

Agent's fear monitors the spread of greed in a social network

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Abstract Fear and greed are interconnected in risk situations. People fear the risk of losses in certain circumstances but are seduced to maximize their gains. There is a competition in our brains between both emotions. This article purposes to analyse the relation between both emotions in social network context and using tax evasion as case study. The risk of greed is spread off by imitation in an social network environment. After multiple interactions between taxpayers, results demonstrate fear monitors the spread of greed due to the inherent existence of tax audits. In this sense, fear is the mechanism to avoid tax evasion and guarantee a better compliance in a social network.

1. Introduction

Risk is an important knowledge area, passive to be deeply study. In risk situations where it is money involved people have tendency to fear losses and a big appetite for gains. According Prospect Theory, people compare levels of risk and establish their preferences under an existent status quo, in society[1]. People are risk averse in terms of gains and are risk seekers in their expected losses. This behaviour is called as reflection effect[1]. Reflection effects refer to the finding that people tend to avoid risk in choice options involving gains but tend to seek risk in choice options involving losses. They simple want to preserve the obtained gains and look for opportunities in a scenario of losses. The gain–loss-dependent risk preferences thus are like reverse mirror reflections of each other. Prospect theory assumes an S-shaped value function that is concave over gains and convex over losses, implying diminishing marginal value as the size of gains or losses increases. Thus, the concavity of the value function in gains entails risk aversion and the convexity of the value function in losses entails risk seeking. These predictions based on gains and losses rather than on total wealth have also received strong empiric support

Tax evasion is one of the situations where people face risk and have aversion. It is a risk that is incurred voluntarily, but where taxpayers fear the consequences. If a taxpayer decides to underreport his/ her income, he/she faces a risk of being audited and caught by tax authority. On the other hand, taxpayer can take advantage of the opportunity in having extra-income by cheating tax authority. However some taxpayers make their decision influenced by the environment surrounding them. Apart from the media that bombards with daily news, taxpayers are also influenced by the behaviour of other taxpayers, like friends, inside of their social network. Taxpayers, many times, follow and imitate the current tendency in social

network. Social networks are indeed a good vehicle to spread information, tendencies, values and emotions in society.

In this article, inside of a social network context, we propose to analyse the spread of greed and fear when taxpayers are imitators. Our main goal is to understand the relation between greed and fear and try to check out how a social network behaves in risky circumstances. How does fear interact with greed under imitation in a social network environment?

The article is organised as follows. Next section describes the recent literature about this issue. On section 3, we explain how fear and greed workout in human brains. Section 4 introduces our model and presents the obtained results. Section 5 discusses the achieved results, comparing with other works. Section 6 is reserved to present our conclusions. Finally, on section 7, we describe our future steps, in this research.

2. Social interaction on tax evasion: a review

Since social simulations were implemented using multi-agent systems (MAS) perspective, the agent view became foundational. [2]. The need of establishing a micro-macro link had emerged with a promising future. Fundamentally because interactions between agents' individual minds and consequent behaviours are complex and not trivial, influencing the dynamic in society[3].

Last decade was productive for tax evasion research in what concerns social interaction. A few studies based their simulations models on a MAS approach. Those studies had the main goal to add other dimensions, beside economic theory in tax evasion research, like social interdependency. Imitation was firstly introduced on tax evasion by [4]. They divide taxpayers in three types where one of them was imitators. The relative weight of each agent type was calculated by their fitness through a genetic algorithm. These authors proposed to analyse the effect of an increase in tax rate in each group. Agents utility comes from the income generated externally, the non utility of paying taxes and the utility of consuming public goods.

In their study, [5] sustained and reinforced the argument that tax compliance is achieved through the social behaviour of agents. TCS model created agents composed by a large number of attributes and becomes more tricky in calculating the auditory rate [6]. Its benefit is to allow the link between the model outcomes and effective data. In other study, [7] showed that joining the imitation mechanism with a small percentage of stubborn agents (agents that are resilient to their opinion whatever happened) could be sufficient to strengthen of compliance in global society

In 2006, [2] presented a sequence of models designated by EC* series. These models were built sequentially adding new features to the standard economic model. The intention was to see the impact of each feature in the model. Authors had also considered the imitation concept as one of processes of agents' interaction in society. They verified that in many cases, ethical attitude of taxpayers ex-

plains the reason for compliance. This attitude is more preponderant than the perception they have about tax system.

