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How Does the Social Wavefunction Impact Sustainable Economic Growth and the Country's Competitiveness? An Empirical Study of India

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Abstract

Contrary to earlier studies that identified national competitiveness as the chief determinant of a nation's Gross Domestic Product (GDP) and economic growth, this research pivots towards the intricate dynamics of social and cognitive waves. We explore the social wavefunctions, especially in the context of innovation and institutional structures within cognitive waves. These wavefunctions, intricately interlinked, evolve within societies, driving social transformations and shifts. Our main thesis emphasizes the crucial roles of innovation and policy decisions. Our empirical focus is on India, a burgeoning economy, using statistical panel data from the Global Competitiveness Index (GCI) covering the years 2007 to 2018. Through comprehensive interactive testing, we present our results across 9 tables and 7 figures. The findings illustrate that societal evolution manifests through changing patterns influenced by social, economic, and political forces, often producing unexpected results. These insights highlight the pivotal interplay between innovation capacities and institutional policy choices as key drivers of economic growth. This study charts a new course for research and, from the perspective of Quantum Mechanics entanglement, provides a novel understanding of the sustainability of human societal evolution. Keywords: Social wavefunction, Quantum Mechanics, sustainable growth, competitiveness, India

I. Background Issues to the Study

India has emerged as one of the world's most significant burgeoning economies and stands among the largest recipients of Foreign Direct Investment (FDI) globally. This rapid economic progression has captured the attention of numerous scholars, following its rise as the second-largest emerging economy worldwide, prompting extensive research into the underlying factors fueling this growth. Concurrently, an intriguing contemporary debate centers on the notion that the world is becoming increasingly localized rather than globalized. In other words, instead of witnessing greater integration, we are observing a trend toward decoupling. This paradox illustrates that

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while globalization has brought about certain benefits, it has also sparked discussions on the trade-offs involved. For instance, one key question is why India's socioeconomic development exhibits significant discrepancies, especially given the contrast between its vast market size and the substantial portion of its population still living in poverty and deprivation.

Research on emerging economies has pinpointed the crucial role of state-owned enterprises (SOEs), which have been instrumental in enabling large-scale FDI and fostering economic growth (Buckley, Clegg, Cross et al., 2007; Luo & Bu, 2018). However, there is also a debate regarding the developmental paths these economies take. For example, China, the world's second-largest economy, has a highly interdependent system that has led to unbalanced development. This is characterized by export-led growth on one hand and growth constrained by internal linkages on the other (Karagiannis, Cherikh, & Elsner, 2021). Research on China's economic trajectory (Liang, 2021) has highlighted a significant impediment to growth, arguing against the concept of "functional inequality." This refers to the declining labor share in national income, which has a dampening effect on aggregate consumer demand and, consequently, undermines technological advancement.

Fitoussi and Stiglitz (2013) have emphasized how in OECD countries (comprising 38 member nations in the Organisation for Economic Co-operation and Development), the increase in income for 80 percent of the population has lagged behind the overall economic growth rate. This phenomenon is even more pronounced when examining lower-income deciles. Fitoussi and Stiglitz (2013) stressed that to truly assess the impact of economic growth on society, we must understand what is happening to the majority of people. The emerging challenges draw attention to evolutionary changes and selection. The agency of survival and resilience through constant shifting fitness landscapes of adaptation is deemed as habitual adaptation— the evolutionary cycles, adaptation-selection-replication, Darwinian theory. Evolutionary selection of traits selects those perform better than others, though not the best possible (Johnson, Price, Van & Vug, 2013). A good example for study adaptative dynamics draws our attention to India. Similarly, Khalid, Sharma, & Dubey (2021: 304) have claimed that "India's current sustainability strategy is weak and demands more consideration towards social and environmental concerns such as increasing gender and income inequality" (UN Development Programme 2016), large education and health inequalities (Suryanarayana et al., 2016), high poverty rates, large, undernourished population, unbalanced urbanization and increase in frequency of droughts and floods (Jain et al., 2018).

Quantum Mechanics (QM) offers a fascinating lens through which to examine natural selection, particularly through the concepts of entanglement and decoherence arising from quantum correlations (Bell, 1964; Einstein, Podolsky, & Rosen, 1935, hereafter EPR). While Darwinian evolutionary processes necessitate that organisms maintain certain fitness levels, the mechanisms that can drive evolutionary fitness in rapidly changing environments remain underexplored. Our research addresses this gap by critically evaluating growth and sustainability, distinguishing these concepts from traditional GDP-centric views of competitiveness (Porter, 2024; 2011) and from the location-specific advantages related to growth opportunities (Ghamawat, 2017). We posit that India's economic development trajectory and growth patterns may differ significantly from those of many Western countries such as the United States, as well as from other emerging economies like China. China's state-cluster strategy, focused on key regions such as Shanghai, Guangzhou, Hong Kong, and other South-eastern areas, capitalizes on specific location advantages. In contrast, India's diverse geography, which includes hot climates, mountains, and deserts, presents unique challenges and opportunities. Research suggests that managing sustainable growth will require rapid and fundamental changes in our economies, necessitating new investments and innovations (Stern, 2022: 1259). However, the challenge of harnessing investments and innovations that can yield sustainable, resilient, and inclusive growth remains formidable.

To tackle this challenge, we offer explanations from the perspective of Quantum Mechanics (QM). Our framework aims to make three potential contributions. Firstly, we engage in the debate on measuring sustainable growth, arguing that the standard economic model focuses on a narrow range of variables that provide limited insight into sustainability. Secondly, we consider broader dimensions, including economic, environmental, and social indicators, which affect people and impact future generations. Our methods and measures delve into these diverse indicators to offer a more comprehensive understanding. Thirdly, our study is part of a larger research theme applying QM, paying close attention to the interactions between agents, systems, and structures that are integral to these interactions. Our approach not only reflects the entangled effects of an agent's actions but also considers the conditions of possibility set forth by social wavefunctions. While events occur at the intersections of these interactions, sustainability brings to light our observations on innovation and capabilities. Our work on QM is relevant for illuminating social science problems and is increasingly gaining traction. By drawing on quantum mechanics and quantum probability theories, we present a quantum framework for understanding

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organizational complexity and the common decision-making processes that can lead to success or failure within uncertain environments. This quantum approach to time and space changes provides a novel lens through which to comprehend the intricacies of organizational behavior and decision-making in the face of rapidly shifting circumstances.

II. Literature Review and Critical Evidence

Traditionally, economics and management theory have depicted organizational evolution as a straightforward linear progression, moving seamlessly from the past to the present and then into the future. This linear perspective, however, offers minimal insight into the rare, unpredictable events that can dramatically alter historical trajectories and obscure the uncertainties inherent in emerging organizational phenomena within a dynamic and challenging environment (Lord, Dinh, & Hoffman, 2015). Although prior research in several pertinent areas has identified critical factors contributing to economic growth, especially within the context of emerging economies, there remains a significant gap in our understanding of the capacity to handle uncertainty or "unforeseen consequences." Additionally, the limitations of statistical systems pose a problem, as they fail to inform us whether our current actions are sustainable on economic, social, political, or environmental fronts. Recent theoretical advancements in Quantum Mechanics as applied to social science, including fields such as organizational behavior, psychology, and evolutionary game theory (e.g., Aspect, 1999; Bell, 1964; Busemeyer, Wang, & Townsend, 2006; Barad, 2007; Brandenburger, 2010; Lord et al., 2015; Der Derian & Wendt, 2020; Murphy, 2022), have spurred research aimed at providing more profound explanations for the evolutionary challenges faced by human societies. In the realm of emerging economies, existing studies have delved into the implications of government intervention and investment, shedding light on their effects on nations such as India and other developing economies. With regard to innovation and investment, research has examined how the evolving role of the State influences a country's growth dynamics. For instance, changes in the State's and institutions' roles have been pivotal in the socialization of investment, an idea rooted in Keynes' concept of the "socialisation of investment" (Jabbour & Paula, 2021). The connection between university and industry innovation is also widely acknowledged as a powerful driver of social evolution, yet studies have revealed a range of mixed findings.

While leveraging knowledge with universities and co-located international enterprises has proven beneficial for cross-sector knowledge utilization, local firms often exhibit inconsistent international exposure and maintain weak relationships with global firms in advanced technology sectors. For example, Compagnucci, Lepore, and Spigarelli's (2021) study of the Triple Helix Model in China illustrates these discrepancies. Further studies have elucidated how the evolving relationship between the Chinese State and other agencies reflects institutional innovation cycles within a modern monetary economy, emphasizing the importance of the financial system's development and the State's role in fostering investment capital over consumption investment (Wang & Giovanis, 2021). Moreover, numerous studies have recognized the challenging trade-offs that governments face between implementing environmentally sustainable economic policies and enhancing the immediate welfare of their citizens. Conflicting perspectives on the merits of innovation abound; for instance, a firm's R&D and innovation performance tends to improve as its alliances with partners increase (Fey & Birkinshaw, 2005). However, expanding access to external knowledge comes with costs, as Transaction Cost Economics suggests that external collaborations are often plagued by high risks of opportunism and knowledge spillovers (Enkel et al., 2009). The nuanced understanding of organizational evolution, the role of the State, and the complexities of innovation and investment underscores the need for continued research to navigate the intricate and uncertain landscape of emerging economies. Among the various issues highlighted are inequality and public trust, presenting significant challenges for policy decisions and sustainable development. However, these crucial areas remain insufficiently explored. This study is driven by a pivotal question: What are the fundamental elements contributing to economic growth and national competitiveness, particularly in a country like India? To delve deeper into the essential factors that propel sustainable growth, a thorough review was conducted. By employing a pilot study, we examined 45 item measures, utilizing secondary panel data from the Global Competitiveness Index (GCI) database spanning the years 2007 to 2018.

