A CREDIT DESIGN FOR IRRATIONALLY PESSIMIST ENTREPRENEURS

A Master's Thesis

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A CREDIT DESIGN FOR IRRATIONALLY PESSIMIST ENTREPRENEURS
İRRASYONEL KARAMSAR GİRİŞİMCİLER İÇİN KREDİ TASARIMI

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Abstract

In this thesis, we propose a mechanism alternative to stimulate the economy by encouraging pessimist entrepreneurs when the economic activities start to slowdown. We present a credit design which involves two types of agents, banks and the government. We differentiate between two types of agents, the irrationally pessimist entrepreneurs and the rational ones. We define pessimism through rank dependent utility and we use a particular setting where there are only three states of nature. Our main purpose is forming a contract between government and pessimist entrepreneurs, which consists of two possible transactions, withholding profit and financial support. As a result, we find that it is possible to incorporate the pessimist agents into the economy without affecting the rational entrepreneurs by definite restrictions.

Key Words: Pessimism, mechanism design, economic crisis, crediting

Özet

Bu tez çalışmasında, ekonomik aktivitelerin durgunlaşmaya başladığı dönemlerde karamsar yatırımcıları teşvik ederek ekonomiyi canlandıracak alternatif bir mekanizma önerilmiştir. Karamsar ve rasyonel olmak üzere iki tip ajanı, devleti ve bankaları içeren bir kredi modeli tasarlanmıştır. Karamsarlık sıra-bağımlı fayda modeli ile tanımlanmış ve ekonominin üç durumunu içeren bir model oluşturulmuştur. Çalışmanın temel amacı, devlet ile karamsar ajanlar arasında kar kesintisi ve mali destek olmak üzere iki olası işlemden oluşan bir kontrat oluşturmaktır. Sonuç olarak, rasyonel yatırımcıyı etkilemeden karamsar ajanları teşvik etmenin belirli sınırlamalarla mümkün olabileceği görülmüştür.

Anahtar Kelimeler: Karamsarlık, mekanizma tasarımı, ekonomik kriz, kredi

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Contents

1 Introduction

One of the most crucial problems of an economy is finding an efficient and feasible solution for stimulating the economy when the economic activities start to slowdown. For a well-functioning economic system, it is essential to keep all economic factors at balance such as inflation, interest rate, supply-demand relation, unemployment rate and so on. On the other hand, agents' behaviours also have a critical role for the state of the economy. They tend to behave timidly when the economic indicators devolve. This may affect the economic stability adversely. The next question is "Why economic balance is so important for the economic environment?". Because, if one of these factors deviate from equilibrium or the agents do not maintain their economic activities, they may cause the deterioration of the economy.

In the literature, there is extensive research suggesting different approaches for this issue, and there are different applications of these models. U.S government's bailouts, which was used as a major tool during the 2008 economic crisis is a good example government intervention for maintaining economic stability. During the crisis, U.S government chose to support the banks and financial institutions to avoid the deepening of the economic crisis. It was foreseen that letting financial institutions fail would exacerbate the crisis because of the economic connection between institutions. However, this intervention was not enough for the recovery of the economy. Therefore, some researchers (Karni, 2010) have claimed that economic slowdown may not be caused by the lack of liquidity, which constitutes the origin point of this thesis. Karni (2010) asserted that the problem is deficiency of acceptable projects. Because, when the economic activities decelerate, risk of default increases for the banks and interest rate would increase correspondingly. Karni (2010) proposed a design where the government absorbs the interest rate hike and in return of this intervention, it takes a portion of the bank's net profit. He proposes government's intervention in terms of encouraging entrepreneurs to revive the economy.

In this dissertation, we present an alternative way, based on a decision theoretical approach to stimulate the economy. In contrast with Karni's study, we take interest rate as a constant. Our main goal is to encourage only pessimist agents by government's contract while keeping the contract unattractive for rational agents. We use Peter Wakker's (2010) pessimism model which is based on rank-dependent utility (RDU) model to describe the pessimist agent, and von Neumann-Morgenstern's (1947) expected utility (EU) model to describe the rational agent.[1] Then, we design a credit model, which involves three possible states of the economy, and we add the contract for pessimist agents. By this design, we aim to encourage the pessimist agents to invest, and at the same time, we try to implement sufficient economic activity to prevent the economy from getting worse.

