

Stability of Analysis by New Disequilibrium Cobweb Model of Coal Supply and Demand

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(Received 23 February 2014, accepted 25 June 2014)

Abstract: This paper is based on the analysis of the supply and demand of coal and the time lag between supply and demand, the economics cobweb model is applied to coal of supply and demand, establish a coal supply and demand disequilibrium cobweb model under the national macro-control to study the stability of price volatility. The second part is in the coal market of free competition, the use of non-equilibrium cobweb model for the stability of Shanxi Provinces coal supply and demand analysis shows that in free competition in the market, the coal supply is unstable, this same comparison differences in the findings of the original non-equilibrium cobweb model and new model, the new findings further indicate that the cobweb model is more accurate. On this basis, study the stability control of shanxi coal supply and demand situation in to show the government's macroeconomic regulation plays a role in stabilizing of the supply and demand.

Keywords: coal; supply and demand; stability; cobweb model

1 Introduction

Because of the important strategic role to play in economic development, energy, making more and more scholars began to focus on energy issues, the most important issues in energy prices have naturally become a hot research. South Korea found a causal relationship between GDP and coal consumption[1] based on the standard Granger test methods; Based on cointegration test and error correction, model showed that the presence of two-way causal relationship between coal consumption and GDP of the two countries, India and Indonesia, there is a two-way causality [2] between the Philippines and Thailand of coal consumption and GDP.

Cobweb model is a classic model of dynamic economic analysis and has a very common use in the description of the single market fluctuations. Cobweb model with the continuous improvement of its applications continues to expand, the areas and methods have improved the use of Cobweb Model[3], foreign scholars have studied the power systems of cobweb systems when changes have happened[4], and then study showed that the faster providers adapted their products, the more elastic demand and market behavior[5]. Heterogeneous access and rational expectations stable condition cobweb model is studied[6], recently lending, technical and fundamental investor behavior have been bound into cobweb model[7]. Chinese scholars have researched cobweb model of supply and demand in the market for a very wide range. Such as the cobweb model is applied to the money market and monetary policy, drawn both exogenous money supply, but also endogenous[8]. Analysis the food price volatility phenomenon of "cobweb model" and the farmers' income growth[9], China's real estate market on the cobweb model were constructed[10], and the cobweb model corresponding analysis also made in other areas[11].

The traditional cobweb model assumes that the supply and demand functions are linear functions and the supply and demand balance for each period, in the real economy system, the "equilibrium" even assumed establishment, due to its motion type entirely by supply function and demand function identified specific form, and can not ensure that all of the unstable equilibrium price eventually converge to a stable equilibrium price. Meanwhile, the reality of the market are

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unlikely to reach the market clearing installments, the total supply and demand imbalance in the state. Based on non-equilibrium theory, considering the market in a non-equilibrium state, introduce regulatory mechanisms by the number of price regulation in order to achieve the supply and demand sides of the market to adapt to each other to exchange[12]. But the study of such non-equilibrium state is too little with constant adjustment of the quantity or price of a single adjustable parameter. Based on the above analysis, in order to overcome the presence of non-equilibrium cobweb model of this defect, this paper is to improve the non-equilibrium cobweb model from a practical reality of economic operation of the system, the establishment of non-equilibrium cobweb model is more in line with economic reality, the dynamic analysis of the model , based on the study of the stability problems of price volatility ,there are two important differences between the study of this paper and previous models of dynamic cobweb model : First, most previous cobweb model assumes that the demand function and supply function are linear form.Model of this study is extended to any form, they can be linear or non-linear form;Second, conventional non-equilibrium cobweb model has a price adjustment function by a constant to adjust, but the way is too simple to adjust.

Model of this study will enhance the price adjustment function, using the function instead of a constant as the price adjustment parameters to study the market in a variety of non-equilibrium state of the state. Therefore, this study is an extension of the model in the past Disequilibrium Cobweb model. Next, in Section 2.1 , first to use the new cobweb model to make an empirical analysis of supply and demand for coal in Shaanxi province , followed by 2.2 ,having an unstable regulate of supply and demand, to obtain stable regulation. Finally, in section 2.3,comparing the empirical results between new cobweb model and the original cobweb compare to draw more realistic of new cobweb model.

