Over Confidence and Economic Risk—Evidence from China

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ABSTRACT

We focus on the nonlinear effect of over confidence on the economic risk. The smooth transition regression model is modified with the stochastic volatility to test the nonlinear relationships, and then the survey data are collected through the People’s Bank of China from 2007 to 2016 quarterly. The results show, in the linear connection, entrepreneurs’ over confidence positively, whereas the Bankers’ over confidence negatively, affect the economic volatility. After the 2008 global financial crisis, when the entrepreneurs’ extreme confidence outstrips the threshold as the nonlinear transition variable, the over confidence from banker at the present and entrepreneurs in the past enhanced the economic risk. The entrepreneurs’ over confidence is more important than the bankers’ one in their effects on the economic risk behind the prosperity of business.

1. INTRODUCTION

Does the managers’ over confidence correlated with the economic risk? The developed country[1] and developing country[2] give some relevant evidence for the linkage between the managers’ confidence and the economic behavior or the prosperity or the policy. On the contrary, as the entrepreneur are overconfidence[3], What about the over confidence instead of the confidence? Or the economic risk instead of the prosperity? This kind of linkage is not yet tested in the published papers as we know. Especially over the 2008 global financial crisis, it seems too complicate to explain the relationship between the over confidence and the risk from the economic prosperity[4]. The most related researches are focus on the linear relationship[3], seldom paper pay attention to the nonlinear connection.

There are some classical models used to grasp the nonlinear connections. Such as, the Markov regime switching models are restricted to some sharp switch regimes, the threshold Autoregressive Models are assumed to known state variables, the Smooth Transition Regressive (STR) Model[5] is defined by thresholds through smooth transition between regimes. In addition, the STR model show some advantages compared to Markov-switching models and threshold model, it avoids the sharp transition and inflexibility problems from prior presumptions. The STR model reflects economic aggregates changes by many different agent behaviors instead of the simultaneous actions. The STR with stochastic volatility (STR-SV) has the advantage of releasing the non-normal district phenomenon in the STR residential[5]. So, we use the STR-SV model to test the nonlinear relationship about the over confidence and the economic risk.

The paper is organized as follows. With the introduction in section 1 and methodology in section 2, 3 describe the survey data, 4 discuss the empirical output, while Section 5 concludes.

2. MODELING THE NONLINEARITY

The formation of STR-SV model[6] list as (1).

\[ y_t = \alpha z_t + \beta G(x_t) z_t + u_t, \quad u_t = \sigma \epsilon_{t-1}, \quad h_t = \phi h_{t-1} + \sigma^2 \eta_t \]  

(1)

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The dependent variable \( y_t \) is the \( p \) lagged elements may be include in \( z_t \). Weak stationary of \( y_t \) and \( z_t \) processes is priori assumed.

The parameters \( \alpha \) and \( \beta \) are the vectors of the linear and the nonlinear part respectively in the STR-SV model. The variable \( u_t \) is described by a scaling factor and the exponential of the stochastic process \( h_t \). The persistence parameter \( \phi \) of the autoregressive process is restricted to be positive and smaller than one to ensure stationary. Further assume \( \varepsilon_t, \eta_t \sim N(0,1) \), where \( \varepsilon_t \) and \( \eta_t \) are mutually uncorrelated variables, contemporaneously and at all lags with \( h_t \).

The independent or explanatory variables \( z_t = ((1, y_{t-1}, \ldots, y_{t-p}), (x_{t-1}, \ldots, x_{m}))' \) is an \((m+1)\times1\) vector with \( m=p+q \).

The transition function \( G(s_t) \in [0,1] \) is the regime switching function with the meