p)}{\partial x} = t(1-p\theta)U'(W_N) \tag{3}$$

Then we have different results according to the sign of the f.o.c. We have:

- $\frac{1}{p} > \theta$ implies that $\frac{\partial EU(x,p)}{\partial x} > 0$. It means that the expected utility is increasing in x, thus the agent is willing to not declare a share of his income: $x = x^* > 0$;
- $\frac{1}{p} < \theta$ implies that $\frac{\partial EU(x,p)}{\partial x} < 0$. It means that the expected utility is decreasing in x, thus the agent is willing to declare all his income: $x = 0$;
- $\frac{1}{p} = \theta$ implies that $\frac{\partial EU(x,p)}{\partial x} = 0$. It means that the expected utility is constant over x, thus the agent is indifferent between evading and not evading: $x \in [0; \omega]$.

- In the presence of ambiguity:

The expected utility of the ambiguity loving and averse agent becomes :

$$E_F[\Phi(EU(x,\pi))] = \int_{\underline{\pi}}^{\bar{\pi}} \phi((1-\pi)U(W_N) + \pi U(W_A)) \, \mathrm{d}F(\pi, p) \tag{4}$$

However the expected utility of ambiguity neutral agents remains the same to the one in a risky situation[11]. The agents have unbiased beliefs and $\phi(.)$ is linear: $EU(x,p) = (1 - E_F(\pi)U(W_N) + E_F(\pi)U(W_A)$ and by assumption $E_F(\pi) = p$.

Facing ambiguity, agents have different behaviors. Indeed according to Rothschild and Stiglitz (1976), a mean preserving spread induces a decrease of x for ambiguity averse agents (as Φ is concave) compared to the risky situation; while for ambiguity loving agents (Φ is convex), it implies a decrease of x. So we can wonder whether there is a mean preserving spread.

We start from the expected utility without ambiguity at the optimal level of undeclared income:

$$\left.\frac{\partial^2 EU}{\partial x \partial \pi}(W)\right|_{x^*} = -\theta t U'(W_A) < 0 \tag{5}$$

Because we have $U(.) > 0, t > 0$ and $\theta > 1$, we conclude that there is a mean preserving spread of the expected utility's distribution. Thus we can sum up all the outcomes as follows:

	$\frac{1}{p} > \theta$	$\frac{1}{p} < \theta$	$\frac{1}{p} = \theta$
Risky situation	$x^* > 0$	$x^* = 0$	$x^* \geq 0$
Ambiguity averse agent	$x^* \geq x^{**} \geq 0$	$x^{**} = 0$	$x^* \geq x^{**} \geq 0$
Ambiguity loving agent	$x^{**} \geq x^*$	$x^{**} > 0$	$x^{**} > 0$
Ambiguity neutral agent	$x^* = x^{**} > 0$	$x^* = x^{**} = 0$	$x^* = x^{**} \geq 0$

Table 1: The behavior of risk neutral agents.

x^* is the undeclared amount of income in a risky situation but not ambiguous and x^{**} is the undeclared amount in a risky and ambiguous situation.

So if $\frac{1}{p} > \theta$, a risk neutral agent will evade a part of his income. In the presence of ambiguity, if he is ambiguity-averse, he will evade less or nothing, while if he is ambiguity loving the agent should evade more than in the risky situation.

If $\frac{1}{p} < \theta$, a risk neutral agent will not evade taxes unless he is ambiguity loving.

In the third case an agent under-declare his income whatever his ambiguity profile and the situation are.

2.3.2 Risk averse agents

A risk averse agent has a concave utility function: $U'(.) > 0$ and $U''(.) < 0$.

- **No ambiguity:**

The agents still have the same expected utility (1). And they maximize it as previously, the first order condition gives:

$$\frac{U'(W_N)}{U'(W_A)} = \frac{p(\theta - 1)}{(1-p)} \tag{6}$$

Therefore we obtain the following outcomes [12]:

	$\frac{1}{p} > \theta$	$\frac{1}{p} < \theta$	$\frac{1}{p} = \theta$
Risky situation	$x^* > 0$	$x^* = 0$	$x^* \geq 0$

Table 2: The behavior of risk averse agents in a risky situation.

[11] We refer to a risky situation to describe a situation in which there is no ambiguity

[12] The details of the derivation are available in appendix

The risk averse agent evades if the inverse of the probability of being caught is bigger (or equal) than (to) the penalty rate.

- **In the presence of ambiguity:**

Similarly to the previous section we have a mean preserving spread of the distribution of the expected utility. Then, ambiguity loving agents are willing to increase their undeclared income compared to risk, while ambiguity averse agents are willing to decrease x.

$$\frac{\partial^2 EU}{\partial x \partial \pi}(W)\bigg|_{x^*} < 0 \tag{7}$$

So we deduce that:

	$\frac{1}{p} > \theta$	$\frac{1}{p} < \theta$	$\frac{1}{p} = \theta$
Risky situation	$x^* > 0$	$x^* = 0$	$x^* \geq 0$
Ambiguity averse agent	$x^* > x^{**} \geq 0$	$x^{**} = 0$	$x^{**} \geq 0$
Ambiguity loving agent	$x^{**} > x^*$	$x^{**} > 0$	$x^{**} > 0$
Ambiguity neutral agent	$x^* = x^{**} > 0$	$x^* = x^{**} = 0$	$x^* = x^{**} \geq 0$

Table 3: The behavior of risk averse agents.

x^* is the undeclared amount of income in a risky situation but not ambiguous and x^{**} it the amount undeclared in a risky and ambiguous situation.