We present our initial findings in Table 1, which reveals both fast and slow change areas, and some remain unchanged or declined. First, although India is the world second largest population countries, given its annual range rate during 2007-2018 average was 0.245, its GDP growth is 0.184, its GDPPC change rate is small, specifically, PPP the change rate is only 0.060, which is not inclined to the big growth picture. Second, the market size of India has increased, and became one of the world's second largest market, with at an average annual increasing rate 0.218. However, with the increasing rate (11.111) of foreign investments in the past decade, India's world competitiveness

ranking remains unchanged or changing slowly, given the change rate of 0.010 of GCI competitiveness score. This is neither inherent with the investment volume, nor with the market size of India.

Our primary findings highlight that, on the one hand, India has strong growth potentials in the areas of foreign investments, local supply quality, and labour efficiency. On the other hand, India has slow changes in innovation and in firm technology absorptive capacity, which are not inclined with the major picture. The discrepancies also reside with the second world largest population nation with the growth rate in GDP per capita (GDPPC), and in purchasing power parity (PPP). The critical findings suggest there are some unforeseen consequences, which affect economic growth, and more critically, affect sustainable growth in "space and time", past, present, and future. The unforeseen consequences, according to John Bell, are due to the "third factor" or unknown effects.

Table 1: *The interplay between endogenous and exogenous factors in the capacity of innovation and institution capability of India: Change rates of major observed variables*

Item	Change in areas	Annual avg. rate	Accumulated rate	Item	Change in areas	Annual avg. rate
1	Popup (mil)	0.245	1.468	23	Gov-saving	0.289
2	GDP	0.184	1.104	24	Gov-debt	0.200
3	GDPPC	0.123	0.741	25	Gov budget balance	0.173
4	PPP%	0.061	0.364	26	Cooperation-E_E	0.235
5	GCI competitive	0.013	0.081	27	Women labour rate	0.282
6	GCI score	0.010	0.062	28	Basic factors	0.117
7	Foreign investment	11.111	66.668	29	Basic score	0.023
8	Local supply quality	1.100	6.601	30	Overall Innova score	0.003
9	Latest technology	0.572	3.435	31	Innovation-score	0.024
10	Labour efficiency	0.533	3.197	32	Firm tech absorptive	0.040
11	Market size	0.218	1.308	33	National health	0.020
12	Procurement tech	2.201	13.204	34	Life expectancy	0.017
13	Mathematics	1.683	10.100	35	Electricity supply	0.002
14	Science	0.794	4.767	36	IT user	0.000
15	Innova capacity	0.216	1.297	37	% IT user	-0.014
16	Research & RD	0.073	0.437	38	Infrastructure/transport	-0.002
17	Tertiary Edu	0.441	2.645	39	Overall infrastructure	-0.023
18	Public trust	0.645	3.869	40	Domestic market	-0.003
19	Trust in managers	1.125	6.751	41	MaEco environment	-0.008
20	Financial services	0.385	2.310	42	Primary Edu	-0.009
21	Financial develop	0.132	0.790	43	Second Edu	-0.013
22	Public trust	0.645	3.869	44	Trust in managers	1.125

The well-known theorem of "Bell's Inequality" (1964) is seen as a step advance of EPR's (1935) local realism, while Bell's inequality is satisfied by the predictions of any local realistic theory, whereas quantum mechanics predicts measurement outcomes that can violate it. The term in the inequality is the (quantum) correlations of measurement results. The explanations of quantum correlation help with represents the changes in relation to the 'third factor' (Bell, 1964) or the 'unknown factors' in 'space and time', which speak to quantum waves in QM "entanglement" and "decoherence", which stimulate our thinking of the challenges for human societal evolutions and organizational behaviour.

Third, the increasing ranks rest on government procurement technology, advancements in science, research (and R&D), and tertiary education, especially, mathematics that took one of the world leading positions with a positive annual change rate 1.683. India's development of financial services (annual average 0.385), and improved performance on government saving, lower gov-debts, and budget balance. However, innovation, firm technology absorptive capacity, such as the measure of percentage of IT user remains a negligible change. The negative changes or declined areas include primary education and second education, macroeconomic environment, national health, and life expectancy. More critically, the negative change rates include poor infrastructures, road and airline transports, and overall infrastructure quality.

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III. Conceptual Framework and Hypotheses

Quantum theory forecasts a significant correlation between distant measurements, implying that quantum correlation involves nonlocal elements, manifesting through quantum entanglement and decoherence (Asano et al., 2011). The concept of quantum 'entanglement' was initially introduced by Schrödinger in 1935, who described it as an "entangled photon pair" and characterized it as a non-separable entity (EPR, 1935). According to Schrödinger, entanglement precludes the possibility of attributing individual local properties (local physical reality) to each photon. Nevertheless, "in some sense, both photons remain interconnected across space and time" (Aspect, 1999:190). Bell's theorem posits that entanglement is a conditionally dependent probability, where a pure state of a pair of quantum particles is considered "entangled" if each individual particle does not possess a pure state of its own. However, if a state develops its own pure state, the entanglement subsequently exhibits "decoherence" (Hill & Wootter, 1997).

Bell's (1964) theorem asserts that the predictions made by quantum theory cannot be explained by any local theory, as the original interaction, (a,)$^{\rightarrow}$ b$^{\rightarrow}$ is influenced by $c^{\rightarrow} \cdot \lambda$, thereby making c another unit vector c in the interaction (i.e., Eq. 4). This suggests the existence of a 'third factor' that instigates changes. Bell's theorem has been a pivotal subject of research from diverse perspectives, with the nonlocality of quantum theory underpinning numerous advantages provided by quantum information processing in fields such as physics and social science. For instance, quantum correlation can elucidate why viruses exhibit nonlocal behavior and can simultaneously permeate different locations without physical interaction, such that two objects separated in space show a quantum correlation without any perceptible intermediate commuting agent or mechanism. The aforementioned explanation permits us to differentiate between two conditions, such as with and without the "third factor." For the latter, economic growth (GDP) can also be seen as a value-change in a nation's competitiveness (i.e., labor efficiency, security systems, etc.). We aim to address the growth problem from a quantum mechanics (QM) perspective, specifically focusing on the concept of quantum correction. We believe that QM not only aids in comprehending the mysteries of the universe, such as floods, droughts, and climate changes, but it also has implications for human evolution and societal transformation, such as globalization, deforestation, emissions, and viruses. The evolutionary aspects explained through quantum correlation facilitate our understanding of how evolution occurs via entanglement and decoherence. The propagation of viruses, for instance, indicates that evolutionary processes through the combination of particles, cells, or different genes enable viruses to spread and become drug-resistant, as seen with HIV and COVID-19, while also representing some changes in features. Decoherence provides insight into how viruses evolve and induce new and distinct units through variant states in changing environments, due to the integration and combination of particles or cells (Wang, 2021). The selected particles are those that are more adaptable to changes through recombination. Quantum mechanics offers a robust framework for understanding not only the fundamental workings of the universe but also the complex, adaptive systems observed in biological and societal phenomena.

i. Social–Cognitive Wavefunctions

By incorporating quantum theory into our analysis, we gain a richer understanding of both natural phenomena and societal changes, emphasizing the interconnectedness and dynamic evolution of all elements within the universe, some as depicted in Figure 1). In the context of an empirical investigation, our central thesis posits that GDP and national competitiveness are neither the sole indicators nor the primary catalysts for sustainable development and a more prosperous society within the framework of social system functionality.