On the other hand,[8] had included inspectors with autonomy to decide. The article was relevant, since suggested that indirect taxes are unpaid because of the interests collusion between purchasers and sellers.

One year later, NACS model had the intuit to verify the effect of a social structure, in tax compliance behaviour [9]. The author used the Moore neighbourhood structure, where each taxpayer has neighbours around him that affect his choices and decision making. Another model arose as an adaptation of ISING physical model with resemblances to NACS model. Particles were substitute by agents that interact in distinct paths [10]. In this model, taxpayers behaviour depends from others taxpayers actions, on their neighbourhood relations. Authors had found that small levels of enforcement are enough to erase completely tax evasion, independently of the influence that may exist on the part of groups with power in society.

The TAXSIM model, proposed four sorts of agents complemented with some innovative factors like the degree of satisfaction with public services, since it was declared as one of principal reasons to not comply [11]. The degree of satisfaction depends from the previous experiences of each agent, influenced by his social network.

More recently, a different model had appeared, based on four different decisional mechanisms: expected utility maximization, social network structure, decisional heuristics, heterogeneity of tax motivations and morale [12].

Finally, [13], had developed a model where social interaction remains an important relevance on tax evasion. Her model retrieved that tax evasion can increase when public goods supplying increase. This result contrasts with what is referred in literature. She claims that back auditing has the strongest impact in tax evasion dynamics.

3. Fear and greed working on

Fear and greed are both, examples of emotions revealed by human beings. They are supposed, together with herd instinct, to be the three main emotional motivators of irrational decisions. How those two alternating emotions work for risk workers, and how they can distort their decision process, has been the subject of neuroeconomics studies [14]. More generally, those researches show some primacy of emotion over cognition in decision making. Hope and fear explain the alternations on extreme expectations.

3.1. Fear definition

Fear is induced by a threat which causes individuals retraction and where they do everything to omit this emotion from other individuals. It is a basic survival mechanism occurring in response to a specific stimulus, such as pain or the threat

of risk. Fear is the ability to recognize risk leading to the fight-or-flight response.[15]. However, in extreme cases of fear a freeze response is possible.

Fear is normally related to the specific behaviour of avoidance, whereas anxiety is the generated output of threats which are perceived to be uncontrollable or unavoidable. [16] It is also apparent that fear is always associated to future events, where worst expectations are generated. Or when is unacceptable to continue some situation. Instead, fear can also be an instant reaction to something presently happening. Individuals have capacity to react instinctively to potential risk, which is in reality the key mechanism for their survival. The reactions caused by fear should be seen as advantage behaviours and inducers of human evolution. [17]. Fear can be a manipulating and controlling instrument in an individual's life [18]. Cultural influences and our past experiences affect the fear generation. From an evolutionary psychology perspective, different fears may have different adaptations that were useful in our evolutionary past. Fear is high only if the observed risk and seriousness are high and is low if one or the other of the seen risk or seriousness is low[19].

3.2. Fear in human brains

People develop specific fears as a result of learning. There are studies showing the areas of the brain that are affected by fear. When looking at these areas, it looks like that an individual learns to fear independently if they have experienced risks, or if they have observed the fear in others.[20] Amygdala was the region affected when both experiences occurred. Amygdala is the brain structure where it is focus, most of the neurobiological occurrences associated with fear. The role of the amygdala in fear is to be a component of a circuitry of fear learning. [17] It is essential for proper adaptation to risk and specific modulation of emotional learning memory. In the presence of a threatening stimulus, the amygdala generates the secretion of hormones that influence fear and aggression. After stimulated amygdala and fear spread, this can cause the release of hormones by the body of an individual, activating his/her alertness and raising his/her reaction. This defensive response is generally referred in physiology as the fight-or-flight response regulated by the hypothalamus. [21] When the individual has no longer any potential threats surrounding him/her, the amygdala will send this information to the medial prefrontal cortex where it is stored for similar future situations. The storing of memory in the medial prefrontal cortex is known as consolidation memory.