For the ambiguity neutral agents, the outcomes are similar to those for the risky situation because ambiguity neutral agents do not care about the presence of ambiguity. Moreover we find a close behavior of risk averse agents to risk neutral agents.

2.4 Consequences of inequity on the behavior of tax evaders

Here we add to the previous model the concept of inequity. We use the modeling of Cowell(1992). Before evading individuals consider the ratio of taxes paid with respect to the level of available public goods and services. This idea comes from the *exchange relationship hypothesis* of Wallschutzky (1984). It consists in paying taxes to obtain public goods in exchange. If the taxes paid seem too high to the agent, he has incentive to evade taxes so as to restore his optimal level ratio. Tax evasion is a cast as a response to an unjust taxation of agents. Inequity i is modeled as follows:

$$i = \Gamma(t, g) \tag{8}$$

This function (Γ) is increasing in the level of taxation (t), and decreasing in the individual's perceived share of public goods (g). g depends on the overall quantity of available public goods in the economy (G). This overall quantity is defined by the fiscal revenue of the State that is affected by evasion.

$$G = t\bigg(\int \omega dW(\omega) - [Xt(1-\theta p)]\bigg) \tag{9}$$

With $W(\omega)$ the distribution of wage in the economy. And X the level of tax evasion:

$$X = \int x^*(\omega, p, i) dW(\omega) \tag{10}$$

So the global supply of public goods and services (equation 9) is a share of the sum of the global wealth minus the global evasion.

Now we rewrite the expected utility of individual taking inequity into account.

$$EU(x,i) = (1-p)U(W_N, i) + pU(W_A, i) \tag{11}$$

We assume that when the inequity increases, the agent is worse-off ($\frac{\partial U}{\partial i}(.) < 0$).

- without ambiguity, agents behave as follows:

Thanks to the comparative static of the first order condition given by the optimization of equation 11 with respect to i, we obtain the change of the evaded level when the level of inequity varies: [13]

$$\frac{dx}{di} = -\frac{(1-p)\frac{\partial^2 U}{\partial x \partial i}(W_N, i) + p\frac{\partial^2 U}{\partial x \partial i}(W_A, i)}{(1-p)t^2\frac{\partial^2 U}{\partial x \partial x}(W_N, i) + pt^2(1-\theta)^2\frac{\partial^2 U}{\partial x \partial x}(W_A, i)} \tag{12}$$

Here we are not able to determine the sign of this deviation. Indeed without an explicit form of the utility function, we do not know whether $\frac{\partial^2 U}{\partial x \partial i}$ is negative or positive. That's why in section 4 we define an explicit function.

According to Cowell, we should have $\frac{dx}{di} < 0$: if the inequity rises because of a public good supply decrease, the agent perceives it as a decrease of his full income since less public good is available to him. This lowers his own wealth and he evades less because this reduction of wealth makes him less willing to evade. But this result is true for risk averse agents as they have a decreasing absolute aversion of risk.

In order to reach the same conclusion concerning risk averse agents we should assume that $\frac{\partial^2 U}{\partial x \partial i}(.) < 0$. This assumption is not obvious if we consider inequity as a negative externality. A negative externality affects everyone, and makes agents worse-off. In our situation if the State supplies less public goods without changing the tax rates, everyone suffers from inequity.

Thanks to those assumptions, we conclude that in the presence of inequity risk averse agents should reduce the share of undeclared income while risk loving agents should evade more as they like risky situation even more when their wealth decreases.

- with ambiguity :

In the presence of ambiguity, the agents should behave similarly to the previous sections, as the presence of ambiguity does not impact the exchange between the State and individuals. But once again we cannot conclude without more specification.

3 Advice to the State

In this part we derive the comparative statics of the previous first order conditions so as to advise policy makers about the optimal fiscal policies. Before taking into account ambiguity, we focus on the simpler case without ambiguity.

Reminder: the first order condition of the maximisation problem 2 is:

$$(1-p)tU'(W_N) + tp(1-\theta)U'(W_A) = 0$$

For the following subsections, the details of the computations are displayed in appendix C.

[13] All details of the derivation are in the appendix

3.1 The effect of a fiscal policy change in a risky situation

3.1.1 Concerning a change of audit probability

We want to determine how the amount of evaded taxes changes when the probability of audit varies. By using the implicit function theorem, the comparative static according to p gives :

$$\frac{dx}{dp} = \frac{tU'(W_N) + t(\theta - 1)U'(W_A)}{(1-p)t^2U''(W_N) + pt^2(1-\theta)^2U''(W_A)} \tag{13}$$

Whichever is the profile of the agent, we have: $U'(.) > 0, \theta > 1$ and $1 > t > 0$, so:

$$tU'(W_N) + t(\theta - 1)U'(W_A) > 0$$

Then p is a probability so $0 < p < 1$ and so does $1 - p$. Since the sign of the denominator depends on $U''(.)$. We conclude that:

- for risk averters ($U''(.) < 0$), $\frac{dx}{dp} < 0$ the more the probability increases the less the agent evades;
- for risk loving agents ($U''(.) > 0$), $\frac{dx}{dp} > 0$ the more the probability increases the more the agent evades;
- for risk neutral agents ($U''(.) = 0$), we cannot conclude about the sign of $\frac{dx}{dp}$, but it is an expected result as risk neutral agents are indifferent between evading or not.

Given the proportion of population that are risk averse or risk loving, the State can choose the optimal way to decrease evasion. It means that if we consider that a majority of people are risk averse, the State can reduce evasion simply by increasing the audit frequency.

