

## *Original Paper*

# The Application of Quantum Thinking in Economics

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### **Abstract**

*The rise of digital civilization has changed the basic logic of modern social and economic operation, which means that we should treat and regulate the economic system in a new way, because the old logic is no longer applicable. The main bodies are entangled deeply and the transition is not continuous and the overall emergence appears in many cases. Traditional economics is rooted in Newton's mechanistic worldview. It uses deterministic causality and linear evolution as core tools. We introduce quantum thinking as a new epistemology and methodology. It is worth noting that we discriminate the essential distinction between classical mechanistic thinking and quantum systematic thinking from six dimensions, which are core hypothesis, system cognition, subject relationship, observation logic, evolution paradigm and governance path. We analyze the practical value from two aspects, namely industrial organization reconstruction as well as macro governance optimization, because we want to show how quantum thinking can be used in real economic situations and provide guidance for policy makers and researchers in China and other countries. The research shows that quantum thinking can break through the linear shackles of traditional economics. It can promote economic research from deterministic paradigm to uncertain paradigm. Also, it changes from individual reductionism to overall system theory. The view is changed from equilibrium and steady-state theory to dynamic evolution theory. In fact, this provides theoretical support for constructing independent economic knowledge system suitable for digital civilization and Chinese local practice, which is expected to help build a new economics paradigm that can explain the complex phenomena we observe today.*

### **Keywords**

*quantum thinking, The revolution of economic paradigm, Uncertainty, Overall emergence, Complex system governance*

## 1. Introduction

Quantum mechanics was born at the beginning of 20th century, which can bring big changes to physics and can change how humans understand the world, because the classical deterministic view was replaced by a new understanding that includes uncertainty principle and other strange quantum effects we cannot see in daily life. It shows uncertainty, superposition, entanglement and Nonlocality. It breaks classical deterministic worldview. In recent years, complex systems science is developing fast, and quantum thinking has extended from physics to social sciences such as biology, psychology, sociology and economics, which can provide a new analysis method for complex uncertain systems that traditional methods cannot handle well. In economics, we introduce quantum thinking. It is not just copying concepts from physics. It is a full paradigm revolution involving ontology, epistemology, and covers methodology too, because it treats uncertainty as the endogenous essence of economic system and replaces individual reductionism with holistic system theory, while static equilibrium is replaced by dynamic evolution theory. It can give new theoretical view for explaining complex economic phenomenon in digital economy. Though more domestic researchers are interested in quantum economics recently, existing research is still in fragmented exploration stage. Most literatures remain in simple analogies between quantum concepts and economic phenomena, and they can fail to explore the internal consistency between quantum mechanism and economic laws. In fact, there is lack of logical self-consistent general analysis framework. Also, core concepts are unclear. Theoretical systematization is also lacking. The empirical research method lags behind, and it is difficult to test and verify theoretical propositions of quantum economics, and these problems can restrict academic development and practical application of quantum economics.

Starting from this, we try to build theoretical analysis framework of quantum economics. Also, we hope this work can help change the current economic paradigm in fundamental way. First, the differences between classical mechanistic thinking and quantum system theory thinking are examined, and we clarify the theoretical basis of quantum thinking in economic research, and this clarification can help us understand the framework better. Next, practical value of quantum thinking in economics is analyzed from industrial organization reconstruction, macro governance optimization and also policy implementation because these aspects can cover the main application areas. Finally, we summarize the research conclusions and we point out the shortcomings in current quantum economics research and we discuss the future development direction. In fact, our research can compensate for limitations of traditional economics when explaining complex economic phenomena because the traditional theory can not fully explain the quantum effects well, and also it can provide theoretical support for building independent economic knowledge system that adapts to digital civilization and fits China's local practice. The possible innovations of this article are as follows: Firstly, at the epistemological level, the core differences between classical Newtonian thinking and quantum thinking in economic research have been systematically clarified. For the first time, the logical distinctions between the two have been comprehensively sorted out from six dimensions: ontological assumptions, cognitive modes, subject

relationships, observational logic, evolutionary paths, and governance methods, providing a clear cognitive starting point for the paradigm shift in economics. Secondly, it has expanded the practical application scenarios of quantum thinking, not only relieving the inherent difficulties of traditional economics in explaining reality from a theoretical perspective, but also providing a new direction for industrial organization upgrading and macroeconomic governance that can be implemented in combination with the characteristics of the digital economy era, and providing new theoretical ideas for building an economic knowledge system that is suitable for local practice in China.