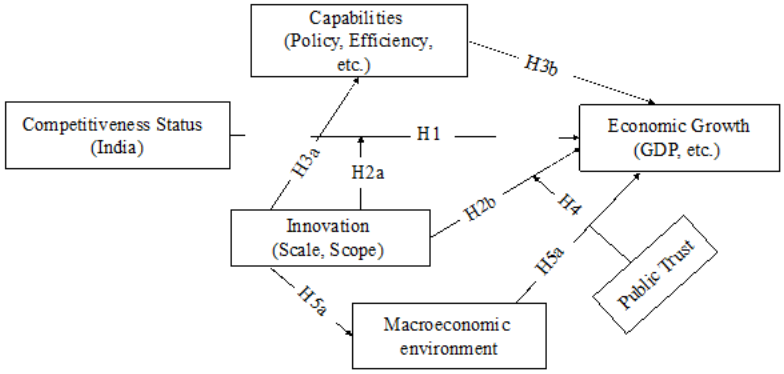

Figure 1: *The proposed conceptual model: The impactful interplay between innovation and social capacity on sustainable growth*

Social waves exhibit both constructive and destructive interference effects, which manifest in outcomes at the individual and societal levels. These inherent and external properties in interactions are better elucidated in relation to other societal elements, akin to how momentum in Einstein's theory of special relativity is interconnected with the momentum of another event or object, and further related to the momentum of Bell's (1964) "third factor." This indicates a necessity to transcend the focus on visible phenomena, which are only discernible if one is aware of their presence, to a paradigm where significant facets of social phenomena are often invisible but have tangible effects, identifiable through the behavioral patterns they generate. In this way, momentum or a universal property is not absolute, just as individuals' experiences are relative. Extending beyond the individual, social wave functions might encompass institutions such as the rule of law, social norms, and collective mental representations (Wang, Zhou, Horsburgh, 2021), alongside various organizations and agencies, which include education, beliefs, cultural groups, and the degree of cultural fluidity (Wang & Giovanis, 2023). From this perspective, the individual embodies a composite cognitive wavefunction comprising all constituent elements and influences, each inseparably linked and thus entangled with the person's beliefs or social norms. Consequently, rectifying the destructive effects of structural impacts is not simply a matter of inducing a phase shift, as this would merely result in a different configuration of privilege patterns, with the destructive/constructive cyclicity of the wavefunction persisting unimpeded (Wang Upadhyay, & Kumar, 2022). For instance, policy decisions that influence the macroeconomic environment and national-level innovation, and consequently sound institutions, are intertwined with physical factors in quantum correlation, elucidating the significance of adaptive dynamics in evolution and survival. Sustainability, therefore, hinges on favorable or unfavorable conditions, and social-cognitive wavefunctions are malleable and can be more socially sustainable than often presumed. This underscores the critical importance of understanding the complex interrelations within societal systems to foster genuine and enduring progress.

In the context of an empirical investigation, our central thesis posits that GDP and national competitiveness are neither the sole indicators nor the primary catalysts for sustainable development and a more prosperous society within the framework of social system functionality. Social waves exhibit both constructive and destructive interference effects, which manifest in outcomes at the individual and societal levels. These inherent and external properties in interactions are better elucidated in relation to other societal elements, akin to how momentum in Einstein's theory of special relativity is interconnected with the momentum of another event or object, and further related to the momentum of Bell's (1964) "third factor." This indicates a necessity to transcend the focus on visible phenomena, which are only discernible if one is aware of their presence, to a paradigm where significant facets of social phenomena are often invisible but have tangible effects, identifiable through the behavioral patterns they generate. In this way, momentum or a universal property is not absolute, just as individuals' experiences are relative.

Figure 1. The proposed conceptual model: The impactful interplay between innovation and social capacity on sustainable growth.

We start modelling with such that the economic growth of India under the normal circumstance (i.e., nature selection), the GDP, G, is explained in relation to the county's competitiveness factors, x, as a set of efficiency elements in the given social environment, with respect to Eq. 5-6 and the critical argument takes account of innovation and institution using the dynamic operator (Q). The mechanisms in the quantum system ψ imply for

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all the cases ψ'_Q (a1, b1, c1…), so that the correlations in the system space, ψ(abc … | xyz…) are through the state activity (x, y, and z) distribution, as specified earlier. In which case, the complex states in interactions in the quantum system ψ on the Hilbert (H) space is $\psi \in$ H where a state $\psi(x)$ of the system is in the process with the evolution of a society or economic growth. Corresponding to our examination about changes in pace and time, we initially assume that the state-change $y(x)$ is Schrödinger's (1926) second order (of momentum $\hbar$), which at any instant time t, $\psi(x,t)$ can start from the basic states $|x_0\rangle$.

Our approach in quantum thinking goes beyond the GCI competitiveness measures, such as "factor driven", "efficiency driven", as we explained earlier, which can be affected by unforeseen consequences, such as "the third factor". So that, context matters, because social waves cannot be separated from quantum waves, their interference forms quantum correlation, such as deforestations and emissions affect ecology and environment, which consequently affect conditions under which human living. Towards our arguments, empirically we develop observation on data that GCI has recorded. And for data testing, we project that the higher level of innovation more effective towards suitable development. Where our initial prediction is:

Hypothesis 1: *Country's competitiveness factors relate to the country's economic growth, such as GDP or and PPP, then increases in the level of competitiveness increase the magnitudes of GDP and PPP.*

As we argued for the interplay between QM and social wavefunctions, we also predict that the growth relates to innovation and institution, such that involve individuals and groups adaptative dynamics as organizational and social behaviours, which are the key to evolutions and survival. We therefore also examine how sustainable growth involves innovation that involves policy, efficiency, adaptation, collective action, and so forth, including product and services quality, and transformational change in societies. Our conjecture informs the second hypothesis:

Hypothesis 2: *Level of innovation moderates the direct relationship between country's competitiveness and GDP growth, such that the relationship is strong when the magnitude of innovation is high.*

Consequently, we develop the argument based on our observation of empirical data of GCI measured scores and predict that higher level of institution capabilities through sounds policy and other efficiency factors lead to GDP growth and resilience of the nation. We draw out measures of soundness of institution, including government policy efficiency, women labour, health, public trust. We also considered social factors of stability of macroeconomic environment, education, infrastructure, and so forth. These elements by impacting the social evolutions affect country's sustainable growth. Our modelling suggests that the adaptive dynamics are invariant properties of the evolutionary systems in measurement because the pure states in the system are the original states before conditioning. In the 'space of possibilities' there are elemental variation functions, which, in the integrated system inevitably cause distributions and interruption for growth or sustainability. Given the phenomenon of evolutionary invasion, whereby quantum transitions of states may also occur. The third hypothesis is:

Hypothesis 3: *Greater attentive forces of government capabilities and sounds policy, greater the mediation effect of the institution on the country's GDP growth and competitiveness.*

The quantum approach enables the advantage by available examinations of the interaction of the entangled states $|0_A\rangle \otimes |1_B\rangle$. The symbol $\otimes$ is the tensor (cross) product of the two modules (A & B), functioning in the n-sets of complex vectors, with probabilities proportional to $|a|^2 + |b|^2 = 1$.

We use state vectors to describe the probability position of growth G, $P(+|G\rangle)$, and $P(+|S\rangle)$ strategies in dealing with unforeseen factors, such as innovation and other policy choices. Then the values of the joint probabilities $P(+|G \cup S\rangle)$ are greater than either G or S performing independently.

The essential points are that social and cognitive wavefunctions diffuse under the condition of nonlocality, or unforeseen consequences, whereby we can examine joint distributions by focusing on dynamic interactivity.

Additionally, we anticipate that the previously mentioned moderation and mediation effects may be influenced by an additional variable or unexpected outcomes, such as uncertainty, stability, and public trust. These elements not only impact innovation and the effectiveness of policies but also have a direct effect on growth factors. This assumption underpins:

Hypothesis 4: *Public trust moderates the relationship between innovation and the macroeconomic environment, particularly when the level of public trust is low.*

he evolution and change in the measurements take account of two sets of mechanisms ($D \cup Q$), the value of growth (D) P_D ($\pm \cap G$) and the value of Strategic choice (Q) P_D ($\pm \cap Q$), which in following the "total probability law" (Khrennikov, 1999) can be expressed, as:

$$P_D(+|G \cup S) = P_{E1}(+|G)P(G) + P_{E2}(+S)P(GS) \tag{1}$$

$$P_D(-|G \cup S) = P_{E1}(-|G)P(G) + P_{E2}(-S)P(GS) \tag{2}$$

E_1 and E_2 are projection operator, given by:

$$E_1 = |e_1\rangle\langle e_1| = \begin{pmatrix} 1 & 0 \\ 0 & 0 \end{pmatrix} \tag{3}$$

$$E_2 = |e_2\rangle\langle e_2| = \begin{pmatrix} 0 & 0 \\ 0 & 1 \end{pmatrix} \tag{4}$$

Taken together, the probability P_D of growth (G) is a *dynamic quantum operator* where the state determining the activation of G depends on the detection state P_D of the activation operator Q, and the detection operator D, which are presented by the complex numbers (of matrices E), based on G and S vector variables. Where the positive and negative (eigenvalued) values (± 1) in the measurements take account of all the state values (of G and S observables) and $\otimes$ is the symbol (cross) product of the two modules (G and S) in the dynamic interactions, the union ($\cup$) symbol denotes that the assumption is true.Given the concept of evolutionary invasion, where quantum state transitions occur to enable us to propose the following:

Hypothesis 5 *a) Innovation is positively correlated with the stability of the macroeconomic environment, and b) the macroeconomic environment mediates this relationship, meaning the indirect impact of innovation on a country's competitiveness, through the stability of the macroeconomic environment, is most significant when the macroeconomic stability is high.*

The interaction will create correlative effect and bring up the value-change, as a result of the complement, C, functions written, as C $(P_G|P_S)t, \sigma$ (see Eq. 5-6). By presuming that a situation has "unforeseen consequences" (s) can affect growth (of G_A, G_B), and s can be converted into the simple term uncertainty or unforeseen consequences, such that also include how policy choice functions to deal with the challenge, using the vector states $s_{\ D}$, where growth G defines self in the probability of:

$$p = G + \sigma_\Delta \text{with} g^2/(|g^2 + |\sigma^2) \tag{5}$$

so,

$$p \rightarrow (G_A, G_B) \rightarrow \sigma \implies (S_A, S_B)) \tag{6}$$

the utility is quantified by the state of growth (G_A, G_B)operationalized by the states (A, B), and $g_a \in G_A, g_B \in G_B$ while the initial state in the Hilbert space is $\rho \in G(\mathcal{H})$.

