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Entrepreneurial financing under uncertainty :
Performance Comparison Between ROMCA and Conventional Microloans using Agent Based Simulation

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Abstract

In this research we create a complex simulation environment where we compare the performance of two micro-financing modes in a group lending context under uncertain market and price conditions : A classical conventional mode and a proposed Profit and loss sharing model called ROMCA (Rotating Musharakah). Both models are based on group lending of entrepreneurs over a specified period. We identify four cases of market and price conditions and use Netlogo as a simulation tool to assess the performance of the two modes in terms of employment , enterprises , investment , tax proceeds and wealth creation. We found a simulation evidence that ROMCA performs better than conventional lending in terms of creating wealth, new enterprise (and therefore new employment opportunities) and better consumption level even under adverse market conditions. On the other hand, Conventional lending is found to dominate ROMCA in terms of employment under favorable market condition.

Keywords: ROMCA , social value , PLS contract , Conventional lending , Microfinance.

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1. Introduction

One of the methods to reduce moral hazards and default risk in the microfinance industry is the use of group lending. in this process the group are assumed to pride solidarity in terms of honouring their loan payment.

many researches have studied the group lending mechanism. for example, Giné et al. (2010) provided an experimental design in Peru. they concluded that used a laboratory experiment in a Peruvian market. They found that group lending stimulates risk taking as the participants know that they are jointly liable for their debt. In the same line Fischer (2011) concluded that group lending stimulates risk taking as the borrower act as free riders and benefit from the co-insurance of their co-borrowers. However, it was found that payments frequency improved when switching from individual to group lending Cole et al. (2011)

Group lending was shown to improve consumption level. this consistent with an experiment conducted in Bangladesh Khandker (2005). the impact of group lending n consumption was heterogenous as found in an experiment in IndiaBanerjee et al. (2013). in the same experiment Group lending however had a positive impact on business creation and stimulating new investment. in the same line group lending was also fund to have a positive impact on entrepreneurial activities as found in an experiment in Rural MoroccoDuflo et al. (2007) ,Karlan and Zinman (2011). in other studies the impact on entrepreneurial activities was found to be heterogeneous Banerjee et al. (2013).

El-Gamal et al. (2014) has conducted a laboratory experiments in the field, using very poor subjects in rural Egypt, and compare the take-up and repayment rates of randomly assigned subjects under the two designs. They found that the insured-ROSCA model elicits much higher rates of take-up by participants, and at least as high rates of repayment, compared to the Grameen model.

Ambec and Treich (2007) showed that ROSCAs are similar to other pre-commitment mechanisms in terms of enhancing savings and alleviating poverty.

Besley et al. (1992),Besley et al. (1993) and Besley et al. (1994) had earlier analysed the mechanisms and efficiency properties of various ROSCA structures, concluding that some types of ROSCAs enhance welfare through credit provision.

Our model however is based on a newly proposed rotating Profit and loss Sharing (Musharakah) Contract involving credit associations, hence named later ROMCA , where funds are handed over to the other

entrepreneur after a roll-over period of work. The profits are then shared between the financial operator and the entrepreneurs on one hand according to a predetermined ratio and then shared between the financial operator and investors who provided the fund according to another sharing ratio. There are some important points to note about Musharakah:

One problem with Musharakah is misreporting . This happens when the agent announces losses while the project is making profits. To overcome this problem,Al-Suwailem (2006) argues that, there should be a higher due diligence from the part of the Islamic institutions as compared to conventional banks. In our model, we allowed for monitoring as a mechanism to reduce moral hazard. we also allowed for training as a mechanism to improve performance. Banks can use collateral in debt contracts to overcome information asymmetries, arising from ex-ante adverse selection Berger et al. (2011). To overcome the problem of information asymmetry, Karim (2002) proclaims that the submission of a warranty can resolves the adverse selection problem in a profit and loss contract. Unlike its conventional counterpart, however, the Islamic financial operator under ROMCA cannot make recourse to warranties in case of projects failure. However, if there is a proof of negligence from the part of the entrepreneur, the recourse to a warranty is permissible AAOIFI (2003)