The rest of the thesis is organized as follows: In section 2, first we present a brief summary of the mathematical progress on the decision making models, which are widely acclaimed in the behavioural economics literature. Secondly, we explain the pessimism model that we use and alternative models. In the third section, we present our design by explaining all actors' role in the economy and all possible scenarios. Then, we conclude.

[1] Actually, EU is a special case of RDU. We will show this relation in the following section.

2 Literature

Questions like "How do the agents decide?", "Which components do they asses when they decide?", "What kind of risk attitudes do they exhibit?" and similar ones have always been very attractive for researchers. They have tried to present an insightful and descriptive model in order to find an answer to these questions. In the literature, when the environment is stochastic, decision making is generally examined under two fundamental headings, risk and uncertainty. Risk describes the known probability (objective probability) cases such as national lottery. On the other hand, uncertainty describes the unknown probability (subjective probability) cases. As an example of uncertainty, one can consider election results. In this thesis, we just focus on objective probability.

Until Daniel Bernoulli's analytical approach to St. Petersburg paradox (1738)[2], expected value had been the tool that was commonly used to analyse choices in uncertain environments. According to this model, whenever an agent makes a choice in an environment where the outcomes are not certain, she calculates the expected value of the random variable at hand. This gives a good measure of the average worth of the random variable. Then when she has to make a choice between say two random variables, she chooses the one with higher expected value. This is a typical problem in economics. The agent observes to objects, has preferences between them, but when there are many objects to choose from, the list that describes her preference relation becomes too tedious to get complete information about her. If instead we have a method to assign each object of choice a numerical value, it would be straightforward to to see what she prefers: simply prefer the one that you assigned a higher numerical value. Choice under risk is no exception: one needs to find a way to assign numerical value to objects of choice, namely in this case the acts or prospect or random variables. Then makes her choice in accordance with the valuation rule. In this sense, expected value was simply a rule to make choices. When faced with different acts, choose the one that

[2]The problem known as St. Petersburg paradox was invented by Nicolas Bernoulli who was the cousin of Daniel Bernoulli.

gives the highest expected value. Now consider the St. Petersburg paradox described as follows (1738):

> "Peter tosses a coin and continues to do so until it should land 'heads' when it comes to the ground. He agrees to give Paul one ducat if he gets 'heads' on the very first throw, two ducats if he gets it on the second, four if on the third, eight if on the fourth, and so on, so that with each additional throw the number of ducats he must pay is doubled. Suppose we seek to determine the value of Paul's expectation."

Expected monetary value (EV) of the gamble is infinite for Paul. If we express mathematically:

$$EV = \frac{1}{2}\cdot 1 + \frac{1}{4}\cdot 2 + \frac{1}{8}\cdot 4 + ...$$

$$\sum_{n=1}^{\infty}\left(\frac{1}{2}\right)^{n}\cdot 2^{n-1} = \infty$$

However, when decision makers are asked how much they would pay to get the gamble, they were observed not to be willing to pay large sums of money despite this infinite expectation. This was a clear violation of expected value theory since higher expected value means strict preference according to this theory. After some time, a clarification came by Bernoulli. Bernoulli (1738) asserted that agents maximize their expected utility instead of expected value and he proposed a logarithmic utility function which gives the intrinsic value of monetary outcomes for individuals rather than using the face value of money itself.[3] Then these utility values are multiplied with corresponding probabilities and when summed over the state space, one reaches the expected utility. This way Bernoulli (1738) obtains a finite value for the aforementioned gamble. Later people were observed to be willing to pay monetary values for this gamble that is close to the value obtained by Bernoulli's suggestion. Even though Bernoulli's expected utility was a great

[3]the logarithmic function that was proposed by Bernoulli is $u(x) = b\log\frac{a+x}{x}$

model, at his time, to comprehend the insight of how agents make decisions, his model has been found more descriptive and lack of information on the calculation utility and rationality properties (Schoemaker, 1982).