2 Using the new cobweb model to study the stability of supply and demand under coal market

Coal supply and demand on the market, making functions of supply and demand be monotonic functions in an economic period .Assuming a supply of a particular commodity is a function of the current forecast price x_t , the demand is a function of the current actual price, price adjustment equation is $x_{t+1} = x_t + \alpha(x_t)(F(x_t) - x_t)$.The system is

$$\begin{cases} D = D(x) \\ S = S(x_t) \\ x_{t+1} = x_t + \alpha(x_t)(F_t - x_t) \end{cases} \quad (1)$$

The three equations of model are demand equation, supply equation and the price adjustment equation, where $F = F(x_t)$ is the current actual price, namely, $(F(x_t) = x = D^{-1}(s(x_t)))$, $\alpha_t = \alpha(x_t)(\alpha_t > 0)$ is a price correction function, a function is a measure of the speed and magnitude of the adjustment to reflect changes in the price along with excess supply and demand.

This article assumes demand function $D(x)$ is a monotonically decreasing function of the price x , the supply function is a monotonically increasing function of the price x ,that is the demand decreases with increase in the price and the supply increases monotonically for price increases .This is consistent with economic significance. Make price adjustment equation be

$$x_t + 1 = G(x_t) = x_t + \alpha(x_t)(F(x_t) - x_t) \quad (2)$$

In real life, the difference between the forecast price and the actual price of the different time periods fluctuated. Therefore, this function at the point in the derivative value with changes in value of the change, if it is a regular operator, namely the cobweb model of literature [10]

$$\begin{cases} D = D(x) \\ S = S(x_t) \\ x_t + 1 = x_t + \alpha(F_t - x_t) \end{cases} \quad (3)$$

In real life, however, the rate of change of the price fluctuations, in rare cases it is a certain value, and hence the price correction function is a function of the price in line with the objective facts, based on the above analysis, the cob web model of literature [11] is a special case, the new cobweb model has a good significance.

For system (1), if there is $x^* \in R$,making $x^* = G(x^*)$,then x^* is known as the equilibrium price of supply and demand.Next this article analysis stability of an equilibrium the stability price of coal supply and demand . According to stability condition of iterative equation ,it shows that $|G(x^*)| < 1$, that is

$$1 - 2/\alpha(x^*)S'(x^*)/D'(x^*) < 1 \quad (4)$$

The system is stable. Inequality (4) can be used for case analysis to determine stability of supply and demand.

3 Case study

Such as Coal supply and demand in Shanxi Province, according to the price index of coal each year and the average price of an individual's life between 2001-2010, it can be estimated for each of the actual price of coal, the list is as follows (see Table 1). With the continuous improvement of people's living standards, social rigid demand for coal is also (Junin,

Table 1: 2001-2010 The amount of coal supply and demand and price in Shanxi of China

time	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
price(tuan/ton)	101.71	109.54	118.52	150.16	182.75	203.35	297.79	353.48	412.33	498.57
Supply (tonnes)	20452	23624	27342	32672	35434	39352	52623	78523	85372	90563
Demand (tonnes)	28326	35933	44165	48576	56482	58213	64327	71526	79438	85295

2012) to increase in an exponent way of $E_t = E_0(1 + KP)^t$ (where K is the coal consumption elasticity coefficient, P is the GDP growth rate over the same period, E_0 is coal consumption in the base year), This part does not vary with changes when prices occurred substantial fluctuation, it is not within the study area, the scope of this article, therefore, take data came from 2013, China Statistical Yearbook" into to $K = \text{Annual growth rate of consumption of carbon content} \div \text{Average annual growth rate of the national economy}$, to calculate annually rigid demand for coal as a whole within the study area, and then delete the part of the rigidity of coal production and demand. The amount of coal supply and demand

Table 2: 2001-2010 The amount of coal supply and demand and price in Shanxi of China

time	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
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and prices revised of Shanxi in 2001-2010. Make coal supply function and demand function are: $s(x) = s_0 + kx$, $k > 0$, $d(x) = d_0 - mx$, $m > 0$.