Given the conjectures and information, we essentially seek explanation for the behaviour of adaptive dynamics of both social and cognitive wavefunctions. Given the states of social system mechanism combined with states of learning system, what are at play in the process for generating the possible effects should take account of the interactivity while the interactivity involves quantum mechanics, their effects bring about the behaviour of adaptive dynamics. The processes are expected to bring about compatible experience with the environment, human agents reconcile their states of knowledge while the quantum mechanics influence a particular pattern of neurological activity to be prolonged (Schwartz et al., 2011). Human agents are active participants in the consequential, purposeful interventions (Wang, Upadhyay, & Kumar, 2022).

IV. Empirical Study

i. Overview of the Study

ocusing on India, we draw on a set of panel data from the Global Competitive Index for the period past and present and observe four measures: today's society; future sustainability; innovation; and institution capabilities (see, Fig. 5- Fig. 7), using current available databases of some large world organizations (i.e., GCI, World Bank, world emissions). Our analysis captured 12 years panel data during, using systematic random sampling in taking each second year during the period 2007- 2018. We employed total 65 variables, including country profiles, competitiveness, innovation, economic growth, and societal factors, specifically, related to 12 pillars of countries competitive measures.

The analysis firstly generated descriptive statistics of four countries: India, China, the UK, and the US, while the focal population enables double comparisons of cross-countries: Developed (USA, UK) and emerging economies (India, China). The observations are with assumes equal variance across groups, while Bayes factor results rejected the Null hypothesis. We obtained result which showed significant difference among the countries on the observed

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variables (in Table 2), including Purchasing Power Proprietary (PPP). We considered differences between "factor driven", "efficiency driven", and "innovation driven" economies. We also included a set of measures such as education; infrastructure and transportation; growth, quality. We, specifically, examine the relationship between innovation and institution capabilities, how which affect transformations change, such as, growth, competitiveness, product /service quality, and so forth.

ii. Measures

As we indicated earlier, we neither attribute causalities of industry or environmental incidences to the performances of policy and control systems nor do we apportion blame to specific groups. education; infrastructure or transportations (road/rail/air); quality of life; women labour force, equality, policy. We specifically examine sustainability issues from QM perspectives, which drive such as strategic innovation (functioning as mediator, Fig. 1). We stress how factor driven links to input and consequently output, and what can make a better society. For examining interactivity and interference, we adopted the Global Competitiveness Index (GCI) database and entered data into our speed sheets (in excel) of both competitiveness scores and country rankings, from the annual report of GCI), while we captured data from the period from 2007 to 2018. From the indexes, we drew out Country/Economy Profiles, taking 65 variables (see, Appendix 1) each year, and consistently for 11 years, those measures were drawn from 126 items under 12 pillars (or measures) in the Global Competitiveness Index (GCI) database, which were normally used as the country competitiveness measures by the World Economic Forum, and those measures were developed in following prior research, such as the microeconomic ranks were based on Michael Porter's Business Competitiveness Index. And the GCI measures were developed by Xavier and Artadi (2004) based on the macroeconomic ranks of Jeffrey Sachs's Growth Development Index. The Global Competitiveness Index (GCI) integrates the macroeconomic and the micro/business aspects of competitiveness into a single index (GCI, 2018). As indicated earlier, we included 65 item measures, which included indigenous, exogenous, moderator mediator and control variables as depicted in Table 2.

Initially, for comparisons, we selected four countries (e.g., from 134 countries in the 2008 data report, or 144 countries in the 2018 data report). The evaluations used the 7-point Likert-type scales (1= very low, 7 = extremely high). Measures exogenous used 8 items measure. Endogenous item measure included the 8-item measure of Innovation (Moderator/Mediator) and the assessment was assumed used scales. Transformational or adaptive capabilities (Mediator) used scales of the 8-item measure. Public trust (Moderator), this assessment also used scales.

Table 2: *Item Measures Used for the Analysis of the Proposed Model*

Exogenous (IV2–IV5)	**Moderator (M1–M3)**	**Mediator (M4–M5)**	**Endogenous (DV1–DV4)**
IV2 Health and primary education IV3 Higher education and training IV4 Goods market efficiency IV5 Labor market efficiency IV4 Financial market development IV5 Market size	M1 Innovation – Capacity for innovation – Scientific research – Company spending on R&D – University–industry collaboration in R&D M2 Gov't procurement of advanced tech M3 Technological readiness	M4 Institutions – Public trust in politicians – Transparency of government policymaking – Reliability of police services – Ethical behavior of firms – Efficacy of corporate boards M5 Macroeconomic environment	DV1 GDP DV2 Population DV3 GDP Per Capita DV4 PPP (Purchasing Power Parity)

The endogenous (or dependent) variables of India considered sustainable growth of India. The item measure considered economically (GDP, PPP, GDPPC, suggesting trends of growth, annual productivity), and equality or social balance (i.e., Stiglitz, Ostrom, 2010). In which case, we also considered social factors (population, mental health/wellbeing), in relation to social wavefunctions. Mediator/moderator variables (MV) of India included innovation measure (8 items), including efficiency, technology advancement, firm absorptive capacity, product /service quality, and so forth (social waves). Then the capability measure (8 items): managerial/organisational level, e.g., policy, efficiency, adaptive, change, social collective action). These advances the extant literature in adaptation

and transformation, while we seek interactive effect of innovation and economic societal developments (Fig. 1), in relation to public policy, decision choice. We examine their correlations in creating impact on the sustainable growth or development.

The exogenous (or independent) variable in the evaluations used country competitive factors both in ranking (1= top rank, 145 = lowest) such the position in the list of those have participated the GCI of Global Economic Forum annual survey, and competitiveness scores (1-7). We finally also used innovation as an exogenous variable in the analysis. We adopted control variable in seeking the robustness of the findings and the validity of the model constructs while studies have argued that gender and population and market stability are all factors that might influence behaviour at the national level. We also included education level, efficiency, and market size etc.

iii. Data Verifications

We validated the construct measure, with respect to our study context through a three-step procedure (i.e., Clark & Watson, 1995; Strauss & Smith, 2009), including abstracting, deducting, reviewing respondents, through pilot studies (pre-survey). With respect to the model that we propose, we developed a set of related studies, using interviews of 15 Indian managers from MNEs, currently working in London as the measure sensemaking for management and organizations. Further, in using statistical methods we tested the construct validity of the measurement items in the applications of the confirmation analysis (CFA). In the application of these procedures, we, specifically, verified the moderation and mediation constructs of innovation, capacity building, and policy choice. Our data capture aimed to avoid common methods variance such as using one industry, or one case (Podsakoff, MackKenzie, Lee, & Podsakoff, 2003).

In using the composite scale, our data of Cronbach's Alpha is 0.944, Cronbach's Alpha based on Standardized Items N of Items is .952 (N = 24) for overall scale data used in the Study. We also used Extraction Method: Principal Component Analysis, and obtained component matrix, from lower 0.802 to high 0.982, which extraction suggest data construct reliability fit, also given Extraction Sums of Squared Loading of Variance 70.245%, $p < .001$. We further examined scale data construct validity using and obtained KMO (Kaiser-Meyer-Olkin) Measure of Sampling Adequacy 0.777 (minimum required by index is .60), and Bartlett's Test of Sphericity Approx. $\chi^2(28) = 262.791, p < .001$.

In the data test our results showed data had no eigenvalue was close to zero, and all data variables in both Lower and Upper Bonds 95% Confidence Intervals (CI) were no close to zero value. We then checked the common variance, of which the estimate was within the requirement (0.45–0.70) of common thresholds. We further checked data collinearity –the criterion for the Variance Inflation Factor (VIF) was in the range of 1.07–3.6, all scale data variables we used were well below the suggested cutoff of 15. We checked Composite Reliability (CR), which was above the required level (0.70), there was no attrition bias. The minimum required Cronbach' Alpha was above 0.70, and our data achieved 0.87–0.90. We also checked for differences in gender, age, expatriate roles- individual level variance (Snijders & Bosker, 2012). The data variables met the validity requirements, multicollinearity was not a concern. The inter-correlations among the items (Fornell & Larcker, 1981) showed all significant coefficients within the range of 0.269–0.610, none was above ≥ 0.7 (except the final test of four countries).