Bernoulli's expected utility model has been a prominent tool since its formulation. John von Neumann and Oskar Morgenstern (1947) laid out the behavioral foundation of it in the case of risk. In their expected utility theorem (EUT) showed that in addition to standard preference axioms, if the decision maker's preferences satisfy the continuity and independence axioms, preferences could be presented by expected utility function.[4] Expected utility theorem aims to show numerical representation of the lottery by utility function.[5] $L_1, L_2, .., L_n$ are lotteries in the space of $\mathscr{L}$ and every lottery consists of the outcomes $(x_1, x_2, \cdots, x_n)$ and their probabilities $(p_1 + p_2 + \cdots + p_n = 1)$. Utility function (U), which is an intrinsic valuation of the lottery, is unique up to a positive affine transformation. It means that we can get a new utility function with multiplying by positive numbers and adding any scalars without destroying the expected utility property.[6] Under these definitions, expected utility is calculated as follows:

$$U : \mathscr{L} \to \mathbb{R} \quad and \quad L_j = (p_1, p_2, ..., p_n) \in \mathscr{L} \quad j = 1, 2, ..., n \quad \sum_{i=1}^{n} p_i = 1$$

$$U(x_1, p_1; x_2, p_2; x_3, p_3; ...; x_n, p_n) = p_1 u(x_1) + p_2 u(x_2) + ... + p_n u(x_n)$$

$$EU = \sum_{i=1}^{n} p_i u(x_i)$$

In contrast to Bernoullian model, EUT presents a more mathematical background by preference axioms and proposes how to measure the gambles, which is not just for monetary outcomes. Although EUT is used in many applied studies, the theorem has some mathematical issues. The well-known mathematical issue is the violation of the independence axiom, which is shown by French economist Maurice Allais (1953). This violation is known

[4] For detailed information on axioms see Mas-Colell, Green and Whinston (1995)
[5] The utility function is also known as von Neumann-Morgenstern (NM) utility function
[6] $v(x) = au(x) + b, \quad a > 0$

as Allais paradox in the literature.[7]

Definition 1. *The Independence Axiom:*

A preference relation $\succeq$ *on the* $\mathscr{L}$ *satisfies* ***independence axiom****, if for any lotteries* $L_1, L_2, L_3 \in \mathscr{L}$ *and any scalar* $\theta > 0$,

$$L_1 \succeq L_2 \qquad \Leftrightarrow \qquad \theta L_1 + (1-\theta)L_3 \succeq \theta L_2 + (1-\theta)L_3$$

It means that if the decision makers choose L_1 over L_2, he make this choice independent of other given lottery. After the definition, we can show the violation of independence axiom by Allais' choice problem:

Problem 1:

$$L_1 = (100millions, 100\%) \;\; or \;\; L_2 = (500millions, 10\%; 100millions, 89\%; 0, 1\%)$$

Problem 2:

$$L_3 = (100millions, 11\%; 0, 89\%) \;\; or \;\; L_4 = (500millions, 10\%; 0, 90\%)$$

Most of the decision makers choose L_1 over L_2 and L_4 over L_3, however, these choices contradict with each other in terms of independence axioms, when we calculate the expected utility of the decision makers. According to the first problem, with u(0)=0, $u(100m)1 > u(500m)0.1 + u(100m)0.89$ and we get $u(100m)0.11 > u(500m)0.1$. On one hand, by second problem, we obtain $u(500m)0.1 > u(100m)0.11$. Therefore, this contradiction implies the violation of independence axiom.

As a response to all the empirical violations of EU such as the Allais paradox, Kahneman and Tversky (1979) have developed an alternative model, prospect theory (PT). PT is also easily applicable as EUT, and also a very plausible theorem. Therefore, it is broadly accepted. In their study, they present some counterexamples to EUT such as certainty effect (explanation for Allais paradox) and framing effect (agents show anomalies when they

[7]Indeed, the paradox is a choice problem.

face the same lottery in two different forms) then they define two different functions, which are called weighting function (w) for probabilities and value function (v) for outcomes.

$$PT = \sum_{i=1}^{n} = w(p_i)v(x_i)$$

Contrary to EUT, non-linearity of probability perception is illustrated by weighting function. Therefore, we can say that PT is a more realistic model than expected utility. Besides, weighting function is not the probability itself, it can be interpreted as the degree of belief, thus it does not have to satisfy the probability properties. Another main contribution of Kahneman and Tversky is the S-shaped value function. According to PT, value function generally concave for positive outcomes, which means that the decision makers are risk averse on gains, and generally convex for negative outcomes, which means that the agents are risk seeking on losses. Moreover, they find that value function graph is steeper for negative outcomes than for positive ones. It means that, in their own words, "losses loom larger than gain". After the article was published, it has been proven that PT violates the stochastic dominance property (Fishburn, 1978).