3.1.2 Concerning a change of penalty rate

We analyse the consequences of a change in penalty rate on evasion. We use the same method as in the previous part.

$$\frac{dx}{d\theta} = \frac{tpU'(W_A) + pt^2(1-\theta)xU''(W_A)}{(1-p)t^2U''(W_N) + pt^2(1-\theta)^2U''(W_A)} \tag{14}$$

The sign of the denominator depends on $U''(.)$. The numerator is positive if and only if: [14]

$$1 > t(\theta - 1)xA(W_A) \tag{15}$$

This condition always holds as $1 > t > 0$. Then we deduce the sign of the derivative of $x(.)$ with respect to θ:

- for risk averters ($U''(.) < 0$ and $A(.) > 0$), $\frac{dx}{d\theta} < 0$ the more the penalty increases the less the agent evades;
- for risk loving agents ($U''(.) > 0$ and $A(.) < 0$), $\frac{dx}{d\theta} > 0$ the more the penalty increases the more the agent evades;
- for risk neutral agents ($U''(.) = 0$), as expected we cannot conclude about the sign of $\frac{dx}{d\theta}$.

After having reviewed the case with no ambiguity, we will now deal with the ambiguous case.

[14] We define the absolute risk aversion by $A(.) = -\frac{U''(.)}{U'(.)}$

3.2 Rules to follow in an ambiguous situation

Regardless the characteristics of the agent, the second derivative of the expected utility according to the ambiguous probability at the point x^* remains the same:

$$\frac{\partial^2 EU}{\partial x \partial \pi}(W)\bigg|_{x^*} = -tU'(W_N) - (\theta - 1)tU'(W_A)$$

From this formula and the previous results, we deduce some rules to comply with in the presence of ambiguity.

Proposition 1 ***Risk averse agents*:** Concerning risk averse agents, the optimal fiscal policy is to define the probability of audit and the penalty rate such that $\frac{1}{p} > \theta$. In this case, only ambiguity loving agents would evade. If p and θ cannot be set in this way, the State would reduce the amount of evaded taxes by developing an ambiguous policy. Risk averse agents and ambiguity neutral/averse would therefore evade less. Then increasing the rate of audit and of penalty is an effective way to reduce tax evasion.

Proposition 2 ***Risk neutral agents*:** Risk neutral agents have nearly the same behavior, so the optimal policy is such that $\frac{1}{p} > \theta$. Increasing p or θ is also effective.

4 Example : applying the model

4.1 The specification

We cannot go any further without defining clearly the function, here we implement a numerical example and define properly the utility and ambiguity functions. We use the function forms reviewed by Chakravarty and Roy (2009) that he used as a theoretical basis for his experiment.

4.1.1 The utility function

We define the utility function by:[15]

$$U(y) = y^\alpha$$

The behavior of the agent with respect to risk depends on α:

agent's type	α
Risk averse	$\alpha < 1$
Risk neutral	$\alpha = 1$
Risk loving	$\alpha > 1$

Table 4: The agent's characteristic according to the parameter of the utility function

This shape of utility enables us to remove the wealth effect as the Arrow-Pratt relative risk aversion index is constant and equal to $1 - \alpha$.

4.1.2 The ambiguity function

The function modeling ambiguity *à la KMM*, is:

$$\phi(z) = z^\rho$$

The agent's preference about ambiguity depends on ρ.

[15]We ignore the shape of the utility in case of loss, as by assumptions our agent cannot make losses.

agent's type	ρ
Risk averse	$\rho < 1$
Risk neutral	$\rho = 1$
Risk loving	$\rho > 1$

Table 5: The agent's characteristic according to the parameter of the ambiguity function

And for the second order probability distribution, we choose a uniform cumulative distribution:

$$F(\pi,p) = \begin{cases} \frac{\pi-\underline{\pi}}{\bar{\pi}-\underline{\pi}} & \text{if } \pi \in [\underline{\pi},\bar{\pi}] \\ 0 & \text{if } \pi < \underline{\pi} \\ 1 & \text{if } \pi > \bar{\pi} \end{cases}$$

Now we can rewrite the global expected utility in the presence of ambiguity as:

$$E_F[\Phi(EU(x,\pi))] = \int_{\underline{\pi}}^{\bar{\pi}} \phi(EU(x,\pi))\,\mathrm{d}F(\pi,p) \tag{16}$$

$$= \int_{\underline{\pi}}^{\bar{\pi}} \frac{1}{\bar{\pi}-\underline{\pi}} \Big(\pi(W_A)^\alpha + (1-\pi)(W_N)^\alpha\Big)^\rho \,\mathrm{d}\pi \tag{17}$$

4.1.3 Modelling inequity

According to the model chosen for inequity, we have to define a function determining the inequity index (i) and how to implement it in the utility function. Then the modeling has to fill up two conditions: Γ has to be increasing in the level of taxes (t) and decreasing in the individual's perceived share of public goods (g). So, we define:

$$i = \Gamma(t,g) = \frac{t\omega}{g} \tag{18}$$

$t\omega$ is the amount of taxes paid.

If $i < 1$, the State is very generous, the agents get more than what they contribute to. If $i = 1$ there is no inequity. And if this ratio is over one, the agent perceives inequity: he does not observe enough public good for the taxes paid.

Then according to the previous reflexion, the utility function has to comply with two conditions:

$$\frac{\partial U}{\partial i} < 0 \qquad\qquad \frac{\partial U^2}{\partial x \partial i} < 0$$

Thanks to the process Fehr-Schmidt model described in the article of Trautmann (2009), we define U in presence of inequity as follow:

$$U(W,i) = \Big(W - \gamma x \max\{i-1;0\}\Big)^\alpha$$

With $\gamma > 0$ otherwise, the agent would enjoy inequity. We did not follow the exact specification as it would be difficult to compare each agent one another. That's why we choose to replace the difference between the payoff of two agents by the difference between 1 and i. If i is over one, the agent find the State unfair thus his welfare is negatively impacted. And if i is equal to 1, there is no change on his well-being. Then we multiply the term depending on i by x in order to have an interaction between inequity and evasion: if there is inequity, the gain of evading is bigger, it is increased by γi. The previous conditions are checked in the appendix D.1.