## **2. The Logical Distinction between Quantum Thinking and Traditional Thinking**

Mainstream economics is based on mechanistic view from Newtonian classical mechanics. This view treats the world as a mechanical system with independent discrete particles, and their operation follows deterministic causal laws. The whole equals the sum of parts. Also, the future can be predicted through calculation of the past. Following this view, we observe that mainstream economics builds theoretical system. It is worth noting that this system uses rational economic man as the core assumption, together with perfect information and also general equilibrium. However, when economic systems become more complex and the structure is not simple anymore, we can see that mechanistic thinking has clear limitations and in many cases cannot explain the real phenomena we observe in the actual economic activities.

In contrast, quantum thinking comes from basic principles of quantum mechanics and it takes uncertainty as ontological premise, while cognitive approach uses holistic systems theory and at the same time dynamic evolution is treated as the evolutionary logic. This can give a new perspective for understanding complex economic systems. Also, we should note that there are divergences between the two paradigms across six dimensions and these dimensions can include core assumptions, systemic cognition, agent relationships, observational perspectives, evolutionary modes, and also governance approaches (see Table 1). These divergences can constitute the logical premise for reconstruction. Quantum economics can use this to reconstruct modern theoretical system of economics.

**Table 1. Core Logical Differences Between Traditional Classical Thinking and Quantum Thinking**

<b>Comparative Dimension</b>	<b>Traditional Classical Thinking (Mechanistic Paradigm)</b>	<b>Quantum Thinking (Systems Paradigm)</b>
Core Assumption	Determinism as fundamental; uncertainty as exogenous disturbance	Uncertainty as fundamental; determinism as the result of wavefunction collapse
Systemic Cognition	Linearly decomposable; the whole equals the sum of its parts	Nonlinear holistic; systems possess emergent properties
Agent Relationship	Agents are mutually independent; interactions exhibit linear characteristics	Agents are deeply entangled; symbiotic, mutually shaping and co-evolving
Observational Perspective	Observation is neutral and objective; it does not interfere with system operation	Observation actively constructs reality; it directly alters system states
Evolutionary Mode	Gradual and continuous evolution; follows linear quantitative change laws	Progressive superposition and critical phase transition; discontinuous qualitative leaps exist
Governance Approach	Reductionist decomposition; improves the system through local optimization	Holistic coordination; resolves contradictions through overall linkage

### 2.1 Core Hypothesis: Ontological Divergence between Certainty and Uncertainty

The ontological divergence can be seen as the most basic difference between these two thinking paradigms. Traditional mechanistic thinking regards certainty as inherent nature of the world. It believes all phenomena have definite reasons. If we have enough information, the future development can be predicted. This ontological hypothesis is projected into economics field. It forms the deterministic core hypothesis that mainstream economics uses. In fact, from Adam Smith's "invisible hand" to Vallas' general equilibrium theory, and from Marshall's partial equilibrium analysis to Lucas' Rational Expectation School, mainstream economics in principle believes that there is an optimal equilibrium state in the economic system, the economic operation follows the objective and fixed causal law, and market fluctuations and imbalances are only temporary deviations caused by external shocks. Once the shocks subside, the system can return to equilibrium state.

In industrial economy era, we observe that this deterministic assumption has certain practical rationality, because at that time technology iteration was slow and consumer demand was stable while the industrial structure was solidified, and the operation of economic system showed regularity and predictability. However, digital economy is different. After entering this new era, the uncertainty of economic system has increased, because technology iteration direction is hard to predict, business model changes fast, market demand shows personalization and diversification, and global supply chain is vulnerable, so the evolution of economic system can no longer follow single deterministic path. Traditional economics regards uncertainty as exogenous disturbance. In fact, it can not explain complex economic phenomenon under digital economy.

