

# **Combining Systems Theory and Traditional Chinese Medicine to Understand Modern Economics**

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**Abstract:** A social economy, like the human body, is an organic entity. This study uses the methods and theories of traditional Chinese medicine to understand modern economics. Specifically, it uses the theory of the five elements, the yin-yang theory, and the theory of qi to interpret circulation and changes in the social economy, to understand the operation of “the invisible hand” of the market, and to identify the intrinsic causes of economic malfunctions.

**Keywords:** Modern economics; Traditional Chinese medicine; Systems theory; Dynamical system; Eigenvalue

## **1 Economic Systems**

### **1.1 Circulation**

The circulation of commodities and capital is driven by economic activities. For an economic system to maintain long-standing and continuous stability, these activities must form a self-organizing system. To become an orderly system capable of adjusting its internal parts, a self-organizing, complex, adaptive system must develop a mechanism that maintains relative stability and a mechanism that facilitates

self-evolution and it must be open, dynamic, and nonlinear.

An economic system must be open because it needs to exchange material, energy, and information with the natural world, and to exchange personnel, commodities, and currency with other economic systems. It can be described using the following set of nonlinear differential equations:

$$\dot{x} = f(x) \quad x \in \Omega, \quad (1)$$

where  $f$  is a sufficiently smooth function, and  $\Omega$  is an open subset of  $R^n$ .

$x = (x_1(t), \dots, x_n(t))$  is the state vector in  $\Omega$ . The state vector  $x_0 \in \Omega$  is called the equilibrium point of the system if  $f(x_0) = 0$ . At the equilibrium point  $x_0$  the linearized system can be written as

$$\frac{dy}{dt} = Ay, \quad (2)$$

where  $A$  is the Jacobian matrix evaluated at  $x_0$ , and  $A = Df(x_0)$ .

## 1.2 System Structure

To function as a self-organizing system, an economic system must have basic facilities, human resources, and relevant regulations to support its activities. Economic activities can be classified according to their different functions and the system can be divided into a number of different subsystems according to these classifications. These functional subsystems must each have their own basic facilities, human resources, and relevant regulations. The operation of one subsystem will naturally affect the operations of the other functional subsystems. For instance, one subsystem may facilitate the sustainable development of a second subsystem, which in turn facilitates the development of a third subsystem. The interactions of these series of functions form a causal loop, and thus a modern economic system can be described as a multi-loop circulatory system.

### **1.3 Equilibrium**

Equilibrium theory, first introduced in Newtonian mechanics, is an important concept in economics. In mechanics, equilibrium describes the state of an object when it is subject to balanced external forces; in this condition, the resultant force is zero, and therefore an object will be either stationary or have a uniform linear motion. In economics, equilibrium is used to describe multiple conditions: (1) a market in which a product is offered at a price such that the quantity supplied is equal to the quantity demanded (market-clearing price); (2) a stable economic system in which people are not motivated or able to change the status quo; and (3) sustainable economic conditions, maintained by predictable behavior. The overall equilibrium of an economy and a society is achieved when, under certain conditions, relevant variables reach a relatively stable state.

However, in this relatively stable state the economy has limited flexibility. Fortunately, this relatively stable state does not last long. Whenever profit arises from transactions, the equilibrium is broken. When people have surplus food and clothing they will use their money on consumption, saving, or investment. If they choose to spend their money on consumption, new demands emerge and commercial opportunities are created. People who invest their money expect reasonable returns and this will create jobs; as employment increases, more people have more money for consumption and investment. These activities form a circle with positive feedback, creating a market full of vitality and opportunity.

Objects have vitality only when they move and change continuously. When commodities, currencies, and capital circulate freely the economic equilibrium is broken. Human selfish behavior tilts the economy out of its equilibrium state.

### **1.4 Yin Qi and Yang Qi**

In ancient times, Chinese people use yin and yang to interpret the motions and development of all types of objects. Chinese traditional medicine uses yin and yang to explain human physiological and pathological phenomena. The original meanings of yin and yang were the “shady side of the mountain” and the “sunny side of the mountain,” respectively. Later, the ancient Chinese used yin and yang to represent the two opposite aspects of every object and phenomenon. Things and phenomena that are warm, active, excited, hyperactive, and/or exhibiting an ascending motion are categorized as yang; cold, passive, and inhibited things or phenomena, and those exhibiting a descending motion are categorized as yin.