Box.1: The process Fehr-Schmidt model

This model describes preferences for fair outcomes without taking into account how they are obtained. It assumes that agents are looking for as more equitable outcomes as possible. Consider two agents A and B with respective payoffs x and y.The utility of the agent A is given by:

$$U_A(x,y) = x - \alpha_A \max\{y-x;0\} - \beta_A \max\{x-y;0\}$$

With $\beta_A \in [0;1[$ and $\beta_A \leq \alpha_A$ We have the same utility function for the agent B.
If both agents have inequale payoffs, the agents are worse-off. There exists a tradeoff between selfishness and equity. Nevertheless the disadvantgeous situation for the concerned agent weights more as $\beta_A \leq \alpha_A$.

4.2 Computation

For all the section, we define ρ such that:

- for ambiguity averse agents $\rho = 0.5$,
- for ambiguity loving agent $\rho = 5$,
- for ambiguity neutral agents $\rho = 1$.

4.2.1 Checking for the theory

Before simulating our theoretical model with realistic data, we use some obvious values in order to emphasize our theoretical results. We set the parameters as following:

Parameter	Value
the true probability of audit p	0.1
the potential interval of the subjective probability	[0.05;0.15]
the penalty rate θ	{9;10.75}
the tax rate t	0.45
the annual wage θ	180000
the parameter of the inequity function γ	0.3
the level of ineaquity i	1.10

Table 6: The parameters of the first simulation

When $\theta = 9$ we are in the case where $\frac{1}{p} > \theta$, and when $\theta = 10.75$ we are in the case where $\frac{1}{p} < \theta$

- The ambiguous framework:

The results of the simulation are:

	$\frac{1}{p} > \theta$		$\frac{1}{p} < \theta$	
θ	9		10.75	
α	Risk neutral agent $\alpha = 1$	Risk averse agent $\alpha < 1$	Risk neutral agent $\alpha = 1$	Risk averse agent $\alpha < 1$
Risky situation	27 500	5252	0	0
Ambiguity averse agent	27 500	5231	0	0
Ambiguity loving agent	27 500	5426	0	0
Ambiguity neutral agent	27 500	5252	0	0

Table 7: The amount evaded by risk neutral and averse agents.

We observe the expected results:

- The risk neutral and risk averse agents evade a positive amount when $\frac{1}{p} > \theta$, and do not evade in the opposite situation;

- In an ambiguous situation, the risk averse agent declares more income when he is ambiguity averse than in the risky situation. The risk averse agent declares less than the risky situation if he is ambiguity loving;

- We observe the same result between ambiguity neutral and the risky situation as the ambiguity function is linear for ambiguity neutral agents.

- The ambiguous framework with inequity:

Here we test whether our expectations are supported by our model. And we also want to see whether the behavior of agents under ambiguity and inequity is similar to the previous situation. First we sum up the amount of evaded taxes for the several profile of agents. We use the parameters defined in table 6.

	$\frac{1}{p} > \theta$		$\frac{1}{p} < \theta$	
θ	9		10.75	
α	Risk neutral agent $\alpha = 1$	Risk averse agent $\alpha < 1$	Risk neutral agent $\alpha = 1$	Risk averse agent $\alpha < 1$
Risky situation	27272.7	1917	0	0
Ambiguity averse agent	27272.7	1908.6	0	0
Ambiguity loving agent	27272.7	1987	0	0
Ambiguity neutral agent	27272.7	1917	0	0

Table 8: The amount evaded by risk neutral and averse agents with inequity.

We observe that the amount of evaded taxes strongly decreases for the risk averse agents. And it decreases also for risk neutral agents. Our expectations about the implementation of ambiguity are confirmed. Indeed the presence of ambiguity has the same consequences on the behavior of agents in the presence of ambiguity and inequity.

Another consequence is that the threshold penalty over which the agent does not evade is smaller than the one without inequity. Here we plot the graph of the evaded taxes amount vs. the penalty rate for different level of penalty. We observe that the the penalty threshold fastly decreases.

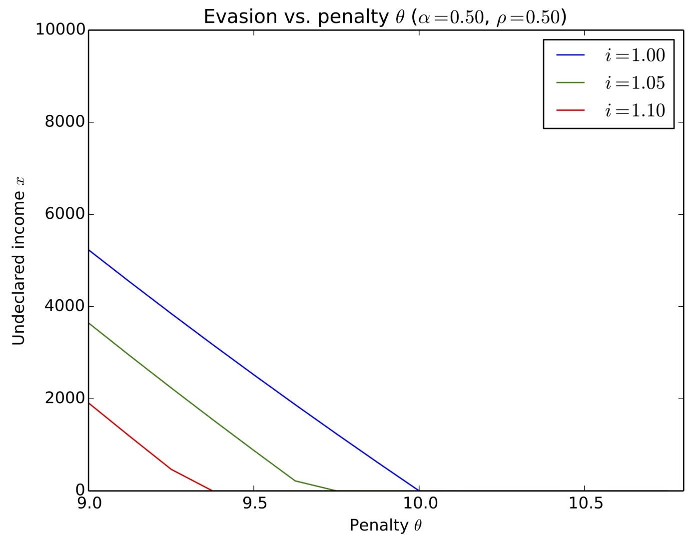

Figure 1: The amount of evaded taxes vs. the penalty rate for different level of inequity.