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V. Results

i. Variation Test of Competitiveness

In comparing the difference, we start observations from three countries (China, India, and USA), focusing on three measures: GDP, PPP, and Competitiveness levels. Our results also revealed (minimum) lower mean scores 2.7 of technological innovation, and innovation 3.5, which rested on India among these four countries, and (maximum) higher score market size scored highest 7 of China and US, whereby India the third position scored 6.4 in the year 2014, and UK 5.7 in the year 2009. Higher score was also macroeconomic stability, including China in 2018, but higher score of health and primary education 6.5 rested on UK in 2017 and 2018, however, the two developed economies have finance and goods market efficiency as 4.9 average and finance market development 4.9 average, suggesting they remain relatively lower areas, comparing with India and China.

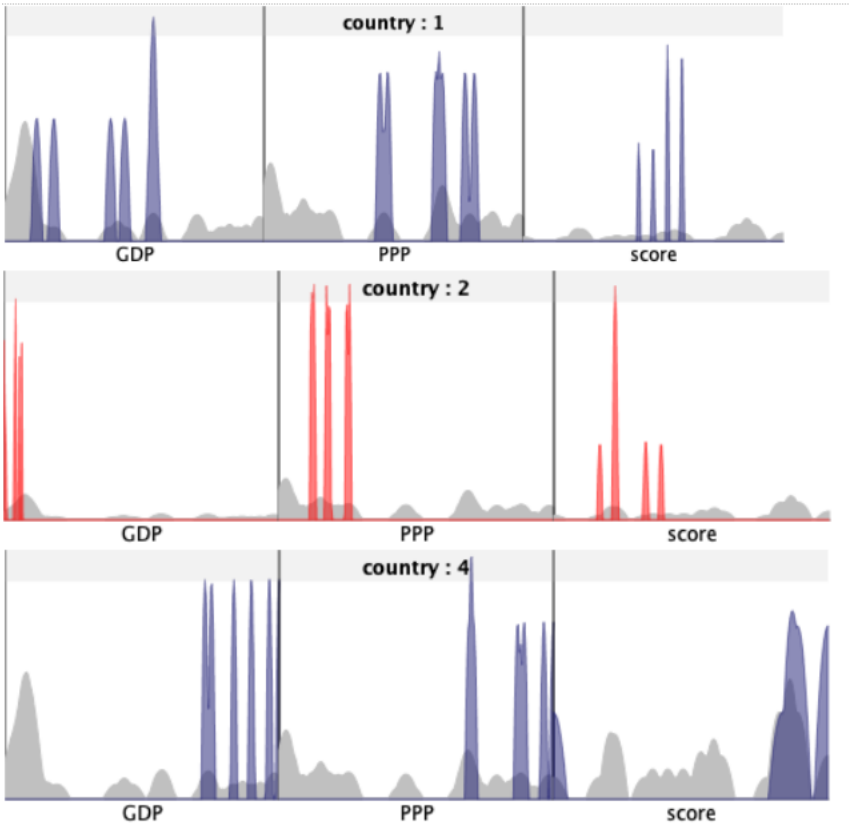

Figure 2: *Competitiveness distributions of China (Country 1), India (Country 2), and USA (Country 4).*

We generated initial descriptive results (in Fig. 2), which suggest that China's GDP and PPP growth are more robust (given both volumes and scales) than India, and USA's competitiveness is stronger and PPP percentage is more advanced than both former countries.

Table 3: *Independent Sample Test of Growth Profiles (Four Countries)*

	Mean Difference	Std. Error Difference	Bayes Factor b	t	df	Sig. (2-tailed)
Population (mil)	-1040.6	6.1009	0.001	-170.566	22	0.001
GDP	8307.75	1063.887	0.001	7.809	22	0.001
GDPPC	45711.067	1460.4691	0.001	31.299	22	0.001
PPP%	4.02	1.03979	0.025	3.866	22	0.001
Competitive	0.4	0.1921	0.651	2.082	22	0.049

We then observed the correlations among multiple factors of four countries, both emerging economies (India, China) and developed economies (USA, UK), in using the index data. And our results revealed that India has (minimum) growth in several areas, including lower mean scores (2.7) of technological innovation and innovation (3.5). Among these four countries (maximum) higher scores rest on USA, China, and UK, respectively from 4.5 to 6.9 in terms of technological innovation, and innovation. The market size was scored highest 7 for China and US, nevertheless India remained the third position, scored 6.4 in the year 2014, and UK was 5.7 in the year 2009. We also developed the independent sample test of growth profiles of four countries (China, India, USA, and UK), and the statistical significance (in Table 3) further demonstrate (by the Bayes Factor Independent Sample Test) the significance of difference among those measures of growth and competitiveness.

Table 4: *Bayes Factor Independent Sample Test of Growth Profiles (India and China)*

	Mean Difference	Std. Error Difference	Bayes Factor	t	df	Sig. (2-tailed)
GDP	-6151.783	1381.0529	0.034	-4.454	10	0.001
PPP%	-8.725	1.25751	0.002	-6.938	10	0.001
Competitiveness	-0.517	0.0778	0.003	-6.639	10	0.001

In using Levene's Test for Equality of Variances, t- test for Equality of Means, we also compared two countries between India and China (Table 4), as two emerging economies. Results from comparing sample means between China and India demonstrate that Equal variances are not assumed- null hypotheses, in effect, are rejected, while results revealed are significant difference and all measurement items including innovation as the two tailed coefficients show significance, there is an exception, science advancement, which is an insignificant variable of difference.

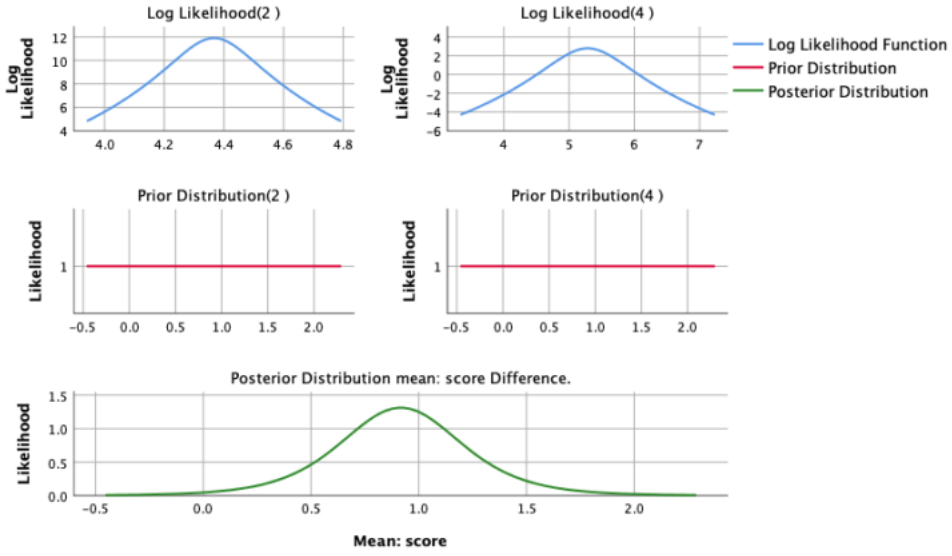

Figure 3: *Competitiveness distributions of India and USA*

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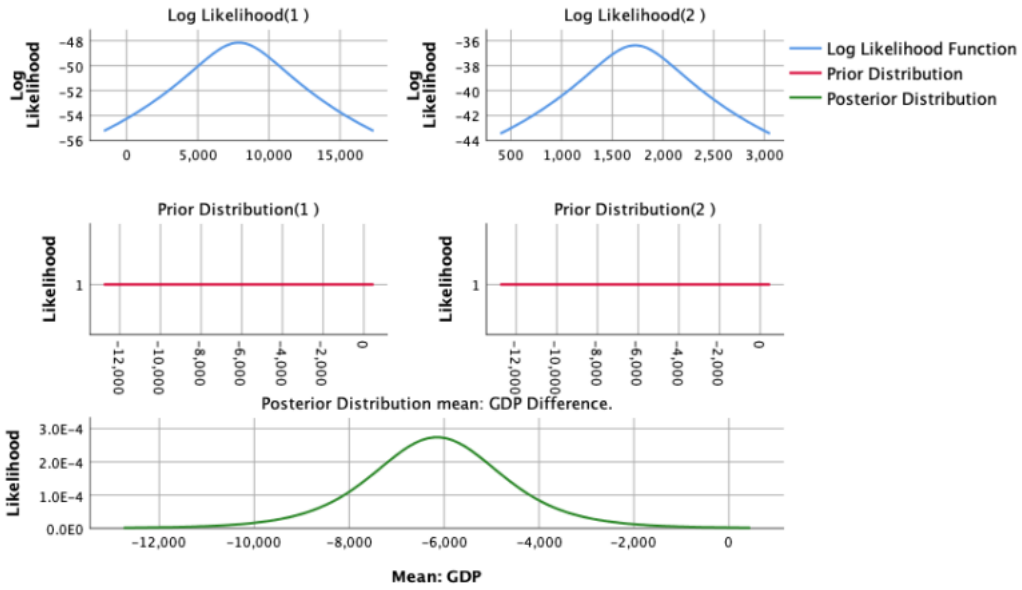