Make a linear regression on prices of the function about Shanxi coal supply and demand, the results are as follows

$$s(x) = s_0 + kx = 12169.618 + 69.569x, d(x) = d_0 - mx = 39941.104 - 19.881x \tag{5}$$

And the regression results show a close degree of explanatory variables and the dependent variable is relatively high, but also shows the extent of the regression line fitted sample data points are relatively high. Where k is positive in line with objective reality, because with the increase in coal prices, it is a corresponding increase in the supply of coal according to the relevant principles of economics, so it is with coal prices are positively correlated. -m is negative, indicating that with the increase in coal prices, coal consumption is decreased, which is in line with economic significance, and the price of coal on the overall impact of coal usage is relevant with other variables, so there will be negative coefficients. Regression for the above data processing, we have

$$\alpha(x_t) = a_1 + a_2x_t = 0.005x_t + 1.443$$

From top, shows that: when $s(x) = d(x)$, $x^* = 310.47$ Then $S'(P^*)/D'(P^*) = -3.4992 < 1 - 2/\alpha = 0.3322$ The power supply and demand is an unstable when $x^* = 310.47$ that means that when the price of coal was 310.47 yuan / hour tons, supply and demand is unstable. Contradictory of coal prices is mainly contradiction between coal and electronicity, but the root cause is that the relationship between the price of coal contradiction with coal is uncoordinated. Furthermore, accelerate tariff reform and establish linkage mechanism of coal prices and electricity prices, electricity prices and grid sales price. so that the sales price grid accurately and comprehensively reflect market supply and demand generation and fuel price changes, thereby contributing to the stability of coal supply and demand.

4 The regulation of unstable situation

On the market of coal supply and demand, with different values of, the stability of supply and demand conditions subject to change, to make the system becomes stable, the introduction of a variable β on the basis of the original system to get a

stable control system:

$$x_{t+1} = x_t + \alpha(x_t)(F_t - x_t) + \beta x_t \quad (6)$$

If make (10) to achieve a stable control effect, namely $|G(x^*)| < 1$, that is when $-2 - \alpha(F'(x) - 1) < \beta < -\alpha(F'(x) - 1)$, the system is stable.

5 Comparies of conclusion between cobweb model on [11] and new model

Next, use the original cobweb model to analysis the situation of supply and demand in Shaanxi Province, make the initial prices $\alpha_1 = 0.32$ value basis corrected as the price of the correction factor of original model, the system (11) expressed as follows:

$$x_{t+1} = x_t + 0.32(F_t - x_t)$$

If $S'(P^*)/D'(P^*) = -3.4992 > 1 - 2/\alpha = -5.25$, The power supply and demand is stable when $x^* = 310.47$ that means that when the price of coal was 310.47 yuan / tonnes for coal, demand and supply is stable.

However, the reality is not the case, coal convergence and coordination problems with the grid power supply have not broken the "bottleneck", resulting in supply and demand on the market can not "cross" these problems to achieve stability of supply and demand, so the current situation is difficult to accept that the existence of a stable relationship between supply and demand.

Through the analysis above, the conclusions of analysis by old and new cobweb model respectively are not entirely consistent, the new cobweb model is through dynamic analysis on prices, the result is more fit in the actual situation. The cobweb model of literature [11] uses a constant adjustment, to reflect the dynamic changes of market prices, and thus results in the analysis may occur large deviations and even come with contradictory conclusions of the actual situation.

6 Conclusion

The traditional cobweb model with non-equilibrium makes constants as adjustable parameters to adjust the quantity or the price, it is too simple. In real life, the rate of change of the price fluctuations, in rare cases it is a certain value, and hence the price correction function fits objective facts for the price. In this paper, based on market of supply and demand of coal, use non-equilibrium dynamics cobweb model to analyze its stability, the result of supply and demand in the coal market is unstable, the result of stability control analysis on the basis of the coal market has laid a theoretical foundation of macro-control. This theory one side shows that self-regulation by the market bring about blindness and avoid fluctuations in coal prices and coal production phenomenon; on the other hand, to reduce the financial burden on the state subsidy, the national coal industry from direct policy intervention to adjust the regulation back to promote the stable development of the coal market.

Acknowledgments

This research was supported by the National Nature Science Foundation of China (No. 11171135) and the Priority Academic Program Development of Jiangsu Higher Education Institutions.

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