4.3 Back to the reality

According to l'INSEE, the mean wage in France is of 2225 euros free of charge a month. And the corresponding tax is of 30%. We do not know exactly what the probability of audit is, so let assume it is 10%. Nevertheless we may wonder whether the mean household really evades. As richer agents are more likely to evade taxes, we will assume that our hypothetical agent earns 15 000 euros free of charge a month, which is equals to $\omega = 180000$ euros a year. The corresponding tax rate is $t = 45\%$. To observe significant results we assume that $\theta = 3$. With those parameters we are in the situation where $\frac{1}{p} > \theta$.

The results are the following:

	without inequity		with inequity	
	Risk neutral agent	Risk averse agent	Risk neutral agent	Risk averse agent
Risky situation	110000	102048	106 451.6	97346.5
Ambiguity averse agent	110000	101987.5	106 451.6	97279
Ambiguity loving agent	110000	102528	106 451.6	97 877.6
Ambiguity neutral agent	110000	102048	106 451.6	97346.5

Table 9: The amount of evaded taxes by a "real" agent.

Once again the theoretical and expected results are supported. Nevertheless the specification of the model enables to only observe small variations.

For risk averse and ambiguity averse, we observe that the amount of evaded taxes decreases when the inequity increase. This is what we expected.

4.4 The consequence of increasing the ambiguity around the probability of audit.

When the situation is ambiguous, agents guess the probability of audit. And the available information may help them to define an interval in which the real probability lies. We want to know whether the accuracy of this interval changes the behavior of agents. The length of this interval is in fact the degree of ambiguity. As ambiguity and risk averse agents should be more sensitive to the probability of audit, we focus on them in this section. Concretely, we only change the limits of the integral of the equation 17. In order to compute more cases, we assume that the real probability of audit is $p = 0.2$.

$[\underline{\pi}; \bar{\pi}]$	Optimal amount of evaded taxes
$[0.15; 0.25]$	73239
$[0.1; 0.3]$	72957
$[0.05; 0.35]$	72490

Table 10: The consequences of more ambiguity around the probability of audit.

We observe that the larger the interval, the smaller the amount of evaded taxes. Therefore it seems that more ambiguity tends to increase the compliance of ambiguity risk averse agents. For risk neutral agents, the results do not show changes in the undeclared amount of wage. For ambiguity loving agents and risk averse agents, we observe the opposite result, for more details see the appendix D.3.

5 Discussion

The theoretical results are appropriate as they underline logical results: ambiguity averse agents tend to evade less, while ambiguity loving agents evade more. Our model also provides a limit level of audit probability and/or a limit level penalty over which agents are totally discouraged to evade taxes. So the smooth ambiguity model is appropriate to study the effect of ambiguity on the decision of evading taxes. And it acknowledges the results of Snow and Warren (2005). Our model also tries to explain the variation of the evaded taxes amount when the agent perceives tax policies as unfair. But it fails to clearly conclude about it without further assumptions.

The model is able to give advices to politicians, but it cannot determine the optimal rate of penalty and probability of audit.

The simulation works pretty well, it supports the theoretical results. But a high penalty rate (at least three) is required to well observe the different behaviors of agents. So we may reproach to our simulation that they are far from reality. May be another specification of the model would improve the results. And more information about the real fiscal policy would create better estimates.

Globally our model remains limited as many things account for the decision of agent to evade. Indeed the environment of agent is likely to affect him. If many of the agents' relatives evade taxes, he is more likely to evade. This phenomenon can be related to the study of Alm and Torgler(2005) in which the culture of agents influence their tax compliance.

Then another effect that is not captured by our model, is the substitution between labor and leisure. Before thinking of avoiding, an agent may just reduce his labor offer, so as to pay fewer taxes. In our model, we do not take into account tax avoidance. The choice is binary: the agents evade or not, they have no intermediate mean to reduce their level of taxation.

Nevertheless our model gives realistic intuitions on the behavior of tax evaders under ambiguity. The previous remarks could be the development of further works.

Conclusion

The ambiguity modeling of KMM acknowledge the finding of Snow & Warren(2005): ambiguity on the probability of audit increases the compliance of ambiguity averse agents. Nevertheless all agents are not ambiguity averse. Ambiguity loving agents evade more. Therefore ambiguity about the probability of audit is an effective mean to reduce tax evasion if and only if a majority of agents is ambiguity averse or at least ambiguity neutral.

This model gives some insights of how the perceived fairness of the State may matter in the decision of under-declaring income. If the State is perceived as unfair in the sense that the tax rate is too high for the available commodities, risk averse agents reduce the undeclared amount of income because of a negative wealth effect. But risk loving agents evade even more. We expect similar outcomes in the presence of ambiguity as ambiguity does not change the inequity level.

Our numerical evaluation supports our theoretical results. It confirms the significative effect of the probability of audit and the penalty rate on the behavior of agents.

An empirical application of this model would enable us to evaluate the trustworthiness of our model. It would permit us to confirm whether this modeling of ambiguity is the right one to model the decision of tax evasion, and to observe the effect of inequity.

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A The basic model

Here we detail the derivation to know whether there is a mean preserving spread of the distribution of the expected utility.

A.1 Risk averse agents

We detail the algebra concerning the behavior of risk averse agents.