Figure 4: *Competitiveness with PPP distributions of India and USA*

Table 5: *Variation test of innovation and growth and competitiveness (India vs China)*

	Country	F	Mean	Std. Error Mean	df	Sig.	Levene's variance	t	Sig. (2-tailed)
Basic factors	India	4.745	31.67	2.108	10	0.054		-7.815	0.001
	China		79.17	5.700				6.343	0.001
Efficiency	India	1.659	4.7883	0.12357	10	0.227		2.921	0.015
	China		4.3867	0.06037				7.258	0.021
Innovation	India	14.25	4.1717	0.03167	10	0.004		0.777	0.455
	China		4.11	0.0728				6.827	0.463
Research	India	10.843	28.17	1.778	10	0.008		-2.291	0.045
	China		39.67	4.695				6.405	0.059
Technology	India	16.763	12.67	1.585	10	0.002		-2.660	0.024
	China		54.00	15.46				5.105	0.044
Science	India	1.145	39.00	3.651	10	0.310		0.174	0.865
	China		37.67	6.726				7.711	0.866

Results (in Table 5) from the test of variance further revealed the major factors of the competitiveness, which suggest in science area, there is no significant difference between these two countries, but the rest areas are significantly different, and the negative coefficients suggest the gap or weaker areas of India, compared with China such as in "Basic factors", research and technological advancement.

ii. Hypotheses Test Results

Using Model 1 and Model 2, we tested the first three hypotheses. Our results (in Table 6) show first, the historical years positively relate to PPP and GDP, and GDPPC positively relates to PPP, but negatively relates to GDP (b = -0.38 SE = 0.034, $p < 0.001$), suggesting although country's GDP is increased, this did not lead to a significant increase in individual incomes. Second, efficiency positively relates to both PPP and GDP, but innovation remains insignificant, suggesting a gap in innovation, in the other words, changes in PPP and GDP did not drive significant changes in the magnitude of innovation. Third, while growth in population natively relates to PPP, and PPP negatively relates to GDP, suggesting increase in GDP did not lead to increase in PPP. Although the country's competitiveness positively relates to PPP (b = 0.104, SE = 0.056, p = 0.073), it negatively relates to the degree (given the scores) of

GDP growth (b = -62.047, SE = 28.227, p < 0.034, suggesting a gap remaining in the overall competitiveness against the increases in GDP.

Table 6: *GDP, PPP with Productivity, Innovation, and Competitiveness of India*

	Model 1 (DV = PPP)		Model 2 (DV = GDP)		95% Confidence Interval	
	B (SE)	Sig.	B (SE)	Sig.	Lo Bound	Up Bound
(Constant)	575.86 (126.32)	[0.001]	-199171 (73274)	[0.01]	-347382	-50960.30
Year	0.276 (0.067)	[0.001]	83.342 (38.729)	[0.038]	5.004	161.679
GDPPC	0.001 (0.001)	[0.001]	-0.38 (0.034)	[0.001]	0.312	0.448
Basic factors	0.413 (1.31)	[0.754]	-59.87 (670.105)	[0.929]	-1415.29	1295.543
Efficiency	2.68 (1.527)	[0.087]	2217.18 (728.64)	[0.004]	743.356	3691.01
Innovation	1.984 (1.625)	[0.229]	741.99 (837.726)	[0.381]	-952.471	2436.451
Competitive	0.104 (0.056)	[0.073]	-62.047 (28.227)	[0.034]	4.953	119.141
Population (mil)	-11.747 (1.57)	[0.001]	11.747 (1.57)	[0.001]	8.572	14.923
PPP%			-404.093 (50.076)	[0.001]	302.804	505.381
df	(8, 39)		(8, 39)			
Mean^2	16,357		571,248			
F	138.875		374.5			
Sig.	0.001		0.001			

To highlight, first, Hypothesis 1 is supported while it suggested that country's competitiveness relates to the percentage of purchasing power parity (PPP). But second, results show the relationship between GDP and competitiveness also is partially supported and the negative coefficients suggest that the degree of the country's competitiveness is not compatible with the increases in the national GDP. Third, Hypothesis 2 predicted that greater level of innovation would moderate the direct relationship between country's competitiveness and GDP growth, but this is not supported, while the insignificant relationship, in effect, suggests that the magnitude of innovation, in other word, the scale and scope of innovation not suffice in driving the growth factor.

iii. Test of Moderation and Mediation Effects

While we expect that innovation will play a crucial role, to continue with our observations, we test both moderation and mediation effect (Fig. 1). First, the test captured the major constructs of the model that we focused on captured economic growth, as the dependent variable, innovation moderator, and country competitiveness as the independent variable - IV. Results showed F (3, 14) = 32.64 (based on 18 observations), R2 = 0.8749, Adj. R2 = 0.8481, Root MSE (mean standard error) = 115.31, and p < .0001, the model (in data fit indices, Byrne, 2010) provided good fit, where innovation (b = 17258.37, MSE = 1978.495, t = 8.72, p < .001, 95% confidence interval (CI) of upper and lower bounds [13014.92 21501.81]. And the competitiveness variable (b = 888.683, SE= 99.415, t = 8.94, p < .0001, and 95% CI [675.4592 1101.909]. More meaningfully, the interactions of Innovation with GDP at high levels are more positive and significant. Results support Hypothesis 1, suggesting that country's competitiveness factors relate to the country's economic growth measured in GDP or and PPP, and increases in the level of competitiveness increase the magnitudes of GDP and PPP. The findings also support Hypothesis 2, while we tested the relationship between GDP and PPP with the moderation effect of innovation. And findings suggest that greater level of innovation moderates the direct relationship between country's competitiveness and GDP growth, such that the relationship is strong when the magnitude level of innovation is high.

Model 2 test captured the major contrasts (PPP purchasing power parity - IV, innovation moderator, and GDP as the DV), of which results (in Table 7 & Fig. 7) showed the model significance is strong F (3, 14) = 206.21, R^2 = 0.977, Adj. R^2 = 0.973, Root SE = 48.502, and p = .001). Where the value in innovation positively relates to GDP (b = 19.826, SE = 2.875, t = 6.90, p < .0001), but PPP negatively relates to GDP (b = -34.238, SE= 3.371, t = -10.15, p < .001, and 95% CI [-41.469 -27.006], suggesting although GDP increases PPP decreases. However, the interaction value in innovation and PPP positively relates to GDP (b = 3.136, SE= 0.128, t = 24.49, p < .001, and 95% CI [2.861 3.410], the constant value of the model therefore also is positive and significant (b = 977.226, SE= 20.318, t = 48.19, p < .001, and 95% CI [933.648 1020.804]. The interactions of innovation with PPP with GDP at higher level (+1 SD above the mean) is stronger and significant (see, Table 7).

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Table 7: *Model Test 2: Impact of Innovation on PPP (India)*

	Margin	Std. Err.	t	P>|t|	[95% Conf. Lower]	[95% Conf. Upper]
PPP at 1	-74.71616	4.375133	-17.08	0.000	-84.09989	-65.33244
PPP at 2	-34.23827	3.371688	-10.15	0.000	-41.46982	-27.00672
PPP at 3	6.239627	3.009719	2.07	0.057	-0.21558	12.69483

Furthermore, we test our argument about sounds policy, such that insinuation support to R&D may play a critical role, moderating the direct relationship between country's competitiveness ranking (in GCI, general completive index) and economic growth (GDP), and the relationship is positive and strong when the degree of magnitude mechanism in institutional support to R&D is high.

Model 3 test results suggest that the model significance is positive when the degree of R&D is high F (3, 14) = 1184.77, R2 = 0.996, Adj. R2 = 0.995, Root MSE = 24.423, and p = .001), and the country's competitiveness ranking is positively related to GDP (b = 19.826, SE = 2.875, t = 6.90, p < .0001), where interaction value the value in competitiveness ranking R&D positively relates to GDP (b = 19.826, SE = 2.875, t = 6.90, p < .0001), but R&D at lower level negatively relates to GDP (b = 6.458, SE= .933, t = 6.92, p < .001, and 95% CI [4.456 8.461]. The interaction value of R&D and W, competitiveness ranking is positive and significant (b = 1.903, SE =.123, t= 15.45, p < .001) ,95% CI [1.638 2.167]. Hypothesis 3 is supported. Results (Table 8 & Fig. 5) suggest that greater level of innovation moderates the direct relationship between country's competitiveness and GDP growth, such that the relationship is strong when the magnitude level of innovation is high.