In Chinese ancient philosophy, qi is the origin of all objects in the universe; it can be divided into yin qi and yang qi. Yin qi and yang qi combine in different ways to produce all things. In other words, everything in the universe evolves from qi. Qi never stops moving, and it facilitates the emergence and change in everything.

We use the state variables to define economic activities and the circulation of commodities and capital; the state space to define qi. Qi can be divided into yin qi and yang qi. The state space of the dynamical system of Eq. (1) will be decomposed into two invariant sets which are similar to yin qi and yang qi.

Suppose  $\lambda_1, \lambda_2, \dots, \lambda_n$  are the eigenvalues of the Jacobian matrix  $A$ . Each eigenvalue has a corresponding eigenspace. The stable eigenspace  $E^s$  is the space spanned by the eigenvectors whose corresponding eigenvalues have negative real parts, and the unstable eigenspace  $E^u$  is the space spanned by the eigenvectors whose corresponding eigenvalues have positive real parts.

The equilibrium point  $x_0$  is said to be hyperbolic if the matrix  $A$  has no eigenvalues with zero real parts. If  $x_0$  is a hyperbolic equilibrium point, the local stable and local unstable manifolds can be defined, respectively, as follows:

$$W_{loc}^s(x_0) = \left\{ x \in \Omega : \lim_{t \rightarrow \infty} \phi_t(x) \rightarrow x_0 \right\} \quad (3)$$

and 
$$W_{loc}^u(x_0) = \left\{ x \in \Omega : \lim_{t \rightarrow -\infty} \phi_t(x) \rightarrow x_0 \right\}, \quad (4)$$

where  $\phi_t(x)$  is the flow of the nonlinear system of Eq. (1). The local stable manifold  $W_{loc}^s(x_0)$  represents the set of points that flow forwards in time to the equilibrium point, and the local unstable manifold  $W_{loc}^u(x_0)$  represents the set of points that flow backwards in time to the equilibrium point. We take the concept of the stable manifold to define yin qi, and that of the unstable manifold to define yang qi. These two invariant manifolds are used to study the qualitative behaviour of economic Systems.

The power to move objects comes from the interaction of yin qi and yang qi. When yin qi and yang qi interact, their different energy levels act on each other and produce changes in physical forms and in the energy that drives motions. Interaction that leads to changes in physical form and energy is called “qi transformation,” whereas interaction that leads to changes in the type or amount of motion is called “qi activity.” Interaction between yin qi and yang qi is the fundamental cause of object formation and change.

The basic principles of yin-yang theory are opposition, interdependence, waxing-waning, and the inter-transformation of yin and yang, which can be used to explain the contradictory movements of objects. In the following section, I use yin-yang theory to interpret economic operations and to explain their malfunctions.

### **1.5 Positive and Negative Feedback Mechanisms**

Every complex system has positive and negative feedback mechanisms. Negative feedback mechanisms continuously reduce or even eliminate changes, keeping the

system stable and objects in a state of equilibrium. Positive feedback mechanisms continuously promote changes, upsetting the balance of the system and moving objects away from a state of equilibrium. When the external environment changes in a way that makes it no longer conducive to the development of an object, positive feedback mechanisms will drive the object away from its equilibrium state. The object will then evolve from one structure to another.

## 2. Market Mechanisms

In *The Wealth of Nations*, Adam Smith points out that the “invisible hand” of the market is the mechanism through which the social economy automatically adjusts, balances, and develops.

### 2.1 Energy Function

An economy needs a driving force to energize all of its economic activities. Qi can be regarded as “vital energy” or “life force.”

If  $x_0$  is a type- $k$  equilibrium point, there exists a nonsingular matrix  $P$ , such that the matrix  $A$  can be diagonalised to form the following block diagonal matrix:

$$P^{-1}AP = \begin{pmatrix} A_+ & 0 \\ 0 & A_- \end{pmatrix}, \quad (6)$$

where  $A_+ \in R^{k \times k}$  has eigenvalues with positive real parts, and  $A_- \in R^{(n-k) \times (n-k)}$  has eigenvalues with negative real parts. Let  $y = (y_1, y_2)$ , where  $y_1 \in R^k$  and  $y_2 \in R^{(n-k)}$ .