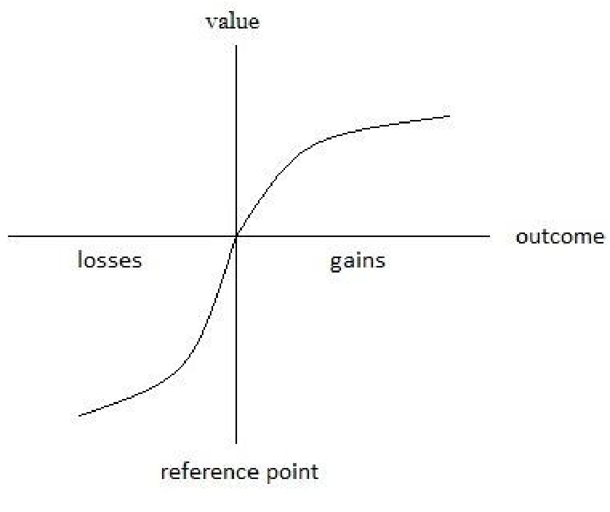

Figure 1: s-shaped value function

Definition 2. *L_1 and L_2 are two lotteries, and F(x) and G(x) are cumulative distribution function of lotteries, respectively. L_1* ***first-order stochastically dominates(FOSD)*** *L_2, if $F(x) \leq G(x)$ for all x.*

For a given lottery, the value of the cumulative distribution function at outcome x is a portion of outcomes in the lottery that are no greater than the outcome x. By definition, FOSD means that the outcomes which are less than or equal to x in L_2, are more than L_1. Therefore, if L_1 dominates L_2, the decision makers prefer L_1 over L_2. After the stochastic dominance problem, researches try to develop a better descriptive model, and Quiggin (1982) has presented alternative model which is called rank-dependent utility (RDU) (or anticipated utility) to resolve the violation. RDU provides the evaluation of not just the probability of prospect, but also the benchmarking of other prospects when the decision makers face gambles. The model aims to rank the prospects of the lottery from the best to the worst. Let us explain with an example:

Example 1. *L=(10,0.4;50,0.3,30,0.2;60,0.1) is a lottery. RDU of the lottery calculates as follows:*

$$\begin{aligned} RDU &= u(60)\pi[w(0.1)] + u(50)\pi[w(0.3+0.1) - w(0.1)] \\ &+ u(30)\pi[w(0.2+0.3+0.1) - w(0.3+0.1)] \\ &+ u(10)\pi[w(0.4+0.2+0.3+0.1) - w(0.2+0.3+0.1)] \end{aligned}$$

$$\begin{aligned} &= u(60)\pi[w(0.1)] + u(50)\pi[w(0.4) - w(0.1)] + u(30)\pi[w(0.6) - w(0.4)] \\ &+ u(10)\pi[w(1) - w(0.6)] \end{aligned}$$

There is a decision weight function of probability (p_i) which is denoted by $\pi(p_i)$, and it depends on weighting functions of the outcome's probability and its rank ($r_i = p_{i-1} + \cdots + p_1$). The rank of the best outcome is zero and it is called the best rank, and when the outcome gets worse, its rank is also called worse, but numerical value of the rank increases. RDU is a descritively powerful model because it fits better with empirical studies. It is known that people pay much more attention to the extreme outcomes and the model provides a room for this kind of behaviours. Furthermore, rank dependence is free of mathematical problems and may also be used in applied studies readily (Diecidue & Wakker, 2001). Under continuous, strictly increasing utility function assumption and existence of decision weight function (existence of probability weighting function directly), general formulation of RDU is:

$$RDU = \sum_{i=1}^{n} \pi(p_i)u(x_i) \qquad \sum_{i=1}^{n} p_i = 1$$

$$\pi(p_i) = w(p(x_i) + rank\ of\ p) - w(rank\ of\ p)$$

Please note that EU is a special case of RDU where the weighting function is an identity function ($w(p) = p$). After Quiggin's contribution, Kahneman & Tversky (1992) recover their theorem and they develop Cumulative Prospect Theory (CPT), which is based on rank-dependent utility with some differences. They propose to calculate the gambles separately for positive and negative outcomes.