3.3. What is greed?

Greed is commonly considered as an inordinate desire to possess wealth, goods, or objects of abstract value, with the objective to keep it for one's self, far beyond the dictates of basic survival and comfort. It is applied to a sharp high desire and pursuit wealth, status and power. Psychologically, greed resembles, an inordinate desire to acquire or possess more than one needs. The degree of inordi-

nance is related to the inability to control the ambition, since the pretended needs are eliminated. The purpose for greed, and any actions associated with it, is possibly to deprive others of potential means perhaps the basic survival or future opportunities. Alternately, the purpose could be defence or counteraction from risk or danger. The consequence of greedy activity can be the inability to sustain efforts associated with what was or is being driven. So, the level of "inordinance" of greed pertains to the amount of vanity, malice or burden associated with it.

3.4. Greed in human brains

There are no feasible studies relative to the workflow in our brains about greed. Many are suppositions. It is known that the mechanisms inside the brain are very complex in what concerns to greed. We know for instance, there are neurochemicals that increase or decrease libido. It is supposed that greed acts like power on the brain's reward system, which if over-stimulated for long periods develops appetites that are difficult to satisfy, like drug addiction. Holding power interferes in our brains by boosting testosterone, which in turn increases the chemical messenger dopamine in the brain's reward system. For instance, greed is fuelled by dopamine, a busy hormone. The anticipation of a reward shoots off dopamine that makes individuals feel good. In fact, it is so intensive that often if individual actually wins the award, he/she will feel a disappointment. Greed also inactivates frontal cortex along with some other cortical areas of the brain that control shame and regret. But, when inactivated, neither shame nor regret are felt. The greed system of the brain then operates uncontrolled according to its own laws. When given stingy offers, the anterior insula that is associated with negative emotions was activated [22] Greed is only part of the puzzle. It can be trumped by other emotions such as injustice.

4. The greed fear interaction model

This model demonstrates the spread of greed through a social network. Although the model is somewhat abstract, one interpretation is that each node represents a taxpayer, and we are modelling the progress of greed through this network. Each taxpayer may be in one of three states: susceptible, greedy or resistant.

4.1. Model description

In each time step, a greedy taxpayer, using red colour attempts to persuade all the neighbours in his/her social network. Susceptible taxpayers, described by green colour will imitate with a probability given by the greed-spread-chance slider. This might correspond to the probability that someone considered susceptible to be seduced by greed and take risk in tax evasion. Resistant or risk averse taxpayers, coloured gray have fear in taking risk and will not imitate the greedy taxpayers. These taxpayers correspond to the ones that have high aversion of be-

ing audited by tax authority. Their fears are supposed to make them immune to greed.

Greedy taxpayers are not immediately aware that they are possessed by greed. From time to time these taxpayers become aware of their greed. This frequency is determined by the risk-perception frequency parameter. This may find correspondence into a taxpayer regularly scheduled risk perception, where he/she simply weigh the benefits of greed and the risk taken for his/her aversion level. When a taxpayer is audited by tax authority, the fear has been stimulated and there is a probability that the greed disappear momentarily. This probability is determined by the fear impact. It is important to point out the assumption that caught taxpayers may or may not control forever they greed. This assumption comes from the tax system in some countries where taxpayers are punished and get awareness or guilty of their acts.

If a taxpayer faced fear and does “recover” from greed, there is some probability that he/she will become resistant to greed in the future, because fear hath seized on him/her. This is given by the risk-averse-chance. When a taxpayer becomes resistant, the links between it and its neighbours are darkened, since they are no longer possible vectors for spreading the greed. So fear impact establishes a probability to erase greed momentarily and risk-averse-chance gives the probability of a taxpayer that erased greed momentarily, given his/her fear, becomes resistant to greed in future interactions.

In this model, we choose the number of taxpayers in social network and the average number of possible imitations coming out of each taxpayer. This is given by the links established among taxpayers. The social network that is created is based on proximity between taxpayers, using Euclidean distance. A taxpayer is randomly chosen and connected to the nearest taxpayer that it is not already connected to. This process is repeated until the social network has the correct number of links to give the specified average taxpayer degree. The initial-greedy-taxpayers parameter determines how many of the taxpayers will start the simulation as greedy agents. After these arrangements we are in conditions to create the social network and run the model. The model will stop running once the greed has been completely abolished.

In this model the spread of greed inside network is done under some conditions. First taxpayers must be holders of greed. Second, they must to be linked to non resistants, Finally, the last condition is if the greed generated randomly is below of the greed spread chance the taxpayer will become greedy.