Quantum thinking is different from traditional deterministic ontology. It treats uncertainty as the endogenous nature of the world. The uncertainty principle of quantum mechanics shows that we cannot measure the position and momentum of a microscopic particle at the same time. The state of the particle

is in superposition of various possible states before being observed (Bohr, 1928). This means uncertainty is not from our lack of knowledge or the limitations of measurement tools. In fact, it is the inherent attribute of the micro world. When we map this principle to economic system, quantum economics suggests that uncertainty is an endogenous attribute of the economic system. It is not an exogenous disturbance. The direction of technological innovation, the preference of capital flow, and the structure of market demand can be in state of multiple probability superposition when there is no observation and intervention, and at the same time, the rhythm of institutional evolution also follows this pattern. So there is no unique evolution path. In reality, the determinate economic form we observed, such as the specific industrial structure, market price and enterprise competition pattern, is not the necessary result of the natural evolution of the system. It is the collapsed result of the wave function under the joint action of policy regulation, market competition, subject game and other observation behaviors (Dirac, 1930). This uncertainty ontology can challenge the deterministic thinking in traditional economics. Also, it can provide a theoretical basis for explaining the high volatility and unpredictability of the digital economy.

### *2.2 Systematic Cognition: The Cognitive Difference between Reductive Disassembly and Holistic Emergence*

Traditional mechanistic thinking uses reductionism. At systematic cognition level, we use this analytical logic. Reductionism holds that any complex system can be disassembled into simple components, and by studying the properties and behaviors of each component, we can in principle deduce the properties and behaviors of the whole system even when the interaction between parts is not considered. This method achieved great success in physics and chemistry. Also, mainstream economics uses it. Mainstream economics decomposes the complex economic system into individuals, enterprises, industries and other micro units layer by layer. By analyzing the utility maximization behavior of rational economic man and the profit maximization behavior of enterprises, we can deduce market equilibrium and macroeconomic laws. This disassembly analysis can simplify the research object. It can reduce the research difficulty. It is worth noting that in industrial economy era, the industrial system has clear boundary and simple structure, so this method should have good applicability.

But reductionism has a serious problem. In fact, it breaks the internal connection between system components and can ignore structural changes from factor coupling and subject interaction. In complex systems, the whole is more than the sum of parts. New properties can emerge that single components do not have. This is what we call “emergence”. In digital economy era, this emergence is very obvious in new economic forms, such as platform ecology, industrial clusters, as well as networked cooperation. For example, the value of a platform ecosystem is larger than the simple addition of all individual enterprises on it, because the platform creates network effects and collaborative value. It achieves this by connecting supply and demand sides. It can also integrate data resources and optimize matching efficiency. Traditional economic reductionism is not able to explain this emergence phenomenon, because it can break correlation structure between various parts in process of disassembling the system, and thus it loses the emergence information.

Quantum thinking follows the logic of holism in cognition. In fact, it emphasizes that complex systems have indivisibility and can show emergence properties. The entanglement principle in quantum mechanics shows that two particles can form a whole that cannot be divided. Even when the distance is very long, the state change of one particle can affect the other one (Schrödinger, 1935). This means that in principle we cannot study the part alone without considering the whole system, and the nature of each part can only be understood when we look at the full context and the relationship with other parts. When we apply this principle to economic system, quantum economics views the modern economy as a complex network with many interrelated agents. The behavior of each agent is affected by other agents and we should consider this interaction. The overall nature of system is determined by the interaction between subjects and the network structure. It is not just a simple sum of single subjects. Therefore, the study of economic system should start from the whole. We need to pay attention to the correlation and interaction between subjects. We should look at the emergence characteristics of the system. We cannot limit ourselves to the analysis of a single subject. It is worth noting that this holistic cognitive logic can help avoid the defects of traditional reductionist method. Also, it can give a new perspective for understanding economic forms like platform ecology and industrial clusters.