Thus far, we have briefly summarized the mathematical progress on decision making models under risk. In the literature, there are many studies on subjective probability (i.e Savage's subjective utility model (1954)); however, as we said before, this dissertation focuses on known probability. Please notice that, all this process is not just pure mathematics, each model aims to present a better explanation to the insight of human decision making. Now, we can present the details of pessimism model.

2.1 Pessimism Model

There are several pessimism models, which include complete theoretical framework, in the literature. One of them is Peter Wakker's pessimism model, which is based on RDU (2010). Rank dependence is an appropriate model for pessimist-optimist behaviours. Because, as we have explained before, the model gives well-described information about humans' probability perception. In a nutshell, pessimism is overweighting the probability of the worse outcome. Formally, we define the pessimism as follows (Wakker, 2010):

Definition 3. ***Pessimism*** *holds, if the decision makers give higher decision weight to lower outcomes, in other words, decision weight increases while the rank is getting worse (or numerically rank increases) and we can implement the definition by convex probability function:*

$$\pi(p_i) = w(p(x_i) + r) - w(r) \qquad w = convex function$$

$$r > r^{'} \ and \ \pi(p^r) \geq \pi(p^{r^{'}})$$

Optimism holds in reverse situation by concave probability function. One critique for Wakker's model is using specific function, it is found limited. On the other hand, RDU is found very appropriate to model the pessimistic behaviour because of dual evaluations, probability weighting function and concavity of utility function (Bleichroth & Eeckhoudt, 2005). Osaki and Quiggin (2007) suggest an alternative pessimism-optimism model by RDU. First, they define risk-neutral decision weight and compare two weighting function according to monotone likelihood ratio dominance. They call pessimist whose risk neutral decision weight is dominated by the other one.

Apart from the rank dependence pessimism, Dillenberger, Postlewaite and Rozen (2012) suggest a pessimism-optimism model, which is based on expected utility for subjective probability. Similarly, they define pessimistic behaviour the situation where the probability of the favourable outcome is lower than the Savage probability. Besides, they call their study a cognitive notion of pessimism and they assert that pessimistic behaviour is not observable. Gumen, Ok and Savochkin (2012) present a generalized pessimism model for the subjective evaluations of risk, which is not bounded by specific function. Out of these theoretical models, Bleichroth and Eeckhoudt (2005) use RDU for saving decision and they call pessimist agent whose transformed probability (weighting function) of the worst outcome is bigger than the exact probability. Wigniolle (2014) also uses similar pessimism definition on his study to examine existence of financial bubbles.

The new critique of Wakker model that we have noticed while working on the dissertation, the pessimism model does not hold at every probability mass. It is certain that it holds when the outcomes are equally likely so we assume that $p(x_1) = p(x_2) = \cdots = p(x_n)$ relation is valid in this study.

3 Design

We design a credit mechanism which consists of two types of agents, -pessimist and rational-, the bank and government. We assume an economic environment where the economic activity slows down and rational agents still continue to invest while other agents do not. Indication of slowness is that interest rate and agents' expected return per dollar is equal to each other. It means that there is no gain or no loss for entrepreneurs. According to the design, all actors in the economy have linear utility of money. We also assume that the banks are fully rational and they assess the projects in need of loan, perfectly.