Information sharing can be used to reduce moral hazards. In fact, credit bureaus have been shown to increase efforts from borrowers Padilla and Pagano (1997). Information sharing is useful if borrower mobility is higher Pagaon and Jappelli (1993) and if asymmetric information problems are more important Brown and Zehnder (2010). Empirical research has shown that, information sharing is correlated with higher access to credit Pagaon and Jappelli (1993). This case is important especially in developing countries with inefficient creditor rights Djankov et al. (2007), but lower lending to low-quality borrowers Hertzberg et al. (2011). in our ROMCA model, the credit bureaus or even consultancy firms can be used for monitoring purposes in case the financial operator lack the expertise in monitoring. However, this might entail a high cost. In our model this high cost can be mitigated by a high tax subsidy for monitoring.

One argument suggests that the agency problem is based on an unfair distribution of returns if the project fails Shaikh (2011). Taking into consideration the risks related to a project, the financial institution may demand a higher sharing ratio. This, according to Shaikh (2011) however may result in less motivation of the entrepreneur and therefore a lower project return. In our model, we allow for the flexibility in changing the sharing ratio to fit the requirement of the entrepreneurs. More than that, our model suggests the provision of an altruism bonus for the entrepreneur with high performance compared to his co-entrepreneur. The

altruism bonus is to be reinvested in new projects, allowing the entrepreneur more profit generation. this altruism bonus also proved in our model to be very effective in generating new employments especially if the number of enterprises financed is high.

Low job protection can also be made like a high pledged collateral. i.e. a confident manager will demand a high reward in case of success but also signs for a low job protection in case of failure. This case agrees with previous research such as the ones existing in Subramanian and Sheikh (2002). Low job protection, however, be unfair to the entrepreneur since failure of the project can be due to factors beyond the entrepreneur's control. Demanding security by the financier, in the form of low job protection, be making the entrepreneur lose more than his contribution. This, however, contradicts the Musharakah principle which calls for a fair sharing of profits and losses as we mentioned earlier in Usmani (2002). in our ROMCA model however, the entrepreneur is in fact offered more job protection as his generated profit is re-invested in other projects allowing him to get returns from his work and from the work of others who are using his funds. Also, our model, proved to be solid even under adverse market conditions allowing for more market stability.

A research suggests that moral hazard can be solved under Mudaraba but cannot be solved under Musharakah YOUSFI (2013).

This can be criticized in a sense that under Mudaraba the financier provides the whole capital and therefore assumes all monetary risks. On the other hand, under Musharakah the capital is shared and intuitively the risk of losing capital is shared. This, also, contradicts the findings of Nabi (2013) which proposes that moral hazards can be solved subject to a contribution from the entrepreneur. i.e. moral hazard is more likely to be solved under a Musharakah contract than under a Mudaraba contract. This is also inconsistent with the findings of Innes (1990) who argues that sharing contract is not feasible in case of total external financing of the project.

Also, it is proposed that the entrepreneur's participation in the capital can reduce information asymmetries in a profit and loss contract Karim (2002).Consistent with this finding, and to induce the entrepreneur to exert high effort and therefore reduce moral hazard, a research suggested a minimum capital contribution by the entrepreneur given a minimum profit sharing ratio Nabi (2013). In our model, we allow for the entrepreneur to contribute with a personal wealth collectively with others. This has two important

features. First, each entrepreneur will co-monitor the other as he knows that his personal capital is in the hands of his co-workers. Second, an entrepreneur would hand over his capital to his co-workers only if a high trust is in place.

Another research, proposed the usage of two profit sharing ratios instead of one to reflect the effort of the entrepreneur compared to the financier Maheran (2010). The model proposed, however, suffers from the non-treatment of asymmetric information .