Table 8: *Model Test 3: Moderation effect of R&D on GDP (India)*

	dy/dx	Std. Err.	t	P>|t|	[95% Conf. Lower]	[95% Conf. Upper]
R&D at 1	-14.101	2.203	-6.40	0.000	-18.826	-9.374
R&D at 2	6.458	0.934	6.92	0.000	4.456	8.460
R&D at 3	27.017	0.656	41.17	0.000	25.609	28.424

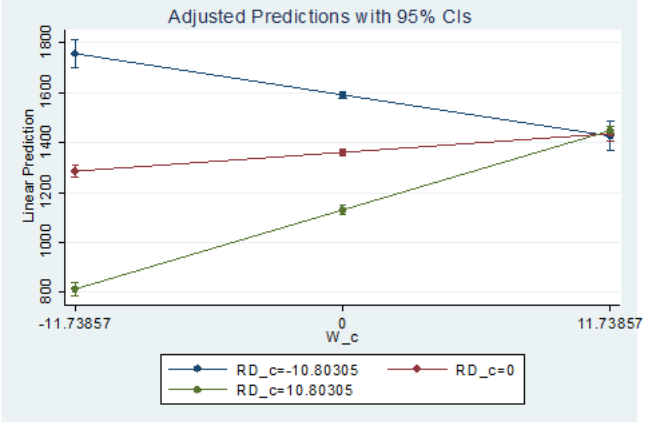

Figure 5: *Moderation effect of R&D on the direction relationship between GDP and competitiveness (India)*

We then calculated item level variance, as compared with the null random intercept model (Snijders & Bosker, 2012), three levels of competitiveness of innovation (+1 SD above the mean, –1 SD below the mean, and 0 SD average level of mean). Results in Figure 5 suggest that when the level of institutional support to R&D is low, the direct relationship between GDP growth and the magnitude of competitiveness decrease and negatively related. But when the level of institutional support to R&D is high, the direct relationship between GDP growth and the magnitude of competitiveness increase, and the relationship is positive.

Results presented in Figure 6 suggest with sounds policy in national level scale and scope innovation in place, the direct relationship between GDP growth and the magnitude of competitiveness increase, and the relationship is positive (= 0.117; SE = .019; 95% CI [0.019; 0.165], p < .01). And when the magnitude of policy choice in innovation was high (b = 0.344, p < .01), both competitiveness score and GDP are high, such as the degree of policy choice in support innovation is high (+1 SD above the mean), the slope in innovativeness changed. Otherwise, if institutional support is low or not in place, as the slope change (in red and blue colours) suggest that the positive relationship becomes insignificant, suggesting neither GDP nor competitiveness had increased.

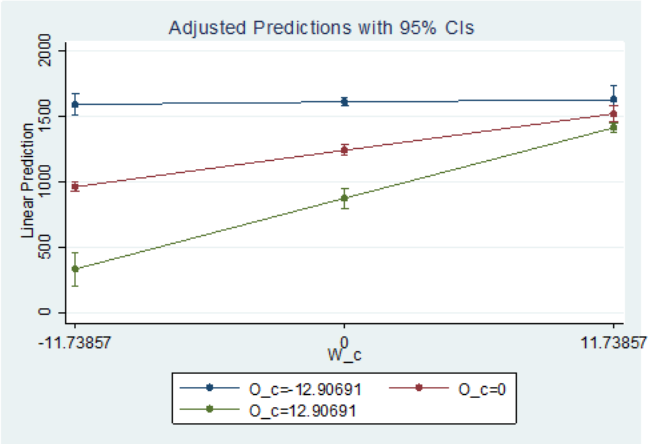

Figure 6: *Moderation effect of Innovation on the direction relationship between GDP and competitiveness (India)*

iv. Model Test Results

The analysis hitherto enables us to draw some concluding remarks based on the proposed model. Our initial model depicts our assumption of the direct relationship between innovation

and economic growth, which also highlights the major constructs of the model we propose. Figure 7 demonstrates results we generated, which capture two mediating roles of macroeconomic stability of environment and sound institution, whereby generalised trust also plays a crucial, moderating the direct relationship between innovation and macroeconomic stability of environment. This means in the test we also include the variable of foreign direct investment. By which we explain the drivers of a better society, in using the GCI data of India. We employed Hayes' PROCESS Macro and executed the 7–level model analysis, corresponding to the model proposed. We verified the construct of moderation construct of the innovation variable and the measurement (in data fit indices, Byrne, 2010) provided good fit to the data (χ^2= 1089.530; R = 0.66, df = 21, p < .001). We also verified the construct of the mediation variable and the measurement provided good fit to the data (χ^2 = 884.113; R = 0.872, df = 28, p < .001).

First, in the total model, our results suggest that the direct relationship between innovation and country's competitiveness is positive and strong (b = 0.634, p < .001). This lends further support to Hypothesis 2. Second, innovation strongly and positively relates to sounds institution (b = 0.998, p = .009), which then created a mediation effect, of which the indirect effect of innovation on competitiveness becomes strongest when policy choice is more effective. Thus, findings lend further support to Hypothesis 3. Fourth, public trust moderates the relationship between innovation and macroeconomic environment when the level of public trust is low (b = -0.004, p =.037), and Hypothesis 4 is supported. Furthermore, macroeconomic environment has a mediation effect, whereby higher stability leads to stronger relationship between innovation and competitiveness, of which Hypothesis 5 is support. More importantly, results suggest that: a) Innovation positively relates to stability of macroeconomic environment (b = 0.659, p =.009) and stability of macroeconomic environment has a mediation effect, whereby b) the indirect effect of innovation through stability of macroeconomic environment on the country's competitiveness is strong when the degree of stability of macroeconomic environment is high (b = 0.971, p = .023). In what follow, we bring discussion from which to draw out the conclusion of the study.

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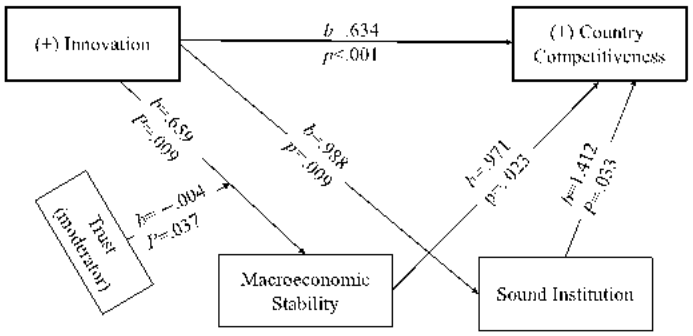

Figure 7: *The proposed model: Direct, indirect, and total effect (India)*

v. Post Hoc and Robustness Checks

In the post hoc study, we computed for 1000 sample size for the robust checks of construct validity of the model that we propose. Specifically, we verified the initial construct variables of economic growth, innovation, and measures of a better society, within the GCI database. We tested their significance while they might have driven economic growth, specifically, as the start we used innovation as the moderator (results reported in Table 9). We then test correlative effect of four countries and results revealed (minimum) lower mean scores 2.7 of technological innovation, and innovation 3.5, which rested on India among these four countries. Higher score was macroeconomic stability which also included China in 2018, but health and primary education 6.5 rested on UK in 2017 and 2018. Collectively, goods market efficiency (4.9) average and finance market development (4.9) average suggesting they remain relatively lower areas, but both India and China remain higher positions respectively in financial market development and in low debts of government and high national saving.

Table 9: *Correlation of Innovation Societal Factors*

	1	2	3	4	5	6	7	8	9	10
1 Competitive	1									
2 Innovation	.669**	1								
3 Primary	.346*	0.106	1							
4 Second	.760**	.755**	.441**	1						
5 Tertiary	.685**	.927**	-0.04	.704**	1					
6 Latest-technology	.583**	.886**	-0.159	.683**	.799**	1				
7 State-cluster	.408**	.580**	0.13	.494**	.598**	.578**	1			
8 Research	.737**	.919**	0.131	.803**	.905**	.794**	.486**	1		
9 Technical	.354*	.350*	0.164	.289*	.453**	0.022	0.011	.536**	1	
10 Science	0.217	.600**	-.420**	0.267	.512**	.700**	.414**	.317*	-0.13	1
Observations	24	24	24	24	24	24	24	24	24	24

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Results suggest that innovation is important and positive parameter of education at all levels, research, and science. And the Model summary R^2 = 0.602, SE = 0.227, F (46, 257) = 8.440, p < .001. Findings from the robust checks are consistent with our earlier test results. Results (in Table 10) from the test of correlations is consistent with the above suggest that innovation is important and positive parameter. But the negative coefficients of competitiveness, efficiency, infrastructure, with innovation rather suggest the gap remain in both developed and emerging economies in national level of innovativeness.