3.1 The Banks

Crediting takes substantial place among banking operations. Banks consider four components when they evaluate the projects to finance by giving loans (x) to entrepreneurs. During the period of deceleration in the economic activity, the risk of default for the banks increases. The increasing risk of default is denoted by γ. It is calculated by the standard deviation of the projects' return and the projects' correlations with the returns of the current portfolio (Fama & Miller, 1972).[8] We take the interest rate r as constant, which is greater than or equal to the return rate of risk-free asset $\bar{r}$.[9] The banks also make choice between giving credit or not, we can implement crediting condition for banks as follows:

$$u(\bar{r}, \gamma) = u(r, 0)$$

$$r \geq \bar{r}$$

The reason of assuming constant interest rate is to simplify the model. Because this dissertation focuses on agents investment decision instead of the economic indications.Agents' expectation for return per dollar (β) is another

[8] In real life, every bank may have own risk measurement systems, which are based on this method.

[9] The risk-free asset represents government funds

important component for banks because they make certain loan repayments. For simplicity, we assume three possible states of the economy that affects firms' profits: A normal state is illustrated by β_n. The other state is a recovering the economy which is illustrated by β_g which describes profitable state. The last possible situation is that economy could worsen which is denoted by β_w.

$$\begin{aligned} &\beta = (\beta_w, \beta_n, \beta_g) \\ &\beta_w < r, \qquad loss \\ &\beta_n = r, \qquad no\ \ loss\ \ no\ \ profit \\ &\beta_g > r, \qquad profit \end{aligned}$$

Hence, by this quartet (γ, β, x, r), we can summarize the factors that are taken into consideration by the banks when they evaluate the projects to finance.

3.2 The Rational Agents

We describe the rational agents by EU and assume that they are expected utility maximizers (EUM).[10] The agents' utility function of EUM is linear, and we assume $u(0) = 0$. Rational entrepreneurs apply banks to receive credit (x_i) that they need to invest. For loan application, expected return per dollar must be greater or equal to interest rate. We can define the utility function of the entrepreneurs by (β, r, x_i) with $i = 1, 2, \cdots, n$.

$$u(\beta, r, x_i) = x_i\beta - x_i r \qquad and \qquad \beta = (\beta_w, \beta_n, \beta_g)$$

According to three possible states of the economy that we have mentioned in the previous section, rational agents' extended expected utility is defined as:

$$EU = \sum_{i=1}^{n} p(\beta)u(\beta, r, x_i) \qquad (u\ \ linear\ \ function)$$

$$= p(\beta_w)\underbrace{(x_i\beta_w - x_i r)}_{<0 \quad \text{loss}} + p(\beta_n)\underbrace{(x_i\beta_n - x_i r)}_{=0 \text{ no loss no profit}} + p(\beta_g)\underbrace{(x_i\beta_g - x_i r)}_{>0 \quad \text{profit}}$$

[10]EUM is called as the agents who always prefer higher lottery over lower one.

In the meanwhile, we assume that the expectations of all existing states of the economy have equal chance to make rank-dependent pessimism model work.

$$p(\beta_w) = p(\beta_n) = p(\beta_g) = \frac{1}{3}$$

For investment decision, $EU \geq 0$ condition must be satisfied. We design an economic environment where rational agents still continue to invest. Therefore, the following relations can be seen, explicitly: $|\beta_g - r| \geq |\beta_w - r|$ so $\beta_g \geq \beta_w$.

3.3 The Pessimist Agents

The other actor in the design is the pessimist agents, and we illustrate them by RDU with $j = 1, 2 \cdots, n$. This type of agents' linear utility functions consist of the triplet as $u(\beta, r, x_j)$ similar to rational agents and again we assume $u(0) = 0$.

$$RDU = \sum_{j=1}^{n} \pi(p(\beta))u(\beta, r, x_j)$$

$$= \pi[p(\beta_w)] \underbrace{(x_j\beta_w - x_j r)}_{<0 \quad \text{loss}} + \pi[p(\beta_n)] \underbrace{(x_j\beta_n - x_j r)}_{=0 \text{ no loss no profit}} + \pi[p(\beta_g)] \underbrace{(x_j\beta_g - x_j r)}_{>0 \quad \text{profit}}$$

$$\pi(p(\beta)) = w(p(\beta) + r^{\beta}) - w(r^{\beta}) \qquad (w \;\; convex \;\; function)$$