2. The Model

In this research we are comparing the performance of two micro finance lending models in terms of wealth creation, consumption improvement, enterprise and therefore employment creation. The two models are: conventional group lending and ROMCA group lending. The two models are similar in that they involve the financing of a pair number of entrepreneurs who are engaged sequentially into managing a project. For example, one entrepreneur starts the game by investing in and running a project for a period then hand over the proceeds to the second entrepreneur to run the project for the second period. At the end of each period the pair shares the profits (or losses) accordingly. The pair of the entrepreneur are endowed with an initial wealth W0. They need extra financing I_0 to initiate the project which require $I = W_0 + I_0$ The financing comes either through conventional micro finance lending of through which require the payment of interest or through ROMCA where the pair of entrepreneurs share the profits and losses with their financier. Both modes of financing are dynamic in nature. This means that they involve rolling over the investment over a certain period (N). both models are assessed in terms of their abilities to create employment, improve consumption and wealth level in the society under different market and moral hazards conditions.

Further explanation of the two models is explained below:

2.1. The Model under debt-financing

Figure 1: The Model under debt-financing
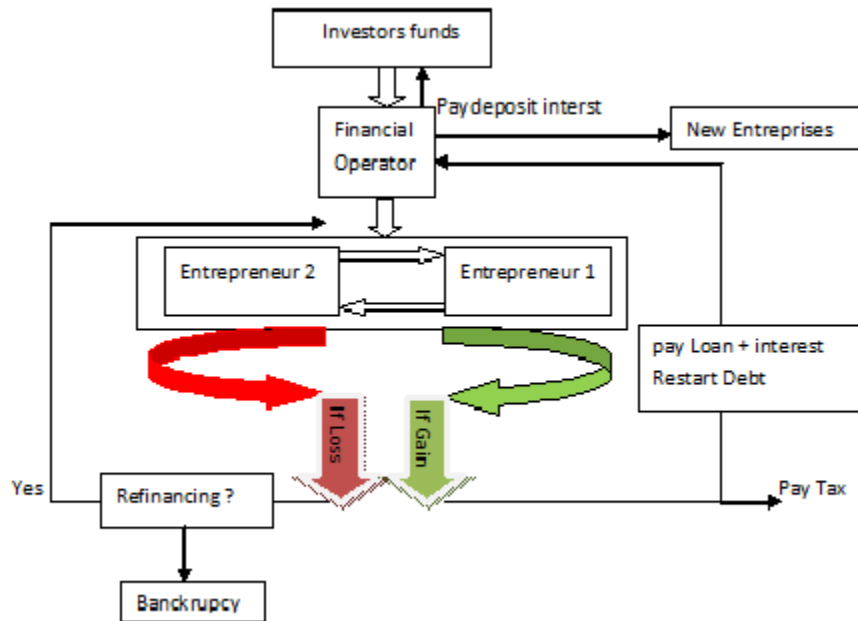
Institution engaged in conventional lending receive their funds from depositors and therefore must pay them interest (i_d) on their deposits. they however receive interest i_l from borrowers (in our case the entrepreneurs). In this scheme the lending institution is not engaged into any form of the entrepreneurs training in terms of project management. the lending institution is as well interested merely in receiving interest payments and therefore social concerns such as charity (Z) giving is of a less concern to it.

