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Designing Philips Model and Philips Curve of Fractional Order in the Economy of Iran

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ABSTRACT

Negative relation between unemployment and inflation is known as the Philips model, which states, when inflation is high, unemployment gently decries and when unemployment is low, salaries will increase rapidly. While economic planners of the country tend to impart this situation highly, it would fall down, because frequent increase of inflation with the hope of keeping unemployment low permanently, ultimately will cause rise in expected inflation of organizations and lead to change in their recruitment decisions. In a section of this model, it has also analyzed, relation between income, investment, and consumption. Regular Philips model with derivative deals with first and second level of calculations, however this model has faced many weaknesses and deficiencies in economic cycle of Iran. Regarding its implementation in the economy of Iran, in this research, through substitution of Caputo fractional-order derivatives, we reach out "Philips model of Fractional-order". Moreover, by numerical calculation of resulted equations and using Maple software, we over reach to Philips curve of Fractional-order in multiple various orders. According to achieved results, this model highly depends on derivation orders and different outcomes will be acquired through various derivation orders. Acquired model in the economy of Iran (situational format in Sugar and Sugar cube Industries) has been studied through phasic technic which proves meaningfulness of relations between variables of the model.

1- Introduction.

By getting complication of economic activities, regular mathematic models could not be efficient for researchers' need. Thus the idea of generalization mathematic models became essential for them. The idea of universalization of derivative to none-integer orders, first time introduced by Lieb Neitz in 1695 for 1 / 2 order and then in 1738, Aviler propounded this method of derivative for new series of functions. In 1812 and 1822 many progresses were accomplished by Lapas and Fourie and then in 1847 Riemann and Liouville introduced a definition for this kind of derivative called "Riemann-Liouville Fractional order derivative". In 1968, Hadamard propounded Fractional order Integral. For more information refer to references 1, 2 and 3.

2- Review of the previous researches

Since 1914, Fractional account rapidly spread, which first conference related to this issue held by Bertram Ross in Newhaven University. Several assumptions for first time propounded by Caputo and Mainardi in 1971 regarding utilization of the models base on none-integer derivatives. From the viewpoint of applicability in different sciences, a book was written by Oldham and Shpiner in 1975 which played very significant role in development of fractional account and its applications. In this article we do modeling the Economic Philips Model base on fractional order derivatives and discuss about the out coming changes.

Research procedures

3- Research Procedure..

In following article, the relation of Philips for fractional order has been stated and proved through applying analysis and affirmation method and out coming results will be discussed and analyzed by using mathematic software Maple and concept of Phasic technic.

4- Philips Model of Fractional Order..

Assume following as variables of this model: Y(t) as income, K(t) as share capital, C(t) as consumption and I(t) as investment (invested amount).

In 1954 Philips in reference 6 stated an economic model as followed:

Philips assumed the relation between consumption and income as:

$$C(t)=cY(t), \quad 0<c\le 1$$

Also, assumed share capital has linear relation with income:

$$K^{(d)}(t)=vY(t), \qquad v>0$$

The relation of share capital and investment amount expressed by differential equation as:

$$K=I(t)=\beta\left(k^{(d)}(t)-k(t)\right)=\beta\left(vY(t)-k(t)\right),$$

$$\beta>0$$

Also assumed that changes in income is related with consumption and investment amount as:

$$Y(t)=\alpha\left(C(t)-I(t)-\mathrm{Y(t)}\right),$$

$$\alpha>0$$

And ultimately he introduced following linear differential equation as the Philips model:

$$Y(t)+(\alpha(1-c)+\beta-\alpha\beta\upsilon)\,\mathrm{Y(t)}+\alpha\beta(1-\mathrm{c})\,\mathrm{Y(t)}=0$$

After introduction of derivative with fractional order a question would be arise which how the Philips model propound by using fractional order derivative and whether changes of derivation order has any effect on out coming results? For answering this question, Philips model of fractional order is presented as follow:

$$C(\mathrm{t})=\mathrm{cY(t)}$$

$$I(t)={}^{\beta}\left(vY(t)-K(t)\right)$$

$$D_t^{\alpha}K(t)=I(t)$$

$$D_t^{\alpha}K(t)=\alpha\left(C(t)+I(t)-Y(t)\right) \qquad (9)$$

From equation (9) following fractional equation is resulted:

$$D_t^{z\alpha}Y(t)+\alpha_1 D_t^{\alpha}Y(t)+b_1Y(t)= \qquad (10)$$

While: $\alpha_1=\alpha(1-c)+\beta(1-\alpha\upsilon)$

and $\quad b_1=\alpha\beta(1-c)$

For solving this differential equation, common and regular methods of differential equation is not sufficient and the answer can be calculated only through numerical method.