Probability rank of the states (β) is denoted by r^{β}. As a requirement of the pessimism properties, the weighting function needs to be convex so we choose $w(p) = p^2$ to satisfy the property. Although rational agents perceive the probabilities as they are, by definition of the pessimism, we obtain the following relation for pessimist agents under equal probability:

$$\pi[p(\beta_w)] > \pi[p(\beta_n)] > \pi[p(\beta_g)]$$

We assume that this type of agents are not willing to invest because of their negative rank dependent utility ($RDU < 0$). At that point, our design comes into play. We propose a contract between government and pessimist agents, which is not attractive for rational ones, to encourage pessimist agents and enhance $RDU \geqslant 0$. It can be interpreted as providing assurance. We keep the contract ineloquent for the rational agents because the government's main goal is to increase the economic activity to stimulate the economy, and the rational agents already take part in the economy. By keeping the contract unattractive to the rational agents, we aim to prevent unnecessary expenses. According to the contract, government will give monetary support, if the agent loses money (if the economy gets worse) and the government will take a share of his profit, if the agent makes profit (if the economy recovers). The support and the government's cut are denoted by S and C, respectively. By the contract, new rank dependent utility forms as:

$$= \pi[p(\beta_w)](x_i\beta_w - x_ir + \mathbf{S}) + \pi[p(\beta_n)](x_i\beta_n - x_ir) + \pi[p(\beta_g)](x_i\beta_g - x_ir - \mathbf{C})$$

To keep the contract unattractive for the rational agents we put $C \geq S$ restriction on the contract. Hereafter, we call it *unattractive restriction.* The existing question is what is the relation of S-C? What should the government propose to the agents by the contract? The rank dependence utility changes when the prospects' ranks change. Therefore, there exist four different cases in parallel with S-C.

Case 1: $C \leq profit$ and $S \leq |Loss|$

Firstly, to implement $RDU \geq 0$ under $C \geq S$ condition, we analyse the extreme points (equality),

$$C = Profit \quad and \quad S = |Loss| \quad \rightarrow RDU = 0$$

$$C = Profit \quad and \quad S < |Loss| \quad \rightarrow RDU < 0$$

$$S \leq C < Profit \quad and \quad S = |Loss| \quad \rightarrow RDU > 0$$

It is shown that at extreme points we can provide a feasible contract except the middle relation.

Out of the equality state, it is found that government's support (S) must be at least

$$minS = \frac{|RDU|}{\pi(p(\beta_w)) - \pi(p(\beta_g))} = C$$

When the support is at its minimum amount, $C > S$ can not be satisfied. If $S > minS$, $S = C$ is satisfied at any point. However, the relation $C > S$ is satisfied in limited situations. When we assume that S is greater than $minS$, we reach the following equation:

$$S = minS + \alpha \quad where \quad \alpha > 0$$

$$C \leq minS + \alpha\frac{\pi(p(\beta_w))}{\pi(p(\beta_g))} \quad \rightarrow RDU \geq 0$$

After finding $minS$, by the preceding inequalities, we implement a contract which brings them up to the mark for investment decision.

Case 2: $C \geq profit$ and $S \geq |Loss|$

We denote the profit by G meaning gain and loss by N meaning the negative amount. First of all, let us investigate the equality points. We have already shown the dual equality (where RDU=0)

$$C > G \quad and \quad S = |N| \quad \rightarrow RDU < 0$$

$$C = G \quad and \quad S > |N| \quad \rightarrow RDU > 0$$

According to the above stated inequality relations, second line is proper for our objective. Out of these points, we can generalize this case as follows:

$$C > G, \quad C = G + x \quad where \quad x > 0$$

$$S > N, \quad S = N + y \quad where \quad y > 0$$

In this situation, $G + x > L + y$ has to be satisfied because of unattractive restriction. We already know that $G > |L|$. We also need to keep the amount of loss less than the amount of profit. Because the bad outcome's probability weights more than good one by the pessimism rule. It means that the multiplier of the loss is higher than profits. Therefore, we can easily see $x < y$. The last question is "What is the relation between x and y under these restrictions?". We claim that the following equation must be satisfied to reach an adequate level for pessimist agent.

$$\frac{x}{y} \leq \frac{\pi(p(\beta_g))}{\pi(p(\beta_w))} \quad \rightarrow RDU \geq 0$$

Case 3: $C < G$ and $S > |N|$

We call this case *certain gain*. Because, it can be easily seen that, this case guarantees the positive outcomes. Therefore, this case is perfect for our goal.