2.2. The Model under ROMCA

Figure 2: The Model under ROMCA
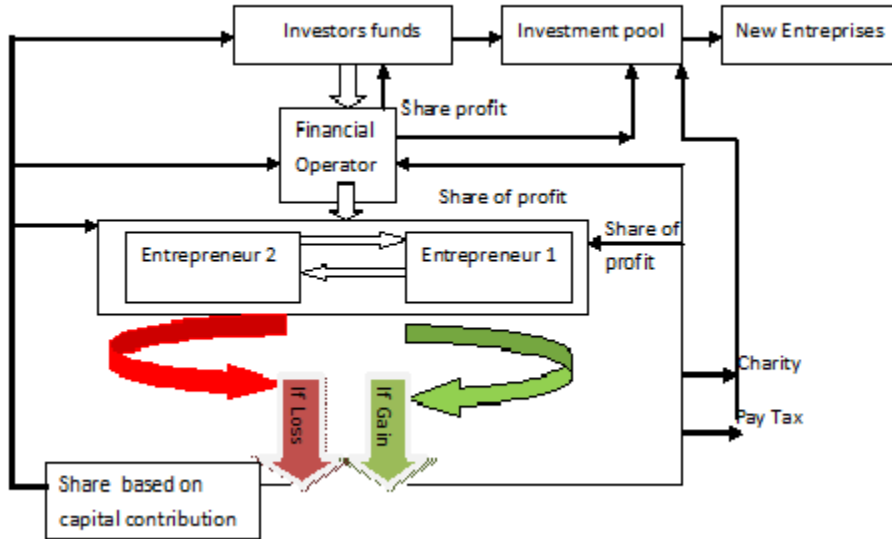
Under ROMCA the lending institution agrees on a predetermined basis to share profits at α_e with the entrepreneurs and to share the rest of the profits with the investors (depositors) at α_d.

In terms of losses they are shared according to each participant's share in the project. for example the maximum the entrepreneur can lose is $\beta_e = \frac{W_0}{W_0+I_0}$ while the maximum loss of the investors is $\beta_d = \frac{I_0}{W_0+I_0}$.

Unlike the conventional lending mechanism, under this model they are not obliged to pay any proceeds to the financier in case the project fails. Institutions engaged in Profit and Loss sharing (like our model ROMCA) receive investments (not deposits) from investors. So, under ROMCA profits and losses are shared between the entrepreneurs, the Lending institution and the investors.

unlike the Conventional lending mode, the ROMCA model is more socially and behaviourally oriented. For example from a social context the model:

- Requires the participant to allocate part of the project profits in a charity (z) pool used for re-investment purposes to sustain new projects.

On the hand from a behavioural context the model :

7

- engages in enhancing the managerial abilities of the entrepreneurs through formal training (at a cost T). This training is estimated to lead to better learning rate L which ultimately should lead to better performance.

- encourages better performance among entredpreneurs by giving outperformers relative to their peers an altruism bonus A_b

- monitors entrepreneurial performance to reduce the moral hazards of the entrepreneurs' misreprting of profits. This mnitoring has a cost (M_c) and depends on its effeciency ($M_{e}ff$)

3. Methodology

Given specific parameters we would like to compare the performance of the two models under a combination of different inflation and market conditions.

- Inflation environment: under this scenario two states are chosen: an inflationary market with high prices and a deflationary market with low prices. High (low) prices are favourable (not favourable) for the suppliers (in our case the entrepreneurs) as its results in higher (lower) income.

- Market Conditions: characterised by being either favourable or adverse to the participants.

we will therefore have a four cases scenario ranked in terms of the preferred outcome to the entrepreneurs:

- HF : this represents an environment with high inflation and prices (H) and favourable market conditions (F). This environment is the mostly preferred by entrepreneur as they can sell at higher process at favourable market conditions. this scenario is therefore ranked (1) in terms of preference by the entrepreneurs.

- LA : this represents an environment with low inflation and prices (L) and Adverse market conditions (A). This environment is the most pessimistic scenario expected by entrepreneurs as they could sell at lower prices in adverse market conditions. This scenario is therefore ranked (4) or last in terms of preference by the entrepreneurs.

- LF : this represents an environment with low inflation and prices (L) and Favourable market conditions (F).

- HA : this represents an environment with high inflation and prices (H) and adverse market conditions (A).