The state vector  $y = P^{-1}x$  satisfies the differential equation

$$\frac{d}{dt} \begin{pmatrix} y_1 \\ y_2 \end{pmatrix} = \begin{pmatrix} A_+ & 0 \\ 0 & A_- \end{pmatrix} \begin{pmatrix} y_1 \\ y_2 \end{pmatrix} + \begin{pmatrix} f_1(y) \\ f_2(y) \end{pmatrix}. \quad (7)$$

We define an energy function  $V(y)$ . If  $x_0$  is a type- $k$  equilibrium point, there exist

two positive definite matrices  $B_1 \in R^{k \times k}$ ,  $B_2 \in R^{(n-k) \times (n-k)}$ , and the nonnegative function

$$V(y) = y_1^T B_1 y_1 + y_2^T B_2 y_2. \quad (8)$$

The function  $V(x)$  is an energy function of the nonlinear system described in Eq.

(1). If  $x \in W_{loc}^s(x_0)$  and  $x \neq 0$ ,  $\dot{V}(x) < 0$ ; if  $x \in W_{loc}^u(x_0)$  and  $x \neq 0$ ,  $\dot{V}(x) > 0$ . The energy function decreases in time along the orbit with state space in  $W_{loc}^s(x_0)$  and increases in time along the orbit with state space in  $W_{loc}^u(x_0)$ .

An economic system must first meet people's material needs, but it also needs a self-perpetuating vitality. If economic activities stop, the whole economic system will collapse.

When capital and labor combine to produce commodities that people need, they also create employment opportunities. When people have surplus income, new consumption markets emerge, and new capital and new development projects appear that encourage talents and create facilities. This is a new source of energy for the market.

Economic systems need two types of capital: the type that flows into production and creates profit, and the type that is invested in the financial market to vitalize the economy. When capital flows into production, commodities that people need are produced; this is an energy consuming process. Commodity production transforms profit into capital and reinvests it in the market; this is an energy-releasing process. Economic activities increase when there are business opportunities in different areas. Business opportunities are the result of different combinations of capital, technology, and demands. The whole economic system depends on the circulation of capital in the market, which facilitates the development of each economic sector and level.

## **2.2 Dynamic Equilibrium**

There are two kinds of economic activities: production or operation activities and investment activities. Capital circulates through both types of activities and the value of currency and capital is dependent on this circulation. Although currency and capital are not directly involved in production activities, they bring vitality to the whole economy. The circulation of currency and capital encourages economic development by creating business opportunities and facilitating reasonable resource allocation. Circulation also promotes exchange between economic systems. An economic system needs to exchange personnel, material, information, and capital with other economic systems, as only exchange can invigorate economic systems; furthermore, to avoid external shocks, a system must respond to changes in neighboring economic systems.

An economic system must meet people's material needs, and each economic sector requires enough capital to maintain its successful operation. Therefore, material production and capital circulation must be maintained in a coordinated and dynamic equilibrium. This is similar to the "balance between yin and yang." When an economy is balanced between yin and yang, it can develop in a steady, orderly, and healthy way. In a coordinated system capital circulation must respond to external changes, and adjust the ratio of production/operation activities to investment activities. When the amount of capital is excessive, it will flow into high value-added investment activities, and production or operation sectors will be short of funds. When money flows too fast, the economy will run out of control; when money is too tight, some economic sectors will be short of capital. If the economy is off balance, it will affect the operations of every aspect of economic production.

## **2.3 The Real Economy and the Virtual Economy**

The real economy consists of the economic activities that focus on material



production and operation. In these activities, materials are made into products and sold on the market for profit. Virtual capital generally refers to capital that will yield returns in the future. The virtual economy uses virtual capital to maximize profits.

The real and virtual economies have relatively independent operating models. The real economy operates on the basis of capital-supported pricing methods. Material production needs a labor force, raw materials, workshops, and equipment. Product prices are determined by various investment and market needs. In contrast, virtual capital is traded according to people's psychological expectations and various discounting methods. During periods of economic expansion, people believe that capital prices will rise substantially, and expect that their investments will produce high returns. During periods of economic contraction, people will transfer funds to savings or overseas.