Additionally, if a taxpayer has his fear impact and risk-averse-chance below fear impact parameter and risk-averse-chance parameter respectively, he/she becomes resistant otherwise becomes susceptible. Of course this reason only makes sense if a taxpayer has greed and perception frequency is equal to zero.

4.2. Output Results

In order to run our model we opted by using a small social network with few greed taxpayers (3) in a total of twenty taxpayers, where each one can imitate in average 3 taxpayers.

After running several times the model and using multiple combinations results revealed that greed could never be removed from network. There are some scenarios that point out for this situation. One of the scenarios is when the probability of having fear is zero, the fear impact is 10%, the greed spread is 5% and risk perception of taxpayers is 20 ticks. [see figure 1]

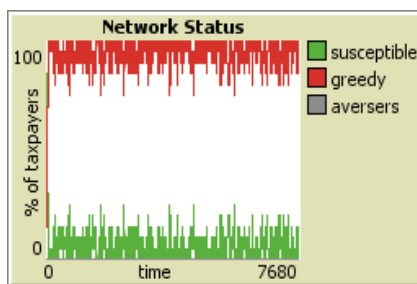


Figure1-Network Status: Greed is never removed. Risk aversion chance equal to 0%, Fear impact is 10%, greed spread is 5% and risk perception frequency is 20 ticks.

Another scenario where greed is not removed is when all probabilities are equal to zero and it is only one tick in risk perception parameter. The difference from the above scenario is the fact that percentage of greedy taxpayers is considerable lower and stable during interactions inside network.(see figure 2) The same output is obtained when risk perception check is 1.

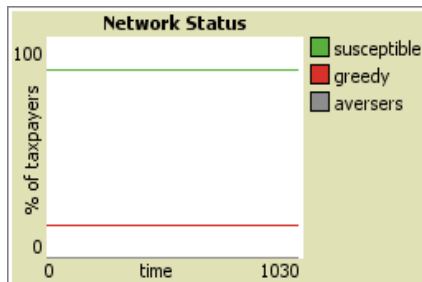


Figure2-Network Status: Greed not removed. Risk Aversion equal to 0%, fear impact is 0%, greed spread is 0% and risk perception frequency is 20 ticks.

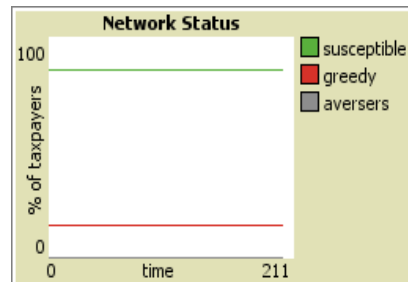


Figure3-Network Status: Greed not removed. Risk Aversion equal to 0%, fear impact is 0%, greed spread is 0% risk perception frequency is 1 ticks.

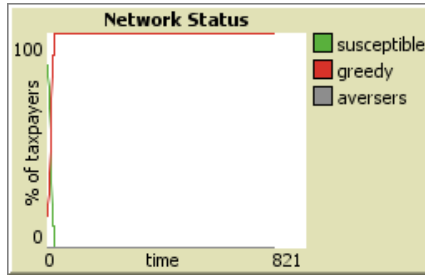


Figure4-Nerwork Status: Greed not removed. Risk aversion equal to 0%, fear impact is 0%, greed spread is 10% and risk perception frequency is 20 ticks.

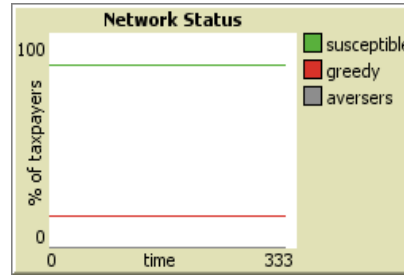


Figure5-Nerwork Status: Greed not removed. Risk aversion equal to 100%, fear impact is 0%, greed spread is 0% and risk perception frequency is 1 ticks.

Figure 4, shows the scenario where the spread of greed is 10% and risk perception frequency is 20 ticks, all the taxpayers in network become greedy in a stable value.