A.1.1 In a risky situation

The agents have the same expected utility as risk neutral agents: $EU(x,p) = (1-p)U(W_N) + pU(W_A)$. And they maximize it:

$$\begin{aligned}
&\frac{\partial EU(x,p)}{\partial x} = 0 \\
\Leftrightarrow &(1-p)tU'(W_N) + tp(1-\theta)U'(W_A) = 0 \\
\Leftrightarrow &\frac{U'(W_N)}{U'(W_A)} = \frac{p(\theta-1)}{(1-p)}
\end{aligned}$$

If :

- $\frac{p(\theta-1)}{(1-p)} > 1$:

We have $\frac{1}{p} < \theta$. So when $\frac{1}{p} < \theta$, $\frac{U'(W_N)}{U'(W_A)} > 1$ it implies that:

$$\begin{aligned}
&\Leftrightarrow \frac{U'(W_N)}{U'(W_A)} > 1 \\
&\Leftrightarrow U'(W_N) > U'(W_A) \\
&\Leftrightarrow W_N < W_A
\end{aligned}$$

As the agent is risk averse, we know that $U''(.) < 0$ therefore we deduce that $U'(.)$ is decreasing. So:

$$\begin{aligned}
\omega(1-t) + tx &< \omega(1-t) + tx(1-\theta) \\
0 &< -tx\theta
\end{aligned}$$

This implies that x is negative, but this is by assumption impossible, so $x^* = 0$.

- $\frac{p(\theta-1)}{(1-p)} < 1$:

We have $\frac{1}{p} > \theta$. So when $\frac{1}{p} > \theta$, $\frac{U'(W_N)}{U'(W_A)} < 1$ it implies that:

$$\begin{aligned}
&\Leftrightarrow \frac{U'(W_N)}{U'(W_A)} < 1 \\
&\Leftrightarrow U'(W_N) < U'(W_A) \\
&\Leftrightarrow W_N > W_A
\end{aligned}$$

As the agent is risk averse, we know that $U''(.) < 0$ therefore we deduce that $U'(.)$ is increasing. So:

$$\begin{aligned} \omega(1-t)+tx &> \omega(1-t)+tx(1-\theta) \\ 0 &> -tx\theta \end{aligned}$$

This implies that x is positive, so $x^* > 0$.

Those algebra support well the results displayed in the table 3.

A.1.2 In the presence of ambiguity

At x^*, we have:

$$\begin{aligned} \frac{\partial^2 EU}{\partial x \partial \pi}(x,\pi)\bigg|_{x^*} &= \frac{\partial}{\partial x \partial \pi}[(1-\pi)U(\omega(1-t)+tx^*)+\pi U(\omega(1-t)+tx^*(1-\theta))] \\ &= -tU'(W_N)+(1-\theta)tU'(W_A) \\ &= -tU'(W_N)-(\theta-1)tU'(W_A) \end{aligned}$$

We know that $U'(.) > 0$ as the agent is risk averse, $\theta > 1$, so we obtain this result:

$$\frac{\partial^2 EU}{\partial x \partial \pi}(x,\pi)\big|_{x^*} < 0$$

This result acknowledges the fact that there is a mean preserving spread of the distribution of the expected utility.

B The consequences of inequity on the behavior of agents

We develop the computation of the deviation of the evaded amount of taxes according to the level of inequity.

The first order condition of the expected utility maximization problem is:

$$\begin{aligned} &\frac{\partial EU(x,p,i)}{\partial x} = 0 \\ \Leftrightarrow &(1-p)tU'(W_N,i)+tp(1-\theta)U'(W_A,i) = 0 \end{aligned}$$

By using the implicit function theorem according to i, we have:

$$(1-p)\frac{\partial^2 U}{\partial x \partial i}(W_N,i)+p\frac{\partial^2 U}{\partial x \partial i}(W_A,i)+\left[(1-p)t^2\frac{\partial^2 U}{\partial x \partial x}(W_N,i)+pt^2(1-\theta)^2\frac{\partial^2 U}{\partial x \partial x}(W_A,i)\right]\frac{dx}{di} = 0$$

By rearranging, we get the final result:

$$\frac{dx}{di} = -\frac{(1-p)\frac{\partial^2 U}{\partial x \partial i}(W_N,i)+p\frac{\partial^2 U}{\partial x \partial i}(W_A,i)}{(1-p)t^2\frac{\partial^2 U}{\partial x \partial x}(W_N,i)+pt^2(1-\theta)^2\frac{\partial^2 U}{\partial x \partial x}(W_A,i)}$$

C Concerning fiscal policy

Reminder: the first order condition is:

$$(1-p)tU'(W_N)+tp(1-\theta)U'(W_A) = 0$$

C.1 A change in the probability of audit

By using the implicit function theorem, the comparative static according to p gives :

$$\frac{\partial}{\partial p}[(1-p)tU'(W_N)+tp(1-\theta)U'(W_A)]dp+\frac{\partial}{\partial x}[1-p)tU'(W_N)+tp(1-\theta)U'(W_A)]dx=0$$

$$-tU'(W_N)+t(1-\theta)U'(W_A)+[(1-p)t^2U''(W_N)+pt^2(1-\theta)^2U''(W_A)]\frac{dx}{dp}=0$$

The result is:

$$\frac{dx}{dp}=\frac{tU'(W_N)+t(\theta-1)U'(W_A)}{(1-p)t^2U''(W_N)+pt^2(1-\theta)^2U''(W_A)}$$

C.2 A change in the penalty rate

I use the same method of the previous part.

$$\frac{\partial}{\partial \theta}[(1-p)tU'(W_N)+tp(1-\theta)U'(W_A)]d\theta+\frac{\partial}{\partial x}[1-p)tU'(W_N)+tp(1-\theta)U'(W_A)]d\theta=0$$

$$-tpU'(W_A)-pt(1-\theta)(-tx)U''(W_A)+[(1-p)t^2U''(W_N)+pt^2(1-\theta)^2U''(W_A)]\frac{dx}{d\theta}=0$$