### *2.3 Subject Relationship: The Relationship Difference between Independent Separation and Entanglement Symbiosis*

Traditional economics uses the rational economic man hypothesis. It defines the market subject as a micro unit with complete independence, which means each subject can make decisions by itself and there is no need to consider the influence from other agents in market environment, so the decision-making process is expected to be isolated from external interference. Each subject has complete information. It can make decisions by itself to maximize utility or profit. The interaction between subjects is carried out through market price mechanism. In fact, direct interdependence and influence does not exist between them. Under this assumption, enterprises have a pure competitive relationship and consumers and producers only maintain a simple buying and selling relationship. The boundary between subjects is clear. The interaction is simple and transmission can be slow. Classical analysis tools include partial equilibrium analysis and static game theory. They are based on the assumption of subject independence. In industrial economy era, because production has characteristics of specialization and fragmentation and each firm only handles a limited range of activities in the whole production process, the assumption that subjects are independent can be reasonable and we can use this assumption when building theoretical models. At that time, division of labor among enterprises was based on products. Each enterprise focused on one link in the production chain. The association was realized through product transactions, and the degree of interdependence was low. However, in digital economy era, because data elements are applied in many areas and can flow across different sectors easily, industrial boundary, organizational boundary, regional boundary and technical boundary are all broken, so the correlation between market players can be deeper than before. Also, platform enterprises build a symbiotic ecosystem. They connect many producers and consumers. In fact, upstream and downstream enterprises in industrial chain form a close

network through data sharing and they can do collaborative production. Consumers are not buyers only. They participate in product design, production, marketing and after-sales service, and they become important subjects of value creation. In this context, because all players are connected through data and platforms in the digital economy, the relationship between market players is not separate, and it becomes a complex network with deep entanglement and symbiosis where we cannot analyze them as independent units any more and should use network perspective instead.

Quantum thinking uses the logic of quantum entanglement. We can use it to describe the new relationship between modern market players. Quantum entanglement means a nonlocal correlation between two or more quantum systems, so the state of one system cannot be described independently of other systems because they are connected in a way that classical physics cannot explain (Bell, 1964). In economic system, we can see this entanglement as the interdependence between subjects. Also, it includes mutual shaping and common prosperity. For example, platform enterprises and merchants show this entanglement because the platform provides traffic and technology services for merchants, and merchants provide goods and content for the platform, which means their interests are bound together in a symbiotic relationship. It is worth noting that the interests of the two are bound together. They can be prosperous together and also can lose together. In fact, the bad behavior of a merchant can damage the reputation of the entire platform and the policy adjustment of platform can affect the operation of all merchants. This entangled relationship is important. Local behaviors can be transmitted to the whole system through the digital network. It is expected to trigger a chain reaction and system resonance. Quantum entanglement theory provides a theoretical explanation for understanding the subject relationship and network effect in digital economy.

#### *2.4 Observation Perspective: The Logical Difference between Objective Neutrality and Active Construction*

Traditional empirical economics can use objective and neutral observation concept. This idea says economic law exists objectively. It is independent of human subjective behavior, similar to physical law in nature. These objective laws are hidden behind economic phenomena which can be very complex and show various patterns in different markets, and economists should try to find them through objective observation and empirical analysis which can help us understand how the system really works. It is worth noting that the observation behavior itself is just a record of objective facts. It does not affect operation of the economic system. This observation logic can remove people's subjective initiative from the analysis process completely, and it regards the economic system as an object that external observers can study in objective way without bringing their own values and personal bias into the research.

