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APPLICABILITY OF NON LINEAR MECHANICS TO GIG ECONOMY FOR SUSTAINABLE GROWTH

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Abstract

The laws of complexities hold universally irrespective of system's constituent parameter. Many real world phenomenon that are part of our everyday life like fluid flow, dripping tap, beating heart, population growth(human, animal, viruses etc.), weather forecasting, national economy, noise in electronic circuit are non-linear in nature.[1] Degree of predictability is the major distinctions between linear and non linear system. Even a relatively simple system can become chaotic for certain range of parameter. In this paper we will discuss how Logistic map (mathematical model) and Lyapunov exponent (a tool to quantify the sensitivity) can be use to understand the course of gig economy, a complex system in itself. Gig economy is characterize by many parameters apart from flexibility and independence. With reference to logistic map keeping the growth rate at optimum value will prevent the system either from entering in chaotic zone or stagnancy.

Keywords: *Logistic Map, Gig economy, Lyapunov exponent*

Introduction:

Not everything around can be observed or predicted perfectly or in a deterministic fashion uncertainties in various sources causes our observation and prediction to behave randomly further not all the randomness we see is due to chance but it is the non-linear relationship that causes things to look random. Economy or fluctuations in economy for that matter can be attributed to non linear phenomenon.

Gig Economy Overview:

Gig Economy also called as free-lance economy or sharing economy refers to a work force that operates using online platform through which a client and service provider can communicate with each other directly. The former can place order, request service from any corner of the globe as per service providers network. Some common examples are Uber, Airbnb, Fiverr, Task Rabbit or any local startup which operates either using app or website.

The gig sector comes with several advantages like online platform, free-lancing. flexible work hours, no age or degree qualification bar as such along with disadvantages like no job security, no earning stability, no health or after retirement benefits but despite these fact freedom to take multiple jobs and flexibility in work hours are two main reasons that draws more people into this. Now in Indian scenario projected figure of gig workers is around 23 million by 2030 and it is expected to contribute 1.25% of Country's GDP.[3]

In 2024, the market size for gig economy globally is of $556.7 billion. By 2032, that's expected to reach $1,847 billion. [4]

Now with such a huge market it is necessary to track the trends in order to regulate the system for steady performance.

Gig as a Non linear Dynamic System:

A non linear system or chaotic system is characterized by extreme sensitivity to initial conditions and unpredictability. The sensitive dependence of long term behaviour of a system on initial condition is referred to as Lorentz effect also called as butterfly

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effect; '*when a butterfly flap it's wing in Texas the weather perturbation propagates over a period of time could lead to great weather front in Brazil.*'[5] So even a minute or seemingly irrelevant change in initial conditions over a period of time can make system chaotic.

Gig economy depends on multiple independent component or variables including platform policies, worker availability, consumer demand, geographical position, poor or no network connectivity, rise in fuel price, market condition etc.

Any minute change or slight shift in this could led to recurring effect and in long term that that could led to system which behaves irregularly with no specific pattern.

In essence, by acknowledging the chaotic nature of the gig economy, we can think of an equation that embrace this uncertainty and create more adaptive, responsive platforms.

Logistic Map Equation Interpretation:

Logistic map is a simple non linear equation given by $x_{n+1} = \lambda x_n(1 - x_n)$ in which present state is mapped on to future state, shown graphically as a parabola with maxima corresponding to $\lambda = 4$, and x is allowed to take values between 0 to 1. The plot of x_{n+1} vs x_n represents a growth of a function and after having reached maximum it drops.

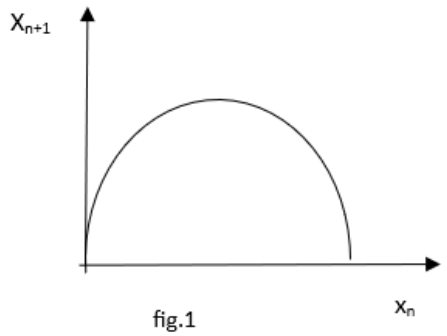

fig.1

It has three parameters x_{n+1} , x_n and λ. x_{n+1} represent future state, λ is control parameter or growth parameter and x_n is a present state.

Graph of $\boldsymbol{fixed\ point}$ vs λ i.e growth rate (control parameter) is shown below.[5]

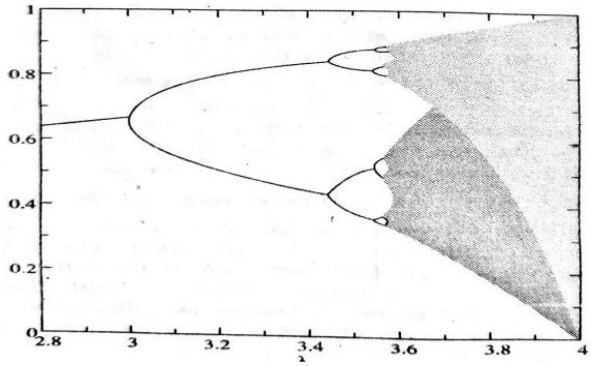

Fig.2

For $1 < \lambda < 3$, there is only one stable point that means even after several iteration x_{n+1} converge to single value . The transition from one stable fixed point to a pair of stable period 2 point is known as Bifurcation. This implies that instead of one there are two stable values and system oscillates between these two values. As λ increases further the difference between the pair of stable point goes on increasing till about $\lambda = 3.45$ for $\lambda > 3.45$ second bifurcation occurs that is a pair of stable period 2 point turns into quartet of period 4 point . . As λ increases further system goes from 4 cycle to 8 cycle system becomes very very sensitive to change in λ .

At about λ =3.57 infinite number of bifurcation occurs and no value of x_{n+1} are repeated hence above λ =3.57 the logistic map shows no periodicity at all such a point is called strange attractor . It shows non repetitive non periodic behaviour, it is the onset of chaos.

Lyapunov Exponent :

(λ_L) tool to quantify sensitivity:

While Logistic map is a mathematical model, the quantitative test of the sensitivity on initial condition is given by Lyapunov Exponent(λ_L).

$$d_k = d_0 e^{\lambda_L k}$$

Above equation is use to calculate λ_L , $Where$ d_0 is the initial separation between the two trajectories generally

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very close to each other at k=0 and d_k is the separation between them after k iterations .

If calculated value of $\lambda_L \leq 0$ system is steady, $\lambda_L > 0$ it's a chaotic system.

With reference to logistic map one can always keep the control parameter less than 3 for steady sustainable growth, the Lyapunov exponent is often calculated to analyse its behaviour as control parameter varies.

λ too low (less than 1) indicates over regulation reducing opportunities heading towards stagnancy

λ too high (greater than 3 less than 4) indicates under regulation or explosive growth

Conclusion :

By understanding gig economy through logistic map , policy makers ,companies and worker can anticipate market behaviour and design strategies for long term stability keeping check on control parameter ($1 < \lambda < 3$). This further aid in predicting futuristic trend and adaptability to market volatility. Thus the logistic map provides insight into cyclical pattern in the gig economy showing how growth, saturation and competition interact dynamically. It highlights why gig market experience boom bust over a period of time.

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Authors Contribution: **PAK** – Conceptualisation, Draft Outline, Writing Original Draft

MPT- Review, Redrafting, Analysis, **PJD**: Resources, Plot, Figure, Validation

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