Environment (LF) is preferred to (HA) as entrepreneurs prefer, despite selling at lower prices, to be acting in favourable market conditions. therefore (LF) is ranked (2) and HA is ranked (3).

For example, the most preferred scenario for the entrepreneurs is an environment of high selling prices and favourable market conditions. This is given a rank of (1) The worst for them will be an environment of low selling prices and adverse market conditions this is given a rank of (4). A favourable market condition is preferred to an adverse market. Therefore, a favourable market conditions with low prices is still preferred to an adverse market even with high prices.

We can represent a summary of the scenarios along with heir ranking in terms of preferences in the flowing matrix:

Table 1: The four simulation cases

Market Conditions

			Favorable	Adverse	
Inflation	High		HF (1)	HA (3)	
	Low		LF (2)	LA (4)	

We are then going to compare the performance of the two models, under each of the four scenarios, in terms of the following outcomes :

- bank's profitability

- Investors profitability

- Entrepreneurs profitability

- Total wealth created

- Tax fund generated from the projects financed by the two modes.

- consumption level generated

- tax recovery. which represents the time it takes for the project to start generating profits and therefore paying taxes.

- altruism bonus: representing the incentive given for better performer entrepreneurs.

- new investor: representing how many new investors have been created during the simulation period

- new entrepreneurs: representing how many new enterprises have been created during the simulation period

- employment: representing the percentage increase in the employment rate from rolling over the projects.

3.1. *parameters needed for simulation*

The two models run under multiple parameters. we are organizing them into common parameters (which are similar in both models) , training , monitoring and behavioural parameters.

3.1.1. *common parameters*

- The entrepreneurs initial endowment. this represents the financial ability to contribute into the project

- The required-fund: this represents what the entrepreneurs needed extra fund to start the project

- The initial-entrepreneurs: this the starting number of the entrepreneurs which is in pairs

- The roll-over-period: each entrepreneurs works for a specific period and then hand in the proceeds to the other entrepreneur(s).

- The working-period: this represents the length of the project where the entrepreneurs have completed their rolling over of the project.

- unit-sales and price: those are the estimated units to be sold and price given a specific project

- Number of employees per enterprise

- Initial unemployed: community number of unemployed.

- Tax rate: this the tax rate on the income from the project

- Probability of Random shock chance: this the chance of adverse market conditions.

- Bank/entrepreneurs sharing ratio: this the share of the bank from the profits before it shares it with the investors

- Bank/investors sharing ratio: this the profits share of the lending institution of the profits. the rest is given to investors.

- Lending rate, deposit rate: the rates at which the lending institution lends and pays for deposits

3.1.2. training parameters

- training time: this the training time taken as a ratio of the total working period.

- Training's cost: this is expressed as a ratio of the training time from the fund. this means that the higher is the ratio the higher is the training cost

- Learning factor: represents the efficiency improvements from one stage to another. for example if the learning factor is 10 % then this means that the entrepreneurs has increased his/her efficiency by 10%. this reflects on an additional probability of success of the project in the next stage.

3.1.3. Monitoring parameters

- The monitoring-efficiency: probability of monitoring in reducing moral hazards of profit misreporting

- monitoring-cost: this represents the ratio of monitoring cost from the required fund. The higher is the extra required fund, the more monitoring is required

- Tax-subsidy-for-monitoring-and-training: this represents the percentage that the tax authorities may choose to subsidize training and monitoring. In fact, it is assumed that the subsidy of monitoring, allows for better profit reporting and therefore, better tax collection. Also, it is believed, that subsidizing training allows for better performance and therefore higher tax collection.

3.1.4. Behavioural parameters

- altruism benefits: this represents a percentage of the excess performance of one entrepreneur in excess of the other. This altruism benefit is given to the entrepreneur because of his superior performance

and his willingness to share profit equally with the other entrepreneur.

- The Propensity-to-consume: this represents the amount of net profit to be consumed.