The result is:

$$\frac{dx}{dp}=\frac{tpU'(W_A)+pt^2(1-\theta)xU''(W_A)}{(1-p)t^2U''(W_N)+pt^2(1-\theta)^2U''(W_A)}$$

The sign of the denominator depends on $U''(.)$. And the sign or the numerator depends on:

$$tpU'(W_A)+pt^2(1-\theta)xU''(W_A)$$

The numerator is positive if:[16]

$$tpU'(W_A)[1-t(\theta-1)xA(W_A)]>0$$

As $tpU'(W_A)$ is always positive, the condition can be rewritten as:

$$1>t(\theta-1)xA(W_A)$$

Regardless of the profile of the agent, we have: $U'(.)>0, \theta>1$ and $1>t>0$, so:

$$tU'(W_N)+t(\theta-1)U'(W_A)>0$$

Then p is a probability so $0<p<1$ and so does $1-p$. Therefore the sign of the denominator relies on $U''(.)$.

D The specification of the example

D.1 The function modeling inequity

Here we check that the conditions that must be satisfy by the utility function are true.

Let denotes by $Y=W_i-\gamma x\max\{i-1;0\}$ with $i=\{N;A\}$.

$$\frac{\partial U}{\partial i}=-\alpha Y^{\alpha-1}\gamma x \tag{19}$$

[16] We define the absolute risk aversion by $A(.)=-\frac{U''(.)}{U'(.)}$, I replace it in the previous line of algebra.

$$\frac{\partial^2 U}{\partial x \partial i} = \begin{cases} -\alpha\gamma Y^{\alpha-1}\Big((1-\alpha)x(t-\gamma\max\{i-1;0\})Y^{-1}+1\Big) & \text{if } W_i = W_N \\ -\alpha\gamma Y^{\alpha-1}\Big((1-\alpha)x(t(\theta-1)-\gamma\max\{i-1;0\})Y^{-1}+1\Big) & \text{if } W_i = W_A \end{cases} \tag{20}$$

We assume that $t > \gamma \max\{i-1;0\}$, then in the case of risk averse agent ($\alpha < 1$), the algebra in the parenthesis is positive, and $\gamma, \alpha > 0$, so we the both conditions are respected:

$$\frac{\partial U}{\partial i} < 0 \qquad \frac{\partial U^2}{\partial x \partial i} < 0 \tag{21}$$

D.2 Graphics: the expected utility and the amount of evaded taxes

Figure 2: From the left to the right, there are the ambiguity averse, the ambiguity loving and the ambiguity neutral agent. The first line corresponds to risk neutral agent while the second to the risk averse agent.We notice that the "linear" expected utility of risk neutral agents is a bit distorted when the agent is ambiguity averse/loving. There is a concave/convex distortion. We observe the same phenomenon for risk averse agents.

Figure 3: We observe that with those parameters, the amount of evaded taxes goes streight to 0 when $\theta = 10$. There is a breaking point in the curve of neutral agents, which probably due to a lack of accuracy.

D.3 Increasing ambiguity

For risk averse and ambiguity loving agents, we have:

$[\underline{\pi}; \bar{\pi}]$	Optimal amount of evaded taxes
$[0.15; 0.25]$	74092
$[0.1; 0.3]$	76424
$[0.05; 0.35]$	80475