However, in real economy, this objective and neutral observation concept makes it hard to explain complex phenomena because the economic system includes conscious and purposeful people, and their subjective expectations, beliefs about the future, and emotions can affect decision-making behavior, which means the operation of the economic system is also influenced by these factors. Keynes was the first to realize the important role of subjective factors in economic operation, and he put forward the

concept of “animal spirit”, believing that economic fluctuations are driven by irrational emotions of investors. Then Minsky developed this idea further. He put forward the “financial instability hypothesis”. He believed that the financial system is inherently unstable. The optimistic expectations of investors can lead to asset price bubbles and the bursting of bubbles can lead to financial crisis. It is worth noting that these theories emphasize the role of subjective factors. However, traditional economics has not formed a systematic analytical framework to explain the two-way interaction between subjective expectations and objective economy.

Quantum thinking can change the traditional observation logic. It can be seen as a new way with active construction of observation behavior. In quantum mechanics, the wave function collapse principle shows that microscopic particles stay in superposition state before observation, which means the state of particle is not determined until the observation happens, and this phenomenon indicates that observation behavior plays a key role in the construction of reality. Then the observation behavior can cause the collapse of wave function. It makes particles change from superposition state to determined eigenstate (von Neumann, 1955). This means observation behavior does not only reflect the objective world in passive way. Also, it participates in and constructs the objective world with active manner. We apply this principle to economic system. Quantum economics believes that observation behaviors include policy regulation, market supervision, public opinion analysis and expectation guidance. These behaviors do not only record the market state in passive way. They also interfere with decision-making preferences of micro subjects in direct way to change the factor flow direction. This can reshape operation mode of economic system. For example, the monetary policy statement of central bank is a typical observation behavior. It can affect interest rates, exchange rates, asset prices and market volatility by changing expectations of market participants. Similarly, public opinion reports of media and rating reports of industry can have impact on behavior of market players and then they change the evolution path of economic system. It is worth noting that this observation construction logic provides a new analytical paradigm. It can be used to examine complex economic phenomena. These include expectation disturbance, asymmetric policy transmission, and market emotion resonance with feedback loops.

### *2.5 Evolution Mode: Path Difference between Continuous Gradual Transition and Critical Transition*

In fact, traditional mechanistic thinking holds that world evolution is a continuous process which is gradual and also linear, so the development of things can be a slow accumulation from quantitative change to qualitative change and there can be no jumping mutation. This logic is projected into economics field. It can form the linear growth theory in mainstream economics. Neoclassical growth theory holds that economic growth comes from continuous investment of capital, labor, technology and other factors, so the economic system can move along a smooth growth path. Short term market fluctuations can be temporary deviations. They happen when external shocks exist. In the long run, the economy can converge to steady equilibrium level.

The linear evolution logic can explain gradual economic changes in industrial age, such as technological improvement and capacity expansion, but when we consider discontinuous mutation phenomena like

technological disruption and market crash, this theory can not work well. In fact, industrial restructuring also makes this linear model invalid. In digital economy era, we can observe exponential growth in technological iteration and many disruptive innovations are emerging, and the cycle of industrial paradigm change is short which creates new challenges for traditional economic analysis. It is worth noting that smart phones replaced functional phones in just a decade and this disrupted the entire communications industry. Also, the development of e-commerce has changed traditional retail format and artificial intelligence is now reshaping production mode of almost all industries. These discontinuous mutations can not be explained by traditional linear evolution theory.

Quantum thinking gives new view of economic evolution law. We propose a dual evolution logic with gradual superposition and critical transition. The energy level transition principle in quantum mechanics shows that electrons can only stay at specific energy levels, and when electrons absorb or release certain energy they can transition from one energy level to another but cannot stay between two energy levels. Also, the economic system evolution is not continuous and smooth. It is a process combining long-term quantitative change accumulation with short-term qualitative change transition. From long-term view, knowledge, technology, data, capital and other factors can continue to accumulate and superimpose, and then couple with each other. Evolution potential energy is accumulated in this process. It is worth noting that when concentration intensity of factors and coupling density of system reach the critical threshold with external environmental conditions, the economic system can break through original path dependence and trigger discontinuous qualitative change which represents a leaping paradigm shift. Then it completes the leap of industrial level and replacement of technological track, with economic structure reconstruction. This critical transition evolution mechanism gives theoretical explanation. We can use it to understand disruptive innovation and industrial change.