- charity-rate: this represents the rate of profits that was agreed to give as charity. The purpose of charity has productive reasons. In fact it is used as a vehicle for the creation of other enterprises.

- Entrepreneurial-motivation: the profits generated are to serve in the creation of new investors who are willing to extend their funds to new entrepreneurs. However not all new investors created result in new entrepreneurs created. This depends on whether we have new entrepreneurs who have the willingness and the motivation to start an enterprise.

- Moral Hazard: this represents an estimated probability that the entrepreneurs will misreport their results.

3.2. The model initial interface in Netlogo

The following figure shows the netlogo initial interface. the initial parameters used for the simulation are:

3.2.1. General parameters

- The combined initial wealth of each pair of entrepreneurs = 15000

- The required-fund: 30000

- The initial-entrepreneurs: 40 ie 20 pairs

- The roll-over-period: each entrepreneur work a period and then handover the proceeds to the other entrepreneur to work for another selected period.

- The working-period: 50 working-periods

- Daily-unit-sales: 100 units

- Rollover period 30 days

- Employees-per-enterprise: 2

- Initial- unemployed: 1000

Figure 3: The initial model's interface
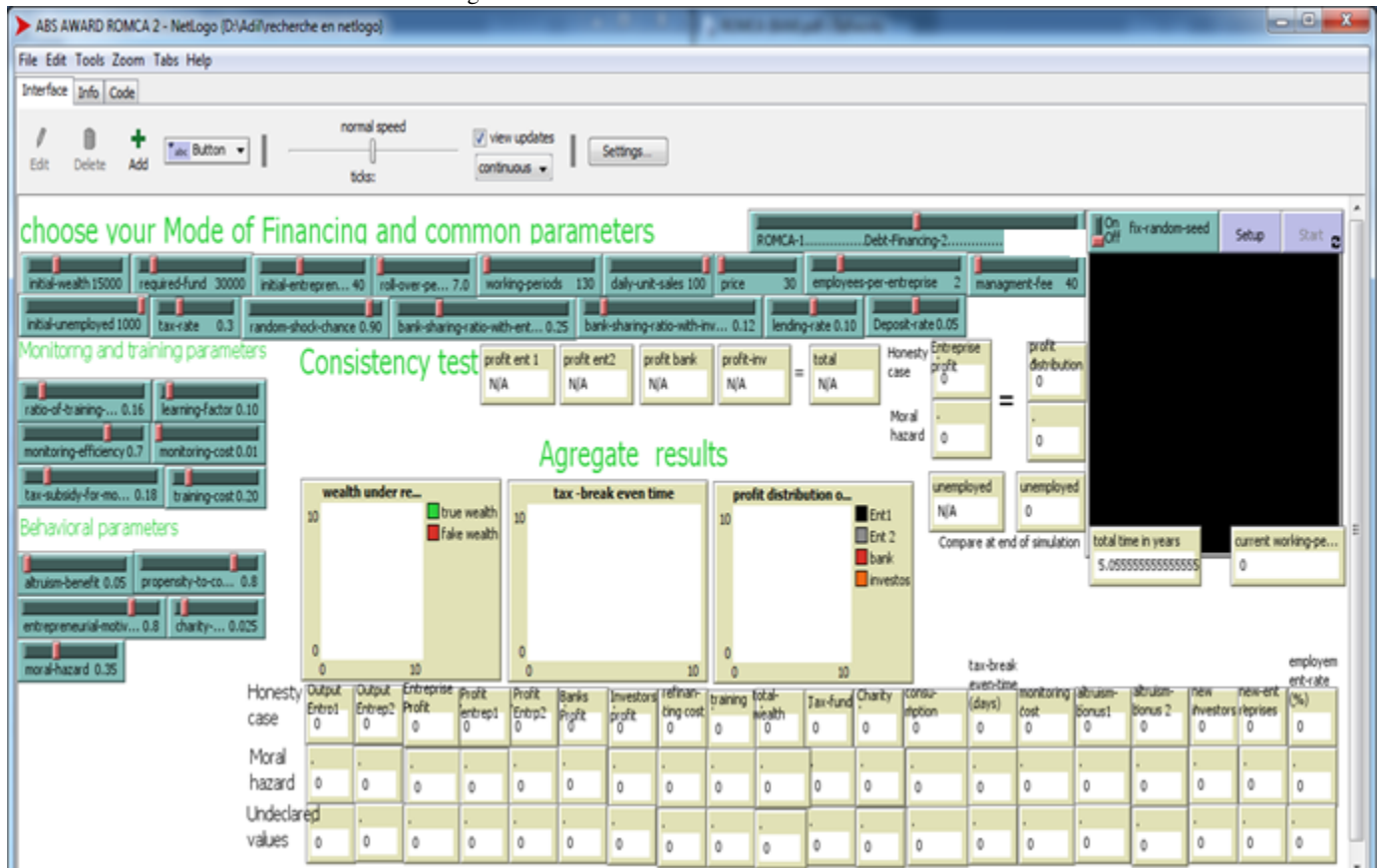
- Tax rate 30%