VI. Discussion

The conclusions derived from our research underscore several pivotal points. Firstly, it is imperative to refocus economic strategies toward sustainable growth trajectories. Both our study and recent scholarly work underscore the monumental challenges that this shift poses for contemporary societies. The burgeoning interest in the interplay between economic, social, and ecological sustainability spotlights the metrics typically employed to gauge individual wellbeing and underscores the intricate trade-offs governments encounter between implementing environmentally sustainable economic policies and enhancing the immediate welfare of their citizens.

Secondly, the endeavor to achieve environmentally sustainable economic development has emerged as a significant hurdle for policymakers worldwide. This focus necessitates sustainable approaches to economic growth that "meet the needs of the present population without compromising the ability of future generations to meet their own needs" (Khalid et al., 2021).

Thirdly, addressing this challenge has prompted a pivot towards innovative forms of economic growth—those that are socially inclusive and foster more resilient ecosystems. This represents a paradigm shift from the notion that competition between corporations and nations is the primary engine of economic growth to one that prioritizes inclusive growth encompassing economic, social, political, and environmental dimensions. The limitations of Gross Domestic Product (GDP), particularly the relationship between the pursuit of GDP and environmental degradation, remain largely unaddressed in this context.

Fourthly, if society is genuinely concerned about its future, it is crucial to evaluate, even if imperfectly, whether its current consumption and wellbeing are sustainable, and whether these come at the cost of future generations.

i. Contributions

A unique aspect of our study lies in its exploration of quantum-like properties, with dynamic interactions among proposed mechanisms creating dynamic interference effects that offer new insights into the interrelationship between cognitive and social learning mechanisms. In an increasingly interconnected world, responses to economic, social, political, environmental, and health-related shocks necessitate an understanding of the impact of Quantum Mechanics (QM) and social wavefunctions. Conventional perspectives on time and space changes often focus on the linear progression of time and the relative stability of attributes that underpin evolutionary theories. However, quantum thinking elucidates why defection arises, and hence why a coherent system also harbors decoherence. The evolving nature of opportunities and challenges demands greater collaboration among corporations, nations, and governments.

To address these concerns, we leverage quantum probability theories to propose a quantum framework for understanding organizational complexity and the common decision-making errors that lead to organizational failures in uncertain environments. This perspective also illuminates how organizations or societies can encounter unforeseen potentialities that drastically alter their developmental paths by conceptualizing the future as existing in a state of potentiality that collapses into the present based on the dynamics of system constraints.

In the context of interpreting quantum-like properties, new knowledge disseminates through dynamic interactions. Knowledge diffusion occurs via transactions, and transactive knowledge can be conceptualized as "decoherence." Human evolution continually faces challenges from quantum environments, where interruptions or disruptions consequently stimulate neural activities that correlate with the production of new knowledge. Ultimately, this quantum perspective sheds light on the complex interdependencies and the dynamic nature of modern challenges, calling for a more nuanced and collaborative approach to fostering sustainable growth and development.

Our study offers significant contributions to both organizational theory and practice, providing a nuanced approach to understanding the multifaceted effects of an agent's actions and the conditions enabled by social wavefunctions. In a constantly evolving environment, organizations establish stability through adaptive behavior (Feldman & Orlikowski, 2011). Adaptive organizations are capable of learning, acquiring new knowledge, and enhancing performance. Through this adaptive function, agents can transform relatively simple states of knowledge into more complex and nuanced states. The driving force behind this transformation is nonlocality, which arises from the intricate and correlated nature of the world, manifesting in various forms and from different locations (Bell, 1964). Nonlocality persists and evolves due to quantum correlations, constituting continuous formative constraints on the universe's evolution, anticipating future events instantaneously. As a result, organizations seek emergent knowledge, considering the dynamic and transient nature of knowledge within them. The interplay between

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nonlocality and contextuality influences knowledge diffusion through the phases of relationships and cause-and-effect interactions with the world. It is important to note that knowledge diffusion is ultimately irreducible and can never be entirely complete.

While events occur through interactions, sustainability informs our observations on innovation and capabilities. We focus on Quantum Mechanics (QM), which is gaining traction for its relevance in illuminating social science problems. By drawing on quantum mechanics and quantum probability theories, we present a quantum approach to time and change, offering a framework to comprehend organizational complexity and decision-making processes that can lead to either successes or failures within uncertain environments. Our theoretical perspectives elucidate how organizations and societies can encounter unforeseen potentialities, better preparing them for radical changes and challenges. This is achieved by conceptualizing the future as existing in a state of potentiality, which collapses to form the present based on the dynamics of system constraints (Lord et al., 2015). We assert that adaptive dynamics play a crucial role in ensuring the viability of institutional policymaking and organizational goals. Various circumstances can create trade-offs; for instance, shifting market demands can influence design performance, and environmental conditions, as well as political, socioeconomic, and cultural circumstances, can affect strategy and business design. Events are assumed to exist only at interactions, and the nature of each event is relative to the systems involved in the interaction. During an event, new information is acquired, rendering previously relevant information obsolete (Wang et al., 2022).

ii. Implication

Our theory has broad implications for organizational theory, research, and management practice. Recent studies (Khalid et al., 2021) suggest that among developing nations, India plays a pivotal role in the adoption and success of the Sustainable Development Goals (SDGs) due to its significant share of global challenges such as extreme socio-economic and demographic inequalities, which have a sub

growing importance is further underscored by its population surpassing China's in 2022, making it the world's most populous country. Increasingly, scholars have suggested that business unit or system design must adapt to the specific circumstances in which the organization operates. However, current research reveals a gap in this area, with insufficient attention given to contextual ambidexterity, particularly the external aspect. To foster economic growth, it is essential to focus on industry behavior capacity and national-level capabilities. We emphasize the central construct of ambidexterity, which concerns whether a nation or national polity can demonstrate adaptation and change in response to evolving environmental conditions. When a complex structure is necessary for a competitive market (structural ambidexterity), the structural effect significantly depends on the institution and organization's capacity and capabilities (contextual ambidexterity) to adapt and change (Wang et al., 2022). This underscores the importance of developing robust adaptive mechanisms within organizations to navigate the complexities of modern environments effectively.

The results from our investigation illuminate that both social and natural environments have the capacity to form "quantum correlations" with affective responses, which can be either positive or negative. This interpretation suggests that each individual possesses a composite wavefunction comprising all constituent elements and influences, which are inseparably intertwined with the person's beliefs and social norms. This also implies that the social structure's wavefunction in regions such as Russia or Ukraine is constituted through the entanglement of successive elements, aligning with individual wavefunctions that influence and benefit from it. Therefore, mitigating the detrimental effects of structural impacts is not simply a matter of implementing a phase shift, as this would only alter the alignment of privilege patterns without disrupting the ongoing destructive or constructive cyclicity of the wavefunction.

This makes the decision-making process or policy formulation much more intricate, reflecting not only the entangled consequences of an agent's actions but also the conditions of possibility established by social wavefunctions that provide the sociocultural backdrop for human behavior. Social wavefunctions can induce phenomena that may either be described as "out of phase" with the social structure or "in phase." The very same social structure that limits the future opportunities available to some will instead amplify the social wavefunctions of those who stand to gain, leading to constructive rather than destructive interference. Quantum Mechanics (QM) refocuses our attention on the correlations that truly matter in terms of survival, well-being, and socioeconomic conditions. The in-phase/out-of-phase

positionality arises from the cyclicity of a specific structure, such as policy decisions that affect the macroeconomic environment and national-level innovation. In turn, these influence sound institutions, which are interwoven with

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physical factors in quantum correlations. This underscores the significance of adaptive dynamics in evolution and survival, while sustainability is linked to favorable or unfavorable conditions, which are more fungible and socially sustainable than often presumed.

Unlike previous research, which posited that a nation's competitiveness drives its Gross Domestic Product (GDP) and economic growth, we neither attribute growth to competitive advantages nor assign blame to the incompetence of certain groups. Instead, we emphasize social wavefunctions intertwined with cognitive waves, evolving within societies, and influencing social transformations and changes. We specifically examined how the interplay between these elements impacts evolutionary fitness and adaptation dynamics, contributing to economic growth and a better society. From the standpoint of quantum mechanics, we explore social wavefunctions in relation to innovation and institutional frameworks within cognitive waves, focusing particularly on the significance of innovation and policy choices.

Our findings, detailed in 10 tables and 7 figures, indicate that societal evolutions manifest in pattern changes driven by social, economic, and political forces. These unforeseen consequences underscore the crucial interplay between innovation and institutions, which emerge as pivotal determinants of economic growth and societal improvement. Our study also points to a new direction for future research, highlighting the need to understand both what is added to existing knowledge and what gaps remain. We contend that the impact of a business strategy cannot be divorced from its external context, within which the business operates. In quantum correlations and QM wavefunctions, elements do not exist in isolation; interactions are essential for understanding "quantum events," as these events generate significant information about the entanglement between agents and social structures.

Our research contributes to a broader theme of applying QM to social phenomena by analyzing behavioral patterns in aggregate terms rather than focusing on isolated individual incidents. Interactions are fundamental to comprehending "quantum events," as such events yield critical insights into the entanglement between agents and social structures.

VII. References

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