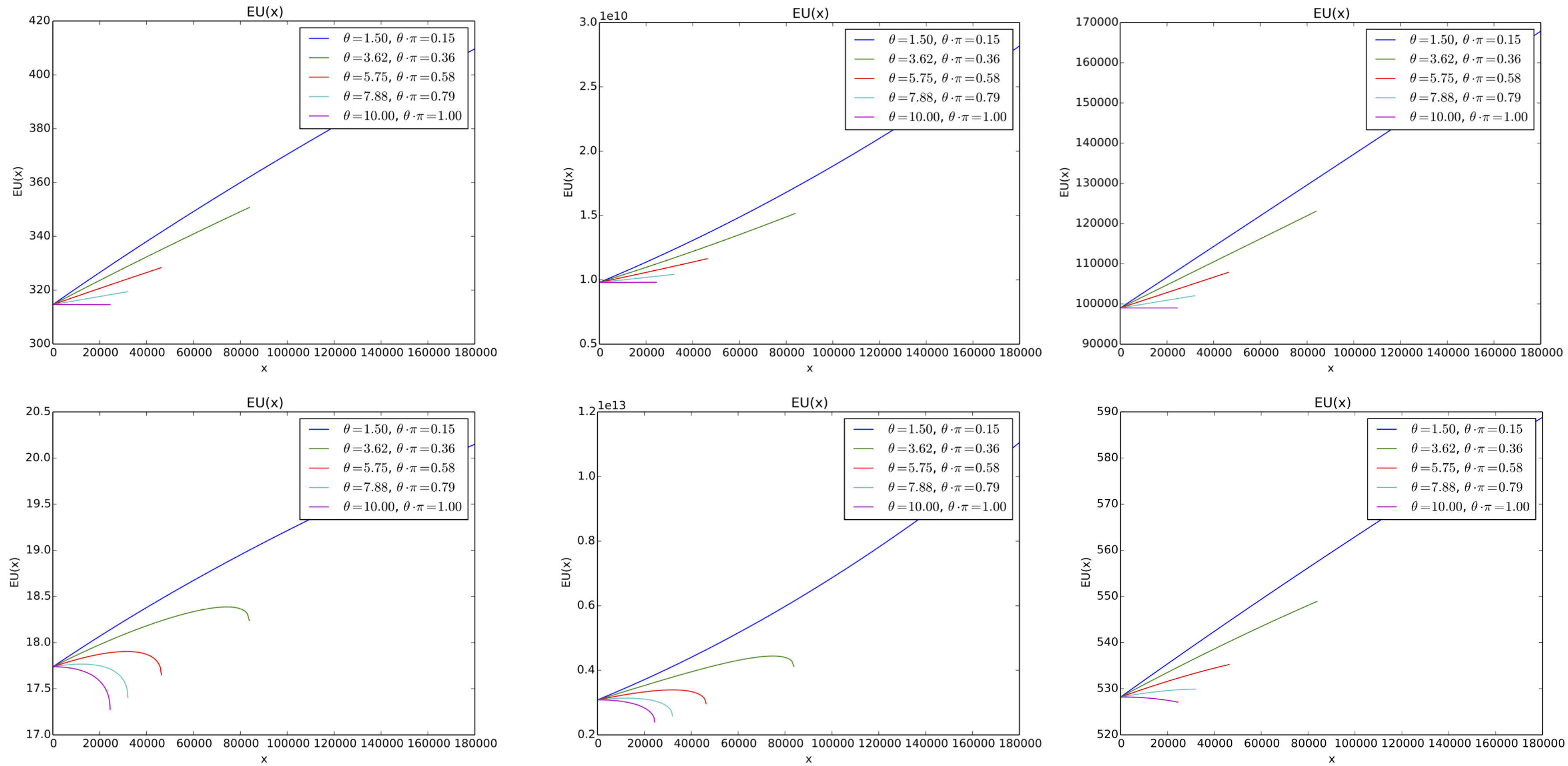

Figure 2: The expexted utility for each type of agents.

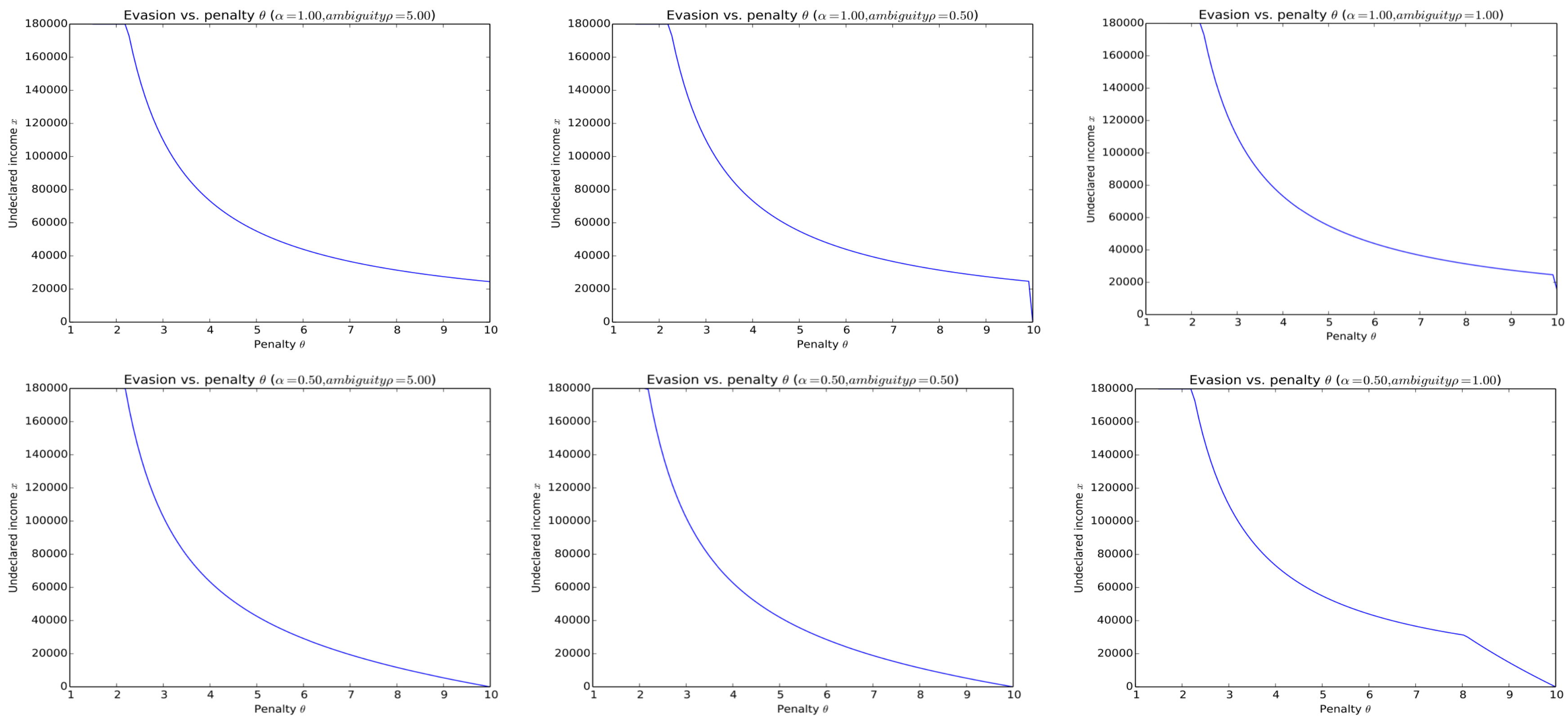

Figure 3: The amount of evaded taxes vs. the penalty rate for all agents'profile.