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The interest rate level and the loose or tight monetary policy -- based on the fisher effect

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ABSTRACT

Differences in understanding of the relationship between the level of interest rates and monetary policy, People put forward different monetary policies. It is of very important significance for people to understand and implement the central bank monetary policy that the correct knowledge of the relationship between the level of interest rates and the tightness of monetary policy. This paper make an empirical analysis of the Fisher Effect in china with the Fisher Effect Model based upon the theoretical analysis, In order to avoid the "Fisher paradox", it distinguishes between short-term and long-term fisher effect. we empirically analyze the long-term fisher effect by applying the minimum deviation completely revised the auto regressive distributed lag model, the short-term fisher effect by using the generalized method of moments estimation method, to the Chinese data in 1990-2003 as a test sample.

KEYWORDS

Interest rate; Monetary policy; Fisher effect; Inflation rate; Yardstick.

INTRODUCTION

According to Fisher's analysis, the nominal interest rate will increase as people anticipate the increase of the inflation rate, which will be fully reflected on the nominal interest rate, and the nominal interest rate, together with the price level, will change in the same direction. This long-term effect is generally called "Fisher Effect". If Fisher Effect does exist, the increase of the nominal interest rate is not the reflection of the implementation of the tight monetary policy, but the result of the increase of the inflation rate. Thus, the nominal interest rate should be used with caution as an indicator of to reflect the degree of tightness in the monetary policy. As a result, whether the discretion of the interest rate can be the best scale to judge the degree of tightness in the monetary policy of the Central Bank mainly lies in whether "Fisher Effect" exists between the nominal interest rate and the inflation rate in China.

LITERATURE REVIEW

In some empirical literature, the adjustment between the nominal interest rate and the inflation rate is one to one, which indicates the real interest rate is equal to constant. Fama (1975)[1], by regressing the nominal interest rate which is used as the explained variable of the inflation rate, finds that the bond market of America is effective, and the reason lies in that the nominal interest rate summarizes all the message of the future inflation rate that the past inflation rate contains, the effectiveness, as well as the observed effective yield, is constant, which means the complete adjustment between the nominal interest rate and the change of the prospective inflation rate[2]. Engle and Granger (1987), as well as Mishkin (1992), used the method of cointegration to analyze the interest rate of one month and the interest rate of three months, pointing out that Fisher Effect is a long-term (not short-term) phenomenon[3]. Wallace and Warner (1993) used Johansen's maximum likelihood estimation method to prove that the one-to-one adjustment relationship does exist between the nominal interest rate and the inflation rate[4]. Evans and Lewis (1995) used the Markov alternative model to specify the change of the inflation trend, and make a second test on the long-term relationship between the nominal interest rate and the inflation rate, finding it can't be denied that the one-to-one adjustment relationship does exist between the two (though the estimated coefficient is less than 1)[5]. Mishkin and Simon (1995) respectively used American and Australian data to test, with the result that strong long-term Fisher Effect did exist in some periods in these countries (though short-term Fisher Effect is denied)[6]. Rose (1998), King and Watson (1997) etc. denied the long-term equilibrium relationship between the two[7,8]. Koustas and Serletis (1999) used the quarterly data from 1957 to 1995 in the 11 OECD countries to study Fisher effect, finding that in these countries (except Japan) there is no equilibrium relationship between the two variables[9].

This paper, based on theoretical analysis, will make an empirical test on Fisher effect in China by using the standard model of Fisher Effect. It also distinguishes between the long-term and short-term Fisher Effect by drawing on Mishkin's analytical method. Based on the research of Caporale and Pittis (2000), we estimate Fisher Effect by using FMADL[18]. According to Mishkin, we can adopt the Generalized Method of Moments to analyze the short-term effect, by using the relevant data from 1990-2012 as samples.