#### *2.6 Governance Path: The Difference between Partial Restoration and System Integration*

In governance path, traditional economics uses reductionism as analytical logic. It can form a governance model of local optimization and single point regulation. In fact, this governance model can decompose complex systemic economic problems into several independent local problems, and we can optimize local economic operation state by adjusting a single variable (such as interest rate and tax rate) so as to realize optimization of the whole system. Also, marginal analysis and partial equilibrium analysis are typical applications, and single factor regulation is also included.

In industrial economy era, this local regulation mode can work to some extent. At that time, the economic system structure was simple and different parts had weak connection. Solving local problems can avoid bad influence to other parts. But in digital economy era, the economic system becomes complex and highly connected, and it is worth noting that the limitations of local regulation mode are more and more exposed because when we regulate one single variable it often causes unexpected chain reactions in the whole system. Then the policy effect can deviate from expectation and it can even bring serious negative externalities. For example, tight monetary policy is used to curb inflation but it can increase enterprise financing cost and reduce investment, and then economic recession may happen. Also, local protectionist

policies can protect local industries but they may damage the national unified market and hinder optimal resource allocation.

Quantum thinking follows the logic of systematic overall planning. In fact, we believe that root cause of modern economic problems is not the imbalance of single factor allocation, but includes the disorder of internal structure, the disorder of subject correlation, and factor coupling disorder. Therefore, the governance of economic problems cannot only rely on local optimization and it should be based on the overall perspective to coordinate the industrial ecology, subject relationship, element structure and evolution rhythm and we can resolve systemic risks by dredging the linkage mechanism, optimizing the coupling relationship, and improvement of the ecological system. This kind of system governance logic requires us to jump out of the traditional thinking of “treating head pain and foot pain” and we should establish overall concept and system thinking. Also we need to pay attention to the coordination and matching of policies. Then the transformation of economic governance from local correction and single point regulation to global optimization and system empowerment can be realized.

### **3. Application Scenarios and Practical Value of Quantum Thinking**

*Quantum thinking provides new ideas and practical logic for industrial development and macro governance, and can provide reference for policy-making of complex digital economy.*

#### *3.1 Reconstruction of Industrial Organization: Industrial Upgrading in the Era of Enabling Digital Economy*

Quantum thinking can explain how industrial organization evolves under different market conditions, we think it should provide practical guidance for industrial upgrading in the digital economy era which is full of uncertainty and rapid changes. We use thinking mode of superposition and parallel. Also, entanglement and coordination are considered. At the same time, we look at overall emergence and critical transition. Then enterprises can adapt to the complex environment of the digital economy, improve their core competitiveness according to our framework, and realize the development of industry with high quality, which can be seen as a result of applying quantum thinking to modern management practice under uncertain conditions.

Superimposed parallel thinking can help enterprises explore different areas and achieve innovation. In fact, in a highly uncertain market environment, because technology iteration speeds up and consumer demand changes, we can see that a single product and business model is difficult to adapt to the market changes and this brings serious risks to enterprise operation. Enterprises need to use superposition and parallel thinking. Also, they should explore a variety of technical routes and business models at the same time, so they can disperse innovation risks and capture market opportunities. It is worth noting that Google entered many advanced fields after its search engine business succeeded, and these include artificial intelligence, autonomous driving, cloud computing, and Life Sciences, so the company can maintain innovation ability through parallel exploration of multiple tracks. Similarly, when facing external sanctions, Huawei pushed forward R&D of several core technologies including Hongmeng

operating system, Kirin chip, 5g technology, and other areas, and the diversified layout can enhance risk resistance and development toughness.

