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Research Paper

On the Comparative Analysis of Investment Options in the Perspective of different types of Stock Exchange Interaction Models

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Abstract
We have used the ODE 45 numerical scheme to investigate the investment options in the scenarios of different interactions models of the stock exchange. Our comparative analysis showed that the first investor is more vulnerable to a severe depletion of his dividends irrespective of the type of interaction whereas the dividends of the second investor are similarly vulnerable to depletion only for the scenario of a mutualistic interaction, while the same investor is associated with increase in accrued dividends for scenarios of competition and predation interactions. Ironically, it was found that in the context of commensalism, the variation of growth rate value of the first investor does not produce any change in the dividends of the second investor.
Keywords*: ODE 45, dividends, depletion, mutualistic interaction, competition, predation, commensalism*

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I. Introduction

A dynamical system such as the interaction between stock exchange investors can be described by different business interaction models. In this work, we have done a comparative analysis of the different interaction models that best explain the different investment options. These options are competition, mutualism, predation and commensalism.

II. Model Formulation

Our model equations are typical of Lotka-Volterra formulation and have purely deterministic parameter value (Lakka (2013), Levinson (2009), Tang and Zhang (2005), Khodabin and Shekarabi (2016), Sikder and Roy (1994), Khamis et al (2011), Cajueior et al (2009), Nafo (2016), Modis (1999), Tsai (2015), Morris and Pratt (2003). They comprise a system of continuous nonlinear first order ordinary differential equations. They are given below with the following notations:

$w_1(t)$ is the dividend of the first of investor at time t

$w_2(t)$ is the dividend of the second of investor at time t

α_1 is the intrinsic growth rate of the dividend of the first of investor

α_2 is the intrinsic growth rate of the dividend of the second of investor

β_1 is the intra-competition coefficient which is the inhibiting factor on the growth of the dividend of the first of investor due to its interaction with itself.

β_2 is the intra-competition coefficient which is the inhibiting factor on the growth of the dividend of the second of investor due to its interaction with itself.

γ_1 is the inter-competition coefficient which is the inhibiting factor on the growth of the dividend of the first of investor due to the interaction of the second investor.

γ_2 is another inter-competition coefficient which is the inhibiting factor on the growth of the dividend of the second investor to the interaction of the first investor.

$w_1(0)$ and $w_2(0)$ are the initial dividends of the first and second of investor respectively.

We thus have

1. Competition interaction (- , -) is

$$\frac{dw_1(t)}{dt} = w_1(t)(\alpha_1 - \beta_1 w_1(t) - \gamma_1 w_2(t)) \quad (1.1)$$

$$\frac{dw_2(t)}{dt} = w_2(t)(\alpha_2 - \beta_2 w_2(t) - \gamma_2 w_1(t)) \quad (1.2)$$

$w_1(0) > 0,\ w_2(0) > 0$

This type of interaction indicates that both investors are competing for survival on the limited resources (Verhulst, 1990). Here, each investor directly or indirectly inhibit the growth of the other investor.

2. Mutualistic interaction (+ , +)

The model for this interaction is

$$\frac{dw_1(t)}{dt} = w_1(t)(\alpha_1 - \beta_1 w_1(t) + \gamma_1 w_2(t)) \quad (2.1)$$

$$\frac{dw_2(t)}{dt} = w_2(t)(\alpha_2 - \beta_2 w_2(t) + \gamma_2 w_1(t)) \quad (2.2)$$

$w_1(0) > 0,\ w_2(0) > 0$

In this type of interaction, both investors are benefiting from the operation of each other as they contribute positively to each individual investor in the interaction (He and Gopulsamy, (1997) and May (1982). It is a type of symbiotic interaction.

3. Predation (+ , -)

The dynamics of this type of interaction is

$$\frac{dw_1(t)}{dt} = w_1(t)(\alpha_1 - \beta_1 w_1(t) + \gamma_1 w_2)(t) \quad (3.1)$$

$$\frac{dw_2(t)}{dt} = w_2(t)(\alpha_2 - \beta_2 w_2(t) - \gamma_2 w_1(t)) \quad (3.2)$$

$w_1(0) > 0,\ w_2(0) > 0$

In this type, the first investor is benefiting at the expense of second investor in their interaction with each other.

4. Commensalism (+, 0)

This model, for commensalism, is given by

$$\frac{dw_1(t)}{dt} = w_1(t)(\alpha_1 - \beta_1 w_1(t) + \gamma_1 w_2(t)) \quad (4.1)$$

$$\frac{dw_2(t)}{dt} = w_2(t)(\alpha_2 - \beta_2 w_2(t)) \quad (4.2)$$

$w_1(0) > 0,\ w_2(0) > 0$

In a commensalism type of interaction between two investors, in a stock exchange, one investor (the commensal) benefits from the interaction while the other investor (the host) is unaffected.

Method of Analysis

We have applied a numerical scheme of ODE 45 to investigate our analysis of the comparison of the different investment options in the stock exchange. This was done using the same initial investment values of 1.2 million naira and 1.4 million naira for the first and second model, for the trading periods of 1 month, 40 months, 45 months, 50 months and 70 months.

Our results are presented and discussed below.