5- Numerical solution of the Fractional order Philips equation.

For numerical solving of equations related to the Philips model of fractional order assume that:

$$y_0(t) = \mathrm{x(t)}$$
$$y_1(t) = D_t^{\alpha}\, y_0(t)$$
$$y_2(t) = D_t^{\alpha}\, y_1(t)$$
$$y_3(t) = D_t^{\alpha}\, y_2(t)$$

Thus, equation (10) will be as followed:

$$D_t^{\alpha} y_3(t) = \frac{\varphi_1\left(y_0(t)\right)}{r(1+4\alpha)} - \alpha_1 \frac{r(1+2\alpha)}{r(1+4\alpha)} y_2(t) \qquad (11)$$

- Through the assumption of:
  $\varphi_1\left(y_0(t)\right) = b_1 y_0(\mathrm{t})$
- and symbolization of:
  $Z(\mathrm{t}) = \left(y_0(t), y_1(t), y_2(t), y_3(t),\right)^r$

Matrix form of system (11) would be as:

$$D_t^{\alpha}\, \mathrm{Z(t)} = A_4 Z \qquad (12)$$

While matrix is defined as:

$$A_4 = \begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ -\dfrac{b_1}{r(1+4\alpha)} & 0 & -\dfrac{\alpha_1 r(1+2\alpha)}{r(1+4\alpha)} & 0 \end{bmatrix} \qquad (13)$$

The answer of system (12) with clause of Z(0) is:

$$Z(t) = \sum_{k=1}^{\infty} E_\alpha\left((-1)^{\alpha k} A_4^k\right) Z(0)$$
$$= (E + \sum_{k=1}^{\infty} (-1)^k \frac{t^{\alpha k}}{r(1+\alpha k)} A_4^k)\, \mathrm{Z(0)} \qquad (14)$$

where "E" is function of Mittag-Leffler in one parameter, which present as:

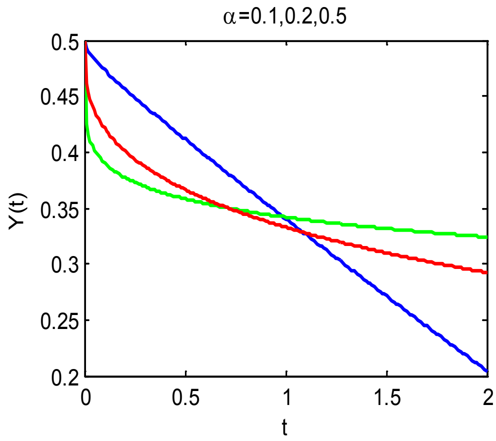
$$E_\alpha(t) = \sum_{k=0}^{\infty} \frac{t^k}{r(\alpha k + 1)}$$

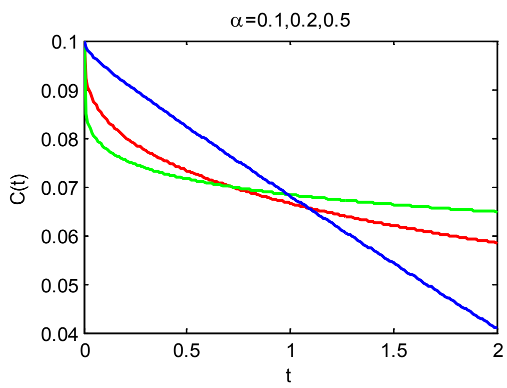
The answers particularly are:

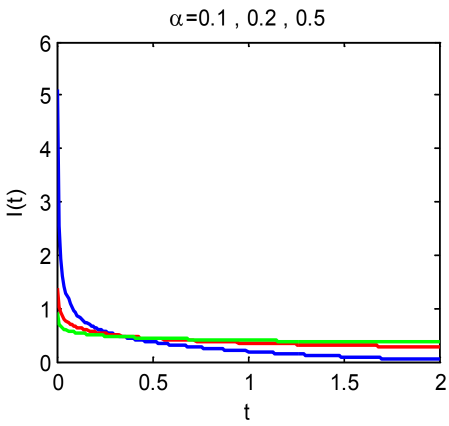
$$Y(t) = (1,0,0,0) Z(t)$$
$$C(t) = cY(t)$$
$$I(t) = D_t^{\alpha} Y(t) + \alpha(1-c) Y(t)$$
$$K(t) = \frac{\upsilon}{\beta} Y(t) - \frac{1}{\beta} I(t)$$