The real economy uses cost to determine price, and therefore is relatively stable. The virtual economy does not involve material production, and does not itself incur any costs. Its transaction costs can be ignored, and thus in the virtual economy price is determined by people's subjective expectations. The operation cycle of the virtual economy is short. When investment returns rise, people will be psychologically ready to win "the greater fool," and consequently prices will continue to rise. This is an example of a positive feedback mechanism that makes the virtual economy unstable. The real economy and the virtual economy are complementary. In essence, the virtual economy serves the real economy; the real economy is the starting point and reference point for the virtual economy. Ultimately, profit in the virtual economy comes from the real economy.

The real economy can meet people's basic needs, and can supply the material foundation for economic development. It is an essential part of human existence and social development and requires a stable business environment and the regular

circulation of capital. The virtual economy has high mobility and high risks. High mobility is favorable for social resource allocation and industrial structure optimization. The high risk nature of the virtual economy allows enterprises to transfer risks, and reduces the damage that unstable elements can have on the real economy. The virtual economy has highly unstable and highly speculative characteristics. According to the theory of yin-yang, instability is a characteristic of yang and stability is a characteristic of yin. Therefore, the virtual economy can be classified as yang and the real economy can be classified as yin. If the virtual and real economies can be coordinated, the negative effects of high instability and high speculation on the economy can be effectively mitigated.

The real economy is based on production, whereas the virtual economy aims to strengthen the circulation of capital. In the *Huang Di Nei Jing Su Wen* Chapter 5 it says:” yang transforms qi, yin completes physical appearance”<sup>1</sup> The virtual economy finances the real economy, and profit from the real economy can accelerate the development of the virtual economy.

As yin and yang interact, yin qi and yang qi coordinate and produce “qi transformation” and “qi activity.” In this example, “qi transformation” means that the virtual economy is invested in the real economy, while the real economy produces material wealth and economic benefits. At the same time, the profits of the real economy can accelerate the development of the whole economy. “Qi activity” produces the business opportunities that coordinate the real and virtual economies. The high mobility of the virtual economy enables capital to flow into different

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<sup>1</sup> Paul U. Unschuld. *Huang di nei jing su wen : an annotated translation of Huang di's inner classic - basic questions*. Vol 1: page 96. Berkeley : University of California Press, c2011.

production sectors and social classes, thus creating business opportunities and optimizing resource allocation.

## **2.4 Economic Cycle**

An economic cycle refers to the regularly occurring periods of economic expansion and contraction. Economic cycles have four phases: recovery, prosperity, recession, and depression. These cycles ebb and flow continuously and can be divided into long cycles, long and medium cycles, medium cycles, and short cycles. An economic system is closely related to the natural world, and economic activities cyclically adjust in accordance with the movements of the sun, the moon, and the stars.

In an economic system, because market expansion leads to an increase in overall demand, most resources are directed towards expanding the market; investment in basic research and scientific invention is neglected. However, economic expansion cannot last forever. During periods of economic contraction, people invest in technical improvements, optimize treatment, production and operation, and create the conditions for the next round of economic recovery. Scientific invention and technical innovation are thus necessary conditions for economic prosperity and economic expansion.

The economic cycle is one illustration of the waxing-waning behavior of yin and yang. In an economic system, yin and yang exhibit a regular alternating cycle, corresponding to the rhythm of nature.

## **3 Macro-Economy**

### **3.1 Inflation**

Inflation is a continuous increase in overall prices. The monetarist school believes that inflation is a monetary phenomenon. When a currency devaluates or purchasing power declines, commodity prices rise, causing inflation. The causes of inflation

include (1) demand-pulled inflation, (2) cost-pushed inflation, and (3) structural inflation. The ultimate cause of inflation is that total social demand is larger than total social supply.

Total social supply is the sum of social production activities. Production incurs costs such as salaries and interest. When salary growth exceeds labor productivity, production costs rise; when interest rates rise, capital costs also go up. Increasing production costs can result in a production supply that is unable to meet social demand, leading to economic problems. Total social demand is determined by income; increasing salaries lead to increasing demands. When production costs rise and supply cannot meet demand, the result is an economy in which total social demand exceeds total social supply.

A social economy is an organic entity. It consists of multiple functional subsystems, each of which has its own operational characteristics. These subsystems interact to form an organic entity. Each functional subsystem has its own basic facilities, human resources, and relevant regulations that support its activities and functions.

If the basic facilities of some of the subsystems cannot adapt to changes, for example if human resources are unavailable or relevant regulations are out-of-date, the functioning of the subsystems will be affected. Functional subsystems are integrated; when some subsystems are obstructed, the operations of other subsystems will surely be weakened.