Results also show that when the probability of spreading greed in network is 10% only the fear impact can removed greed from network. This condition is achieved when this probability is greater than 5%. As we can see on figure 5, greed is never removed from network when fear impact is 5%. It is only removed when this parameter assumes a value greater than 5,5%. (see figures 7, 8 and 9)

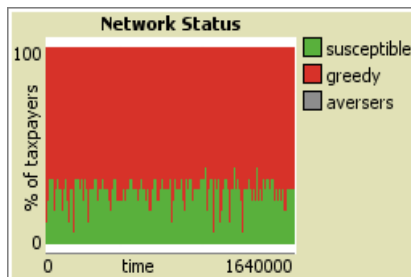


Figure6-Nerwork Status: Greed removed. Risk aversion equal to 0%, fear impact is 5%, greed spread is 10% and risk perception frequency is 1 ticks.

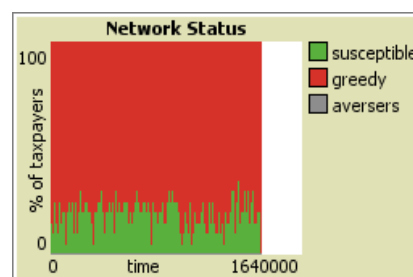


Figure7-Nerwork Status: Greed removed. Risk aversion equal to 0%, fear impact is 5,5%, greed spread is 10% and risk perception frequency is 1 ticks.

At 10% of fear impact, the greed is removed rapidly from network. [see figure 10] The results also show that volatility in each taxpayers type decreases as the fear impact increases. Figure 9, shows also the number of greedy taxpayers automatically decreases when it starts the interaction.

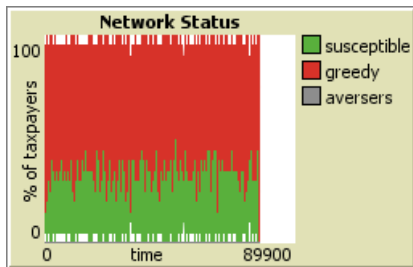


Figure8-Network Status: Greed removed.
 Risk aversion equal to 0%, fear impact is 6%,
 greed spread is 10% and risk perception frequency is 1 ticks.

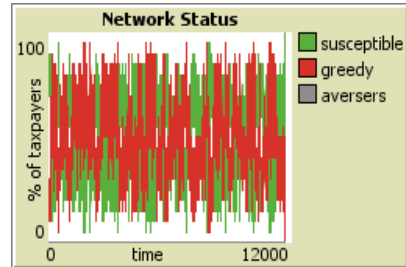


Figure9-Network Status: Greed removed.
 Risk aversion equal to 0%, fear impact is 7,5%,
 greed spread is 10% and risk perception frequency is 1 ticks.

Figure 11 describes that if risk aversion chance is 100% and fear impact is 0%, then greed is never removed and stabilizes quickly in a maximum level..

On the other hand, figure 12 states that if greed spread changes to 0% and the risk aversion chance to 100% greed remains constantly in social network and does not disappear. Unlike, Figure 13 shows that there if exists just 1% of fear in being audited, the number of greedy taxpayers disappears from the social network. Even if they do not resist coming back again and to be greedy.

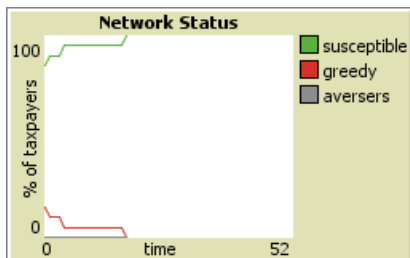


Figure10-Network Status: Greed removed.
 Risk aversion equal to 0%, fear impact is 10%,
 greed spread is 10% and risk perception frequency is 1 ticks.

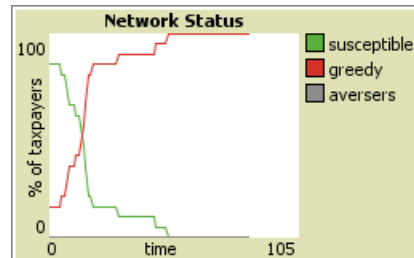


Figure11-Network Status: Greed never removed.
 Risk aversion equal to 100%, fear impact is 0%,
 greed spread is 10% and risk perception frequency is 1 ticks.