- Random-shock-chance: 80

- Bank-sharing-ratio-with-entrepreneurs:25

- Bank-sharing-ratio-with-investors:12

- Lending-rate: 10%

- Deposit-rate: 5%

3.2.2. Monitoring and training parameters

- Ratio-of-training-time-to-working-period: 16%

- The monitoring-efficiency: 70%

- monitoring-cost: 1%

- Tax-subsidy-for-monitoring-and-training: 18%

- Training cost :20%

- Learning factor: 10%

3.2.3. Behavioural parameters

- altruism benefits:5%

- The Propensity-to-consume: 30

- charity-rate: 2.5%

- Entrepreneurial-motivation: 80%

- Moral Hazard chance:35%

4. Results

The following tables show our results for the two modes of financing under the four scenarios:

4.0.1. Simulation under deflationary prices and different market conditions

Under the initial data, we select a deflationary environment using a low selling price. Then we run the simulation under a high chance and a low chance of adverse market conditions respectively. we run the simulation for both models. The price chosen is 10. we have chosen the high and low chance of adverse market conditions to be 80% and 20%

Table 2: Simulation outcome under deflationary prices and high chance of adverse random market conditions (LA)

Outcome	ROMCA	Debt − finance	
profit − bank%	4.6	83	
profit − investor%	20	9.47	
profit − entrepreneur1	37.5	3.48	
profit − entrepreneur2	38.27	3.48	
Total − wealth	3604086	3252473	
Tax − fund	2175743	1963672	
consumption	1525332	1374608	
tax − recovery(days)	110	248	
altruism − bonus	13499	0	
new − investors	13	1	
new − entrepreneurs	11	1	
employment%	2.2	0.2	

Table 3: Simulation outcome under deflationary prices and low chance of adverse random market conditions (LF)

Subject	ROMCA	Debt − finance	
profit − bank%	4.61	3.84	
profit − investor%	20	1.99	
profit − entrepreneur1	37.5	47	
profit − entrepreneur2	38	47	
Total − wealth	1.56E7	1.52E7	
Tax − fund	9528632	9327213	
consumption	6672344	6529085	
tax − recovery(days)	55	58	
altruism − bonus	58787	0	
new − investors	212	255	
new − entrepreneurs	169	204	
employment%	33	40.8	

4.0.2. Simulation of outcomes under inflationary prices and different market conditions

In this approach, we select a high price and test its effect under high and low chance of adverse random market conditions respectively. The price chosen is 30. we have chosen the high and low chance of adverse market conditions to be 80% and 20%

Table 4: Simulation outcome under inflationary prices and high chance of adverse random market conditions (HA)