A momentum shortage of economic growth and a lack of vitality in the economy are signs of “qi deficiency.” When subsystems have pathological changes, it is because various yin and yang failures exist in the whole economic system. A rise in production costs, deficient production resources, or weak productivity are signs of “yin deficiency.” Deficient yin cannot counterbalance the existing yang, and therefore the yang is relatively strong. A decline in currency purchasing power,

continuously rising prices, and economic overheating are similar to a diagnosis of “yin deficiency leading to internal heat” in traditional Chinese medicine. The causes of deflation may be a steep reduction in consumption, or a dramatic increase in productivity. Deflation causes a situation in which supply exceeds demand. When supply and demand are unbalanced, economic problems emerge. Deflation causes falling prices, and this obstructs the flow of money and causes economic contraction, a sign of “yang deficiency.”

### **3.2 Economic Bubbles and Bubble Economies**

Economic bubbles and bubble economies can both be damaging. Economic bubbles occur when asset prices are overestimated and people still unreasonably expect prices to rise. Some economic bubbles can vitalize the economy and promote economic growth. A bubble economy is the rapid expansion of the virtual economy; this phenomenon will produce vicious boom and bust cycles that hurt the real economy. If the virtual economy continues to expand, it becomes unconnected from the real economy, and thus market mechanisms do not function, and multiple asset prices rise in the short time. However, the real economy cannot produce economic benefits in a short time. When the bubble bursts, it will damage the economy. If economic bubbles cannot be curbed, they will evolve into bubble economies.

When asset prices are much higher than the level that the current economic fundamentals can bear, but people still expect asset prices to rise, a bubble economy appears. During economic expansion, people are optimistic, and the market becomes more and more attractive. However, after a period of economic expansion, commodity supply will exceed demand and overstocked products, repetitive construction, mistaken investment, and excessive investment will negatively affect the business environment. However, asset prices do not reflect these negative factors immediately. People continue to expect prices to rise, and hot money is introduced

into the market. Only a small portion of hot money goes into production, and the business environment gets worse. Most of the hot money is used for speculation aimed at short-term gains. The market ends up with too much liquidity as virtual capital expands, and asset prices continue to rise, attracting investors interested in short-term speculation. Unfortunately, the overall economy in this situation has no substantial growth, although it shows a false prosperity. This is a bubble economy.

The mechanisms of the virtual economy are important factors in a bubble economy, as are the transaction patterns of virtual capital based on people's psychological expectations and discounting methods. When the real economy and virtual economy are not synchronized, the profitability of the real economy decreases, and the virtual economy expands. In this situation, people will invest in short-term speculations. The high liquidity of the virtual economy accelerates the formation of bubbles, and the high return and high risks encourage people's "winning the greater fool" behavior. In the yin-yang classification system, instability is classified as yang and stability is classified as yin. Therefore, bubbles are formed by an excess of yang. When capital does not serve the real economy, and the virtual economy only rises but never falls, economic problems will occur.

According to the classification of yin-yang, instability pertains to yang and stability pertains to yin. Formation of bubbles pertains to yang. When capital doesn't serve real economy and virtual economy only rises but never falls, economic problems will appear. In Chapter 68 of the *Huang di nei jing su wen*, "When there is neither leaving nor entering, then there is nothing by which there could be generation, growth, adulthood, aging, and ending. When there is neither rise nor descend, then there is nothing by which there could be generation, growth, transformation,

gathering, and storage."<sup>2</sup>

When economic bubbles emerge, if proper adjustments are made and capital is directed towards production, bubbles can be reduced. If yin can restrict yang, the economy can be pulled back on track; if yin cannot restrict yang, there will be economic problems. In Chinese medicine these problems are described as the “predominant yang makes yin disorder” and the “excess of yang brings about heat syndrome.” Large adjustments are needed when either of these conditions occurs.

#### **4. Conclusion**

Chinese traditional philosophy contains rich materialist dialectical wisdom. Chinese traditional medicine has a unique understanding of the human body’s physiological functions and pathological changes. These insights can provide a new and powerful path to solve modern economic problems.

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<sup>2</sup> Paul U. Unschuld. *Huang di nei jing su wen: an annotated translation of Huang di's inner classic - basic questions*. Vol 2: page 238. Berkeley : University of California Press, c2011.