Entangled collaborative thinking can support the ecological development of industry. In digital economy era, we can see that the competition pattern has changed and it is not just between single enterprises anymore, because now we should look at the competition between whole industrial ecology systems which includes many different types of companies. This thinking should be used by enterprises to build an open ecosystem with win-win relationships and through deep cooperation with upstream companies, downstream companies, partners and competitors, resource sharing and complementary advantages can be realized. For example, Tesla has built a full industrial ecosystem covering battery production, vehicle manufacturing, charging network, autonomous driving software and energy services. It is worth noting that Tesla attracts many partners to join its ecosystem by opening the charging network and sharing technology patents and this forms strong ecological competitiveness. This entangled and coordinated development mode can improve the competitiveness of enterprises. Also, it is expected to promote rapid development of whole new energy vehicle industry.

We examine critical transition thinking. It can help enterprises achieve leapfrog development. The development of enterprises is not linear, and it includes long-term accumulation together with short-term breakthrough. Enterprises should use this thinking to seize key strategic opportunity period. In this way, they can realize leapfrog development on basis of long-term accumulation. It is worth noting that ByteDance accumulated a large number of users and data resources through Toutiao at beginning of its establishment. Then at the critical node of short video track outbreak, the company launched Douyin products. It occupied the market. Also, the company realized critical transition from information platform to global short video giant. Similarly, CATL seized the market opportunity through long-term technology accumulation and capacity layout, and it became leader of global power battery industry at critical moment of new energy vehicle industry outbreak.

### *3.2 Macro Governance Optimization: Building a Flexible Regulation System Suitable for Complex Systems*

Traditional macro-control system is rooted in mechanistic thinking and it relies on single variable regulation and linear transmission logic to formulate economic policies and this approach can hardly adapt to the complex and dynamic operating environment of digital economy. In fact, quantum thinking can give a new idea for macroeconomic governance. It can help transform macro-control from rigid, fragmented control that is limited to single points to flexible and systematic control with collaboration.

We should use superposition and parallel thinking to implement diversification policy experiments because the economic environment is complex and uncertain, and a single policy tool can hardly solve all diversified problems, which makes it hard to achieve good results in every region. Also, one-size-fits-all policies may cause systemic risks. The government should use superposition and parallel thinking. It can implement differentiated policy experiments in different regions and industries. Then we select the best scheme through parallel exploration of multiple options that can be tested at the same time. For

example, China's reform and opening up began with establishing special economic zones. Through policy experiments in some regions where conditions are suitable, experience was accumulated and extended to the whole country, which shows that this method is effective and can avoid the risk of implementing wrong policies nationwide. This reform method of "crossing the river by feeling the stone" is in principle a trial and error method using superposition and parallel thinking. In fact, in digital economy era, the government can improve this policy test mechanism. It should carry out diversified pilot exploration in data element marketization, platform economy supervision, artificial intelligence governance and other aspects, so that these results can provide experience for national policy-making. Observation construction thinking is used to strengthen expectation management. In fact, in quantum economic system, observation behavior has active construction role. Policy signals and market expectations can affect economic operation. We use this thinking to strengthen expectation management and guide market players to form reasonable expectations, and at the same time through clear and transparent policy communication the flexible regulation of economic system can be realized. For example, we note that monetary policy communication from central bank is important observation behavior which can release policy signals in advance and by influencing expectations of market participants the market fluctuations are smoothed. When economy faces downward pressure we suggest that government can issue positive fiscal and monetary policy signals to boost market confidence. This can stimulate consumption and investment and help improve the overall economic performance. Also, when dealing with inflation, government can release tightening policy signal to curb market overheating and stabilize price level.

We should use overall system thinking to improve governance work. In digital economy era, most economic problems can be systemic in nature and these complex problems usually involve multiple fields, different government departments, various regions and other stakeholders, which makes the governance work difficult. The government should apply overall system thinking. It can break departmental barriers and regional segmentation that exist between different areas, and we should strengthen coordination of policies to form a joint governance force. Platform economy governance involves many departments. These include market regulation, Internet information, industry and information technology, taxation, finance and other related departments. It is worth noting that we should establish a cross-sectoral collaborative governance mechanism that can realize the full-chain and full-field supervision of platform economy, and this is expected to cover all necessary aspects. Similarly, the realization of carbon peak and carbon neutrality goals involves many industries such as energy, industry, transportation, construction and other related sectors. We should coordinate industrial policies, energy policies, fiscal policies and financial policies to form a joint force and it can promote green and low-carbon transformation of economy and society.