SPECIFICATION AND PARAMETER SETTING OF THE MODEL

Suppose i_t is the nominal interest rate in Period t, r_t is the real interest rate in Period t, π_t^e is the prospective inflation rate in Period t, *P* is the capital, then we have:

$$r_t = \frac{\frac{p(1+i_t)}{1+\pi_t^e} - p}{p} \quad (1)$$

Simplify the above equation, and then we have:

$$i_t = r_t + \pi_t^e + r_t \pi_t^e \quad (2)$$

Because r_t and π_t^e are both decimals less than 1, the numerical value of $r_t \pi_t^e$ can be approximately regarded as zero; then the quantitative relationship between the nominal interest rate and the real interest rate can be expressed as:

$$i_t = r_t + \pi_t^e \quad (3)$$

If there is no money illusion, when the prospective inflation rate changes, the nominal interest rate will go up to offset the influence of the prospective inflation rate, and since the real interest rate depends on people's time preference between immediate consumption and future consumption, as well as capital output efficiency, in the long run the real interest rate can be approximately deemed as unchanged.

Thus, Fisher Effect can be verified by the following equation:

$$i_t = a + b\pi_t^e \quad (4)$$

There into, the constant term *a* indicates ex ante real interest rate; if the null hypothesis *b*=1 can't be denied, Fisher Effect absolutely exists.

Under the hypothesis of rational expectations (Fama, 1975), the real inflation rate and the prospective inflation rate:

$$\pi_t = \pi_t^e + \varepsilon_t \quad (5)$$

The error term ε_t is the random process subject to white noise, ε_t and π_t^e are quadrature, and then we can verify Fisher Effect by establishing the following regression equation based on equations (4)and (5):

$$i_t = \alpha + \beta\pi_t + \eta_t \quad (6)$$

When i_t and π_t comply with first order stable process, that is I (1), if there exists co-integration relationship between i_t and π_t, it's proved that there is long-term equilibrium relationship between the nominal interest rate and the inflation rate. The value of β can be estimated based on this. If H_0 : $\beta = 1$ is accepted, Fisher Effect absolutely exists between the nominal interest rate and the inflation rate; if 0< β <1, weak or partial Fisher Effect exists.

RESULT AND DISSCUSS

Variable definition and data sources

In the interest rate system in China, the one-year deposit interest rate is the standard to determine the interest rate in other phases and also a tool to regulate the monetary policy of the Central Bank. Therefore, this Paper uses i_t to indicate the one-year deposit base rate, which can be regarded as the nominal interest rate; the inflation rate π_t is indicated by the retail price index in the society; the monthly data of the deposit interest rate and the inflation rate from 1990 to 2012 are used as samples, and the data come from the initial data released by People's Bank of China and National Statistics Bureau over the years.

Estimation and inspection of the model

According to cointegration definitions, only when the sequences of the two variables are both integrated series of the same order, can it be considered whether there exists the cointegration relationship. Thus, we first try to have a cointegration and regression test on the equation (6), and determine i_t and π_t are integrated series of the same order, that is unit root test. We use Eviews5 to have an ADF test on i_t and π_t . The test result can be seen in TABLE 1.

TABLE 1 : The original sequence of unit root test results

	Data Name	Type (C,T,p)	ADF Value	ADF critical value 1%	5%	10%	conclusion
π_t	original value	(C,T,15)	-2.108540	-3.993335	-3.427004	-3.136780	No Stationary
	first difference	(C,T,15)	-5.366074	-3.993335	-3.427004	-3.136780	Stationary
i_t	original value	(C,-,15)	-1.209223	-3.991780	-3.426251	-3.136336	No Stationary
	first difference	(C,T,15)	-16.40154	-3.991904	-3.426311	-3.136371	Stationary

The results show that the nominal interest rate i_t and the inflation rate π_t are not stable in themselves, so the fact that the null hypothesis of the unit root exists can't be denied at the level of above 10% according to PP standard. Since the above results show both the two variables contain unit root, we use one difference score to test whether the sequences of various variables are integrated series of the same order, i.e. I (1). It turns out that after one difference score, variables become notable above the 1% level, which indicates the one difference score of the nominal interest rate and the inflation rate is stable. So i_t and π_t are first order stationary series, meeting the conditions for cointegration analysis.