$Subject$	$ROMCA$	$Debt-finance$	
$profit-bank\%$	4.04	5.92	
$profit-investor\%$	20	2.71	
$profit-entrepreneur1$	37.5	45.68	
$profit-entrepreneur2$	39.4	45.68	
$Total-wealth$	$1.10E7$	$1.12E7$	
$Tax-fund$	6720293	6859629	
$consumption$	4706507	4801778	
$tax-recovery(days)$	77	77	
$altruism-bonus$	101754	0	
$new-investors$	42	45	
$new-entrepreneurs$	34	36	
$employment\%$	6.8	7.2	

16

Table 5: Simulation outcome under inflationary prices and low chance of adverse random market conditions (HF)

$Subject$	$ROMCA$	$Debt-finance$	
$profit-bank\%$	4.64	0.99	
$profit-investor\%$	20	0.64	
$profit-entrepreneur1$	37.5	49.3	
$profit-entrepreneur2$	38	49.3	
$Total-wealth$	4.7E7	4.7E7	
$Tax-fund$	2.92E7	2.89E7	
$consomption$	2.05E7	2.02E7	
$tax-recovery(days)$	19	20	
$altruism-bonus$	165642	0	
$new-investors$	651	826	
$new-entrepreneurs$	521	661	
$employment\%$	100	100	

5. Discussion

The results of the simulation shows some important facts as summarised in the following table which show the outcomes where each mode of financing has a comparative dominance over the othr.

Table 6: Outcomes of dominance by market and price scenarios: ROMCA VS debt Finance

CASE	ROMCA	Debt-Finance
HF	Altruism	Employment, Enterprises, Investors
LF	Altruism	Employment, Enterprises, Investors
HA	Altruism	No Dominance
LA	Altruism, Employment , Enterprises , Investors Tax recovery , Tax fund , Wealth, Consumption	No Dominance

17

In an environment characterized by low prices and high chance of adverse market conditions (LA), ROMCA seems to dominate debt financing in terms of employment, enterprises new investors wealth and consumption creation. Tax authorities start to quickly recover their tax proceeds and higher tax fund is noticed. The fact that (LA) is the worst among the four cases scenarios, ROMCA seems to be much more resilient than debt financing in such difficult economic environment.

Regardless of the inflationary level in prices, and as long as market conditions are favourable (HF or LF), it seems that debt financing is more able to generate higher employment, enterprises and new investors. there is no noticeable difference in terms of wealth, consumption, tax fund, or tax recovery.

In an environment characterised by high prices and high chance of adverse market conditions (HA), both modes perform equally likely with minor differences in the reported results.

The results also show that under all cases, ROMCA dominates Debt financing in terms of rewarding entrepreneurs due to the altruism they show towards their peers.

It is also apparent that, except in an environment of high prices and adverse markets, ROMCA dominates Debt-Finance in terms of quicker tax recovery, higher tax funds wealth and consumption levels.

6. Conclusion

In this research we have tried to compare the performance of two financing models under different market conditions and price levels. ROMCA seems to dominate debt financing, at all levels, in a crisis environment characterised by low prices and adverse market conditions. except in an environment of high prices and adverse markets, ROMCA dominates Debt-Finance in terms of quicker tax recovery, higher tax funds wealth and consumption levels.

If market conditions are favourable debt financing however is more able to generate higher employment, enterprises and new investors although no noticeable difference in terms of wealth, consumption, tax fund, or tax recovery was noticeable.

In an environment characterised by high prices and high chance of adverse market conditions, both modes perform equally likely with minor differences in the reported results.

ROMCA also dominates debt-financing as it rewards entrepreneurs for the altruism they show

towards their peers.

While it is apparent that debt-financing performs better only under favourable market conditions, ROMCA however shows to be more resilient under adverse market conditions. We run this simulation experiment purely n hypothetical data. We propose extending this research by running a real experiment where subject perform under both methods of financing.

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