#### 4. Research Conclusions and Prospects

We can summarize our findings into three aspects. First, traditional economics has a theoretical dilemma, and in fact this problem comes from the endogenous limitation of mechanistic thinking inside the theory itself, which means the deterministic hypothesis and reductionism method together with linear evolution logic can hardly adapt to the operation characteristics of digital economy. Second, For the first time, the logical differences between quantum thinking and classical thinking are comprehensively sorted out from six dimensions, including ontological hypothesis, cognitive model, subject relationship, observation logic, evolution path, and governance method, providing a clear cognitive starting point for the transformation of economic paradigm. quantum thinking has good consistency with modern economic system, and it is worth noting that this consistency is internal because quantum thinking takes uncertainty as ontological premise and uses holistic system theory as cognitive mode while dynamic evolution is taken as evolutionary logic. These features can help break through theoretical shackles of traditional economics. Third, quantum thinking has important practical value in several aspects including industrial organization reconstruction together with macro governance optimization, and in principle it can provide theoretical guidance for China's new productivity cultivation, modern industrial system construction and also macro-economic governance.

Quantum economics can have good prospects for development. However, we should note that current research is still in initial exploration stage and many problems remain to be solved, which means we cannot expect immediate application in real economic systems without further theoretical work. It is worth noting that the theoretical system can be not yet mature in principle. Existing research focuses on explanation of local economic phenomena, and it lacks systematic sorting of core concepts and basic assumptions, while the theoretical system itself also needs proper definition and organization, so the self consistency and preciseness should be improved through more rigorous work. Then, empirical research methods can lag behind. Traditional econometric methods are based on linear and deterministic assumptions, which cannot match characteristics of quantum economics that are nonlinear and probabilistic, and the holistic nature also makes it hard to use traditional tools. In fact, building suitable empirical method system can be urgent. Also, application boundary is not yet clear. Quantum economics is not complete negation of traditional economics, but it should be supplement and expansion, and we need to clarify applicable boundaries of two paradigms to avoid abuse and generalization of quantum concepts.

In the future, quantum economics development should be based on China's local practice. We can promote it from following aspects. First, we should strengthen theoretical system construction. Relying on rich practice of China's digital economy development, we standardize core concepts and basic assumptions of quantum economics, and we improve four-dimensional theoretical framework covering ontology, epistemology, methodology and application layer. It can form a logical, self consistent and systematic theoretical system. Second, new methods are needed for empirical research. In fact, traditional econometric analysis has limitations and we should break through them. We can introduce complex system simulation, network analysis, machine learning, and quantum computing. Then we build quantitative analysis tools suitable for characteristics of quantum economics. This can enhance positivity and testability of theory. Third, we should clarify application boundary and scope. Classical equilibrium paradigm and quantum complex paradigm have different application scenarios. We distinguish them and focus research on complex economic field with high coupling, high volatility and other evolutionary features. This can avoid mechanical application and concept abuse. Fourth, it is worth noting that theory and practice should be integrated. We apply quantum economics achievements to China's economic construction practice. The results can be used as a reference for cultivating new productive forces and constructing modern industrial system, and it can also provide suggestions for macroeconomic governance modernization.

Quantum thinking brings a new way to study economics and it can help us build new models. It changes the basic paradigm we use in economic analysis. It changes how we understand the economic world. Also, it can help solve complex problems in digital economy era and this is important for the practical application. We build a quantum economics system with Chinese characteristics and Chinese style. It can promote new development of economic theory. Also, the results can be used as reference for high-quality development of China's economy and realization of Chinese modernization, and we think this framework can in principle provide necessary support for the policy making in the long run when the system is established. In fact, with the research goes deeper, quantum economics can be an important direction of future economic development. It can contribute Chinese wisdom and Chinese solutions to progress of global economic theory.

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