Have a cointegration test on the estimation equation (6) by using OLS, and get the following regression equation:

$$i_t = -34.87729 + 0.380605\,\pi_t + \eta_t$$
$$(-15.65175)\quad(17.91181) \tag{7}$$
$$R^2 = 0.54 \qquad DW = 0.036446 \qquad F = 320.8328$$

Then have a unit root test on the regression residual η_t. If η_t is I (0), there is cointegration relationship between i_t and π_t. Have an ADF unit root test on η_t, the result can be seen in TABLE 2.

TABLE 2 : The regression residual sequence of unit root test results

Data Name	Type	ADF	ADF critical value		
			1%	5%	10%
η_t	(-,-,0)	-2.948555	-2.573398	-1.941982	-1.615929

Seen from the above, η_t is notable at the 1% level, and zero hypothesis is denied. Thus it van be inferred that the regression residual sequence η_t is stationary time series I (0), indicating the variable sequences i_t and π_t have cointegration relationship, that is, there exists a long-term stable relationship between the interest rate i_t and the inflation rate π_t.

Given that the choice of the estimation method has a significant influence on the generation of Fisher Paradox, especially on the single equation regression model of small samples, this paper uses Bewley's (1975)[21] dynamic model to estimate the long-term Fisher Effect, and Inder (1993) demonstrates that in this dynamic model, the complete revision program of parameter correction can be applied to estimate the regression equation that has first order cointegration series, and helps to eliminate deviation in the regression process[22]. this model can be expressed as:

$$i_t = \sum_{s=0}^{p-1} \rho_s \Delta i_{t-s} + \beta\pi_t + \sum_{j=0}^{q-1} \delta_j \Delta\pi_{t-j} + \nu_t \tag{8}$$

Get the estimator of the long-term Fisher Effect via the following two steps:

Firsrly, Regress Bewley's dynamic model, and get β as well as the estimated value $\hat{\beta}$、$\hat{\rho}_s$和$\hat{\delta}_l$. After the test, when p is 61, q is 65, the model is optimal; the value of AIS is the smallest, that's 0.002012, and the R-squared value reaches 0.996913.

Secondly, Define $i_t^* = i_t - \sum_{s=0}^{p-1} \hat{\rho}_s \Delta i_{t-s} - \sum_{j=0}^{q-1} \hat{\delta}_j \Delta\pi_{t-j}$, and then we can eliminate the short-term effect; via the least square regression of π_t by i_t^*, we can get the estimator of the instrumental variable which is completely corrected. The regression result can be seen in TABLE 3.

TABLE 3 : Correction of instrumental variable estimation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-60.34468	0.266836	-226.1488	0.0000
π_t	0.615056	0.002597	236.7982	0.0000
R-squared	0.996287	Mean dependent var		2.804628
Adjusted R-squared	0.996269	S.D. dependent var		2.172132
S.E. of regression	0.132681	Akaike info criterion		-1.192300
Sum squared resid	3.679303	Schwarz criterion		-1.160529
Log likelihood	127.7877	Hannan-Quinn criter.		-1.179458
F-statistic	56073.40	Durbin-Watson stat		0.266969
Prob(F-statistic)	0.000000			

Thus, the estimated model of long-term Fisher Effect is:

$$\begin{aligned} i_t &= -60.34468 + 0.615056\ \pi_t \\ &\quad (-226.1488) \quad (236.7982) \\ R^2 &= 0.996287 \quad D.W = 0.266969 \quad F = 56073.40 \end{aligned} \tag{9}$$