Case 4: $C > G$ and $S < |N|$

We call this case *certain loss*. There is no room to encourage the agent to invest, in other words, it is impossible to make $RDU \geqslant 0$ in this case. Therefore, we do not put this case on the contract.

3.4 The Government

In the design, the government proposes the contract to pessimist agents. Actually, the contract is valid for every agent in the economy but we make it special only for the pessimist agent by unattractive restriction. At this section, we examine government's side of the contract. Firstly, remind that government's utility function is linear and we present it by EU as rational agents.[11]

There are three factors for government's expected utility as the agents. When the economy gets worse, government loses money in amount of S, when the economy recovers, it gains in the amount of C or at last possible state, there is no alteration for government. In mathematical expression,

[11]Remind that $u(0) = 0$

$$EU(gov) = \sum p(\beta)u(S,C) \qquad (u\ \ linear\ \ function)$$

$$= p(\beta_w) \underbrace{u(S)}_{<\,0(\text{loss})} + p(\beta_n) \underbrace{u(0)}_{=0} + p(\beta_g) \underbrace{u(C)}_{>\,0(\text{gain})}$$

By unattractive restriction ($C \geq S$) and equal probability, $EU(gov) \geq 0$ can be seen, explicitly. Therefore, it can be said that making the contract is profitable for government. The follow-up questions are "How long does the government maintain this intervention?" and "When should it finish?". We propose that the government should continue using this procedure until it faces a monetary problem.

Moreover, the contract is very attractive for the government except its monetary gain. During an economic downturn, unemployment rate shows rising tendency, because firms try to keep their cost low by laying off. Our design also provides an opportunity to avoid this upward trend by new investments. Therefore, we can say that the contract is also favourable for the government in terms of its responsibility for implementing economic stability.

4 Conclusion

People tend to exhibit abstaining behaviours when the economy shows negative indications. They may lay off to decrease their cost on behalf of keeping their status quo, or they may not prefer opening new jobs because of bankruptcy risk. These kind of attitudes may lead to crisis. In the circumstances, only utilizing of the economic tools would fall short to stimulate the economy. We also need to influence agents' behaviours in a positive way. Therefore, we investigate an alternating resolution for the credit markets by behavioural economics knowledge. In the general sense, the main aim of our design is taking precaution to avoid a worse scenario for the economy.

We present an economic environment where one type of agent maintains the economic activities, but the other type does not. We try to incorporate them in the economy. By rank-dependent pessimism model, we make a contract between the government and the pessimist agents. The contract is an assurance for the pessimist agents, in our sense. The government implements this assurance by dual activities. It gives financial support to the pessimists if they lose and it takes a portion of their net profits if they make profit We obtain four different cases depending upon the rank dependence model, and among three of these cases, we implement $RDU \geqslant 0$.

We have found that it is possible to encourage the pessimist agent without affecting rational entrepreneurs by definite restrictions. The design that we propose does not contain any room for boondoggles. It is convenient for all economic actors and it is also relevant. On the other hand, the model that we use does not work at every probability mass. Therefore, there is a limitation problem on this study because of equal probability. How to apply this notion on any probability mass can be a good research question for further studies.

Table 1: Summary

First Case
$C = G \quad and \quad S = \|N\|$ $S \leq C < G \quad and \quad S = \|N\|$
$minS = \frac{\|RDU\|}{\pi(p(\beta_w)) - \pi(p(\beta_g))} = C$
if $S = minS + \alpha \quad where \quad \alpha > 0:$ $for \quad C = S \rightarrow is \quad satisfied \quad anywhere$ $for \quad C > S \rightarrow C \leq minS + \alpha\frac{\pi(p(\beta_w))}{\pi(p(\beta_g))}$

Second Case
$C = G \quad and \quad S > \|N\|$
$C > G, \quad C = G + x \quad where \quad x > 0$ $S > N, \quad S = N + y \quad where \quad y > 0$ $x < y$ and $\frac{x}{y} \leq \frac{\pi(p(\beta_g))}{\pi(p(\beta_w))}$

Third Case
$C < G \quad and \quad S > \|N\|$

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