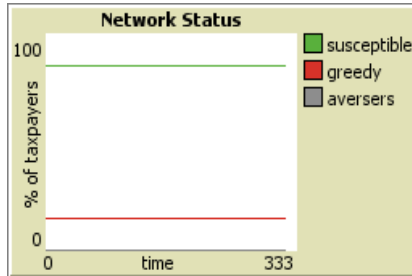


Figure12-Nerwork Status: Greed not removed. Risk aversion equal to 100%, fear impact is 0%, greed spread is 0% and risk perception frequency is 1 ticks.

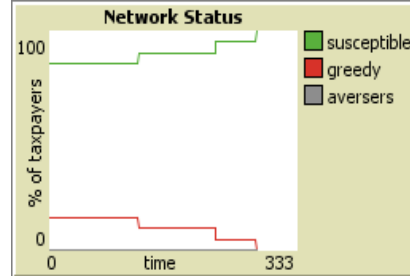


Figure13-Nerwork Status: Greed removed. Aversion probability equal to 0%, fear impact is 1%, greed spread is 0% and risk perception frequency is 1 ticks.

Many are the simulations that could be carried out, however these results are focused in the scope of the problem, trying to answer its questions.

5. Discussing Results

The presented results allow us to note some facts quite sui generis. First of all greed could be removed definitively from a social network. To make it happen it is enough a fear impact of 5,5% for greedy taxpayers become fearful of being audited. Even if the probability to remain resistant to greed, in future is 0%. It means that in future, even susceptible taxpayers remain not fearful and vulnerable to greed, the fact of one taxpayer has been audited by tax authority generates in himself fear. Fear that is propagated by social network. In this sense, only audits can eradicate greed from social networks, because it will stimulate fear in taxpayers. This evidence suggests that if tax authority wants to be effectiveness and efficiently, it must plan its audits based in clusters of taxpayers which are socially related. Since it only needs to audit one taxpayer to generate fear in social network that he or she belongs. Thereby achieving the vanish of greed and reducing tax evasion.

However results also demonstrate in some scenarios, greed could not be eradicate from social network increasing the propensity to tax evasion. This happens when the spread of greed is sufficient high to cancel the fear effect coming from a tax audit combined with fact of higher risk in a taxpayer still greedy. Even if taxpayer think a lot and judges about his/her own greedy behaviour and the percentage of risk aversion is null.

Clearly, simulations demonstrates that exists a rivalry between greed and fear that influences the propagation or not of a tax evasion in a social network. The greed dissemination on a network is only avoided if the fear generated impact by a tax audit is stronger enough to suppress itself. The relation is achieved having fear impact as more than half of greed spread.

Another interesting result is to verify that the existence of some taxpayers in network with risk aversion which is not sufficient to eliminate greed. Only tax audit can stimulate the fear to finish greed proliferation in network. This fact, even inside of other perspective raise some issues about the findings of [7]. In the same way, making judgments about greed risk is not sufficient to stop greed in social network. These facts launches some interesting thoughts. First gaining resistance, in future, to greed is useless compared with fear impact. This brings us to justify greed temptation is only fought by concrete situations of fear. Besides we can also thought that a negative occurrence in a social network is more powerful than positive occurrences. Finally, greed and fear, as emotions disseminated in a social network, can relegate our judgements into a second plan.

The presented results are in line with the argument made by [5]. Tax compliance is achieved through the social behaviour of agents. There are also in consonance with [10] achievements.

6. Conclusions

In this article we proposed to analyse the dynamic between greed and fear on tax evasion, when taxpayers are members of a social network. The preliminary results demonstrated the existence of a competition between greed and fear. It also shows fear as the emotional mechanism to “win” this competition. Fear monitors the spread of greed in a social network. In this sense, and extrapolating an audit can generate the sufficient fear in a social network in order to avoid greed and consequent tax evasion. Simulations suggest that tax evasion can be avoided more efficiently, if tax authority audits on a proportion of taxpayers belonging to a social network.

7. Future work

This article presented preliminary results which allow us to make some important considerations. Next step is to analyse the ratio between susceptible taxpayers and resistant taxpayers and how links among taxpayers can influence it. We are going to analyse the case when the number of taxpayers in a social network increases and also the number of greed taxpayers.

Other objective is to model other emotions involved in tax evasion and check how would these emotions interact.

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