Long-term Fisher Effect is the result of adjusting the inflation rate in the long run, while short-term Fisher Effect exists to show the instant adjustment of the nominal interest rate accompanied by the change of the prospective inflation rate. That's to say, in testing regression equation, if the regression parameter is conspicuously positive, in the following equation β>0 is also markedly established:

$$i_t - i_{t-1} = \alpha + \beta(\pi_t^e - \pi_{t-1}^e) + \mu_t \tag{10}$$

In the hypothesis of rational expectations (Fama, 1975), substitute the relation (5) of the inflation rate and the prospective inflation rate into the above equation, and we can get the test model of short-term Fisher Effect:

$$\Delta i_t = \alpha + \beta \Delta \pi_t + \eta_t \tag{11}$$

There into, $\eta_t = \mu_t - \beta(\varepsilon_t - \varepsilon_{t-1})$, the hypothesis of rational expectations does not exclude the correlation between ε_{t-1} and the variable in Period *t* (such as $\Delta\pi_t$). In the formation of the error term η_t, the appearance of ε_{t-1} signifies it is related to the explanatory variable Δi_t, so the above regression equation can not be estimated by using OLS. In order to get the estimator of the regression equation, we, resting on Mishkin's research, uses Generalized Methods of Moments (GMM) to estimate equation (11). The instrumental variable set includes difference variables in t-1 period as well as before t-1 period ($\Delta\pi_{t-1}$、$\Delta\pi_{t-2}$、$\Delta\pi_{t-3}$、$\Delta\pi_{t-4}$、Δi_{t-1}、Δi_{t-2}、Δi_{t-3}、Δi_{t-4}). The estimated result can be seen in TABLE 4.

TABLE 4 : GMM estimation results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.001534	0.004589	-0.334277	0.7385
D(π)	0.619119	0.023263	26.61350	0.0000
ECM	0.016738	0.053687	0.311768	0.7555
R-squared	0.971600	Mean dependent var		-0.030610
Adjusted R-squared	0.971320	S.D. dependent var		0.403644
S.E. of regression	0.068357	Sum squared resid		0.948560
Durbin-Watson stat	1.918655	J-statistic		0.025043

So short-term Fisher Effect is：

$$\begin{aligned} \Delta i_t &= -0.001534 + 0.619119\ \Delta\pi_t + 0.016738\ ECM \\ &\quad (-0.334277)\ (26.61350) \quad (0.311768) \\ R^2 &= 0.9716 \quad D.W = 1.918655 \end{aligned} \tag{12}$$

CONCLUSIONS

There exists long-term stable equilibrium relationship between the interest rate i_t and the inflation rate π_t, though they are not stable respectively. Since the interest rate is influenced by the inflation rate, their correlation coefficient is 0.615056. Test shows there exists partial long-term Fisher Effect between 1990 and 2012 in China. The existence of partial long-term Fisher Effect signifies the level values of the nominal interest rate and the inflation rate show linear trend in the long run, but the two time variables do not adjust conspicuously according to the scale of one-to-one. If the inflation rate increases 1%, the nominal interest rate only increases 0.615%. This characteristic, in the implementation of policy, can be interpreted as this: that the government adjusts the interest rate is a regulation (not all) to control inflation.

In the short-term estimation model, β=0.619119>0, its statistics t is notable and the estimation of regression equation is notable, so the test fully proves there exists partial short-term Fisher Effect in China. We can say the short-term change of the inflation rate plays a conspicuous but partial influence on the nominal interest rate. Short-term Fisher Effect illustrates that the change of the nominal interest rate partly comes from the change of the prospective inflation rate in the short run.

As is known from the reverse correction mechanism that error correction coefficient ECM has in the model, the nominal interest rate is restricted by Fisher Effect and its deviation from the short-term equilibrium relationship can be corrected in the next series. The size of the ECM coefficient reflects the adjustment of deviation from equilibrium in the short run. From the estimated ECM coefficient, which is 0.016738, if the adjustment is small, the monetary authority's response to inflation is prudent.

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