III. Results

Table 1.1: ODE 45 numerical calculation of the dividend of interacting investors with the initial investment (1.2, 1.4) undergoing uncertain analysis: competition interaction with $\alpha_1 = 0.0037$, trading period interval = [1m, 40m, 50m, 55m, 60m, 65m, 70m]

Dividends (1) [old]	Dividends (1) [new]	Effect 1 (%)	Dividends (2) [old]	Dividends (2) [news]	Effect 2 (%)
1.2000	1.2000	0.00	1.4000	1.4000	0.00
3.9830	1.1572	70.95	3.7750	3.9278	4.08
4.5416	1.1404	74.89	4.2176	4.4472	5.44

5.1433	1.1203	78.22	4.6891	5.0206	7.07
5.7826	1.0968	81.03	5.1861	5.6514	8.97
6.4520	1.0696	83.42	5.7045	6.3412	11.16
7.1420	1.0389	85.45	6.2390	7.0905	13.65
7.8420	1.0046	87.19	6.7839	7.8988	16.44

Table 1.2: ODE 45 numerical calculation of the dividend of interacting investors with the initial investment (1.2, 1.4) undergoing uncertain analysis: mutualistic interaction with $\alpha_1 = 0.0037$, trading period interval = [1m, 40m, 50m, 55m, 60m, 65m, 70m]

Dividends (1) [old]	**Dividends (1) [new]**	**Effect 1 (%)**	**Dividends (2) [old]**	**Dividends (2) [news]**	**Effect 2 (%)**
1.2000	1.2000	0.00	1.4000	1.4000	0
4.9697	1.4571	70.68	4.4685	4.2686	4.47
5.9254	1.5098	74.52	5.1934	4.8799	6.04
7.0469	1.5699	77.72	6.0405	5.5621	7.92
8.3556	1.7178	80.39	7.0319	6.3188	10.14
9.8734	1.7178	82.60	8.1940	7.1522	12.71
11.6219	1.8090	84.43	9.5580	8.0635	15.64
13.6224	1.9147	85.94	11.1607	9.0518	18.90

Table 1.3: ODE 45 numerical calculation of the dividend of interacting investors with the initial investment (1.2, 1.4) undergoing uncertain analysis: predation interaction with $\alpha_1 = 0.0037$, trading period interval = [1m, 40m, 50m, 55m, 60m, 65m, 70m]

Dividends (1) [old]	**Dividends (1) [new]**	**Effect 1 (%)**	**Dividends (2) [old]**	**Dividends (2) [news]**	**Effect 2 (%)**
1.2000	1.2000	0.00	1.4000	1.4000	0.00
4.9221	1.4486	70.57	3.7384	3.9131	4.67
5.8405	1.4974	74.36	4.1568	4.4233	6.41
6.9002	1.5524	77.50	4.5918	4.9854	8.57
8.1090	1.6144	80.09	5.0354	5.6011	11.23
9.4696	1.6845	82.21	5.4779	6.2706	14.47
10.9767	1.7642	83.93	5.9079	6.9935	18.38
12.6158	1.8548	85.30	6.3135	7.7676	23.03

Table 1.4: ODE 45 numerical calculation of the dividend of interacting investors with the initial investment (1.2, 1.4) undergoing uncertain analysis: commensalistic interaction with $\alpha_1 = 0.0037$, trading period interval = [1m, 40m, 50m, 55m, 60m, 65m, 70m]

Dividends (1) [old]	**Dividends (1) [new]**	**Effect 1 (%)**	**Dividends (2) [old]**	**Dividends (2) [news]**	**Effect 2 (%)**
1.2000	1.2000	0.00	1.4000	1.4000	0.00
4.9451	1.4528	70.62	4.0870	4.0870	0.00
5.8812	1.5035	74.44	4.6460	4.6460	0.00
6.9698	1.5609	77.60	5.2659	5.2659	0.00
8.2245	1.6262	80.23	5.9491	5.9491	0.00
9.6557	1.7007	82.39	6.6969	6.6969	0.00
11.2684	1.7859	84.15	7.5094	7.5094	0.00
13.0607	1.8837	85.58	8.3851	8.3851	0.00

IV. Discussion of Results

Irrespective of the type of interaction between the stock exchange investors, the dividends of the first investor are dominantly vulnerable to depletion. In particular, the depletion of the dividends for a competition interaction ranges from zero to 87.2 percent while in the scenario of a mutualistic interaction, the depletion of the dividends ranges from zero to 85.9 percent. In the scenario of a predation, the depletion of the dividends ranges from zero to 85.30 percent whereas for a commensalistic interaction, the depletion of the dividends ranges from zero to 85.58 percent. In summary, for the initial investment boundaries (1.2, 1.4), the dividends of stock exchange investors are dominantly vulnerable to depletion.

In contrast, for the second investor in the scenario of a commensalistic interaction, there is a zero effect, that is the dividends are neither increasing nor decreasing. For the competition and predation types of interactions, the dividends of the second investor increase from a zero effect to 16.44 percent and the dividends of the second investor increase from a zero effect to 23.03 percent. In this context, the dividends of the second investor are vulnerable to a dominant depletion from a zero effect to 18.90 percent in the scenario of a mutualistic interaction.

V. Conclusion

In this study, irrespective of the type of interaction, we have found that the first investor is dominantly vulnerable to the depletion of the dividends whereas for the second investor, the mutualistic interaction is associated with the depletion of the dividends while the increase of dividends are linked to the competition and predation interactions between the two stock exchange investors. In terms of the loss of the dividends, the first investor is highly likely to suffer financial liquidation irrespective of the type of interaction followed by the second investor suffering also from the mutualistic interaction. In terms of the profitability of the dividends, for the competition and the predation types of interaction, the second investor is highly likely to benefit. In a future investigation, we shall consider how the variations of the growth rate of the second investor and the combination of the growth rates will affect the distribution of the dividends.

Recommendations

From the results we have obtained from our analysis, we recommend that healthy competition should be encouraged between stock exchange investors for increased economic profitability.

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