6- Diagrammatic analysis of the Philips model

As mentioned in previous section, the answers acquired from this model are different from previous model and now a question would be arise which whether the resulted amount would be different by change in derivation order? For answering this question we will draw diagrams related to each function for derivation amount of 0.1, 0.2 and 0.5 which results would be as followed:



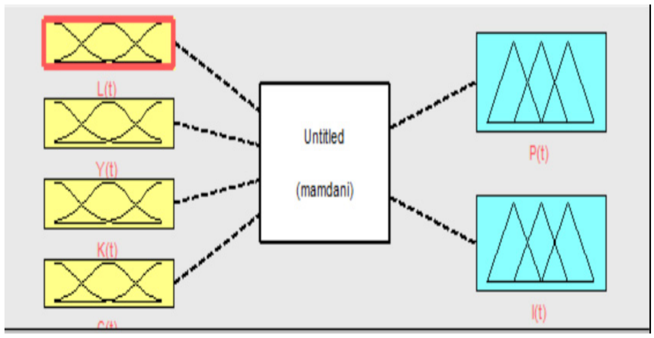




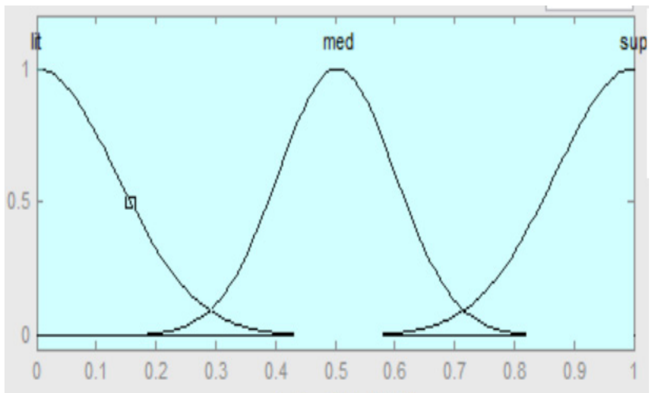
Through careful study of the diagrams, we realize that by changing in quantities α , out coming amounts from functions are also different, even in small quantities of α. Basically, though phasic system, describes indefinite and indeterminate phenomenon, but the phasic theory itself is perfectly accurate. In following article there are two reasons for utilizing phasic system. In the economy of Iran some specific environmental reasons Such as sanctions, resistance acts against these sanctions, fluctuations of international oil price and international fluctuation of demand and supply, resistance economy strategy, simultaneous progress in one sector and recession in other one, etc. have made some of the variables indistinct and unclear. Thus in scientific studies for acquiring real and accurate answer, it is not possible to rely on existing statistical data which sometimes are incomplete.

Being in information era, human wisdom and cognizance has become most significant. Hence it's necessary to formulate human knowledge systematically and use it along with other mathematic models in economic systems. One of the most practical tool for reaching this objective, is phasic logic.

In the definition of membership function, which it's going to survey the relations among six macro variables of the economy of Iran, four variables, Unemployment K(t), Income Y(t), Share capital K(t) and Consumption C (t) are considered as input variables and two variables Inflation P(t) and Investment I(t) as dependent variables according to relation.



In definition of type of membership functions, it is possible to act according to nature and characteristic of each variable. In following situation due to nature of data we consider the kind of membership functions as normal and also select normal type for entire variables due to normal distribution of data of each variable.

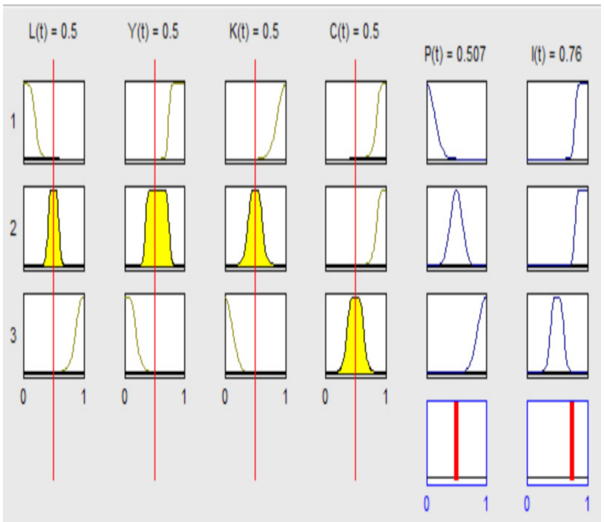


In membership function mentioned above, sign of "Lit" signifies small proportion of respective variables, "med" sign of medium and "sup" presents high proportion of economic variable.

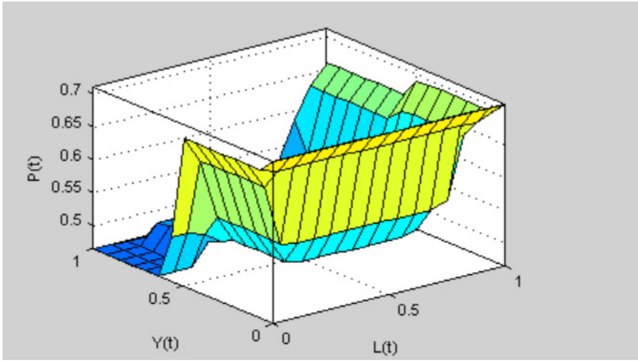
For estimating data and conjecture it's enough to enter data, statistics and human knowledge into respective software. In this section we have entered two hundred opinions of expert and critics from several parts of the country including authorities from sugar industry and economists integrated through phasic model in the form of “If-then”. For instance three cases are displayed as followed:

1. If (L(t) is Lit) and (Y(t) is sup) and (K(t) is sup) and (C(t) is sup) then (P(t) is lit)(I(t) is sup) (1)
2. If (L(t) is med) and (Y(t) is med) and (K(t) is med) and (C(t) is sup) then (P(t) is med)(I(t) is sup) (1)
3. If (L(t) is sup) and (Y(t) is lit) and (K(t) is lit) and (C(t) is med) then (P(t) is sup)(I(t) is med) (1)

In phasic system scripts are prepared in form of “If-then”. Important aspect of the theory of phasic systems is that a systematical process is prepared for transition of an information data base to a none-linear script. In following histogram qualitative data are presented as quantitative output, which reflects scale and condition of dependency of output variables on other variables of Philips model in the economy of Iran. By any change in quantity of each input variable in this histogram, different quantities are achieved as input variables which is debatable, in the condition of existing information, proportion of influence of output variable P(t) is indicated as 0.507 and I(t) as 0.76, which results of Philips model and Philips curve, confirm fractional order higher than medium (0.5).



In following 3D (three dimensional) space, relation between inflation P(t), income Y(t) and unemployment L(t) are indicated, for example in the occasion inflation being 0.6, indicates being less than income which is 0.5 and less than unemployment which is 0.55 and also presents relations of these three variables in respect of different quantities of each other.



7- Conclusions

In this article we used a combination of the Navi Bayes data mining technique and the optimizing artificial bee colony algorithm for problem-solving of the issue of finding a suitable location for a beet factory. We used a combinatorial approach based on classification In order to achieve to a accurate prediction and suitable locating of a new-built sample. At first in the primary phase we used the Navi Bayes to predict a new sample and then we tried to decrease the range of the errors in the predicting of the Navi Bayes in a training set by using an artificial bee colony (ABC) algorithm based on changing the features that it also resulted on decreasing in the range of errors on the testing set. In fact, ABC algorithm has been used in the stage of training the classifying Navi Bayes then the stage of testing would be classified (predicted) more accurate. Performing the proposed algorithm on the data of the beet factory shows that this method considerably has a high accuracy in local resolution of the factories and predicting a new instance.

8- Conclusion and suggestions

According to information presented hitherto, we realize that by any change in derivative type, Philips model formula will change and through drawing diagrams of out coming answers for different orders of α we notice that by change in derivation orders, out coming diagrams will change and in this model, derivation orders encompass specific importance. This is the question that which one of derivation orders and Philips model derived from it, could be compatible to the economy of Iran and for answering this question we have surveyed through choosing industrial sector which our claim in respect of this Philips model and Philips curve of fractional order have been proved and we suggest considering respective data and information related to different sectors of economy, accomplish the study of compatibility of this model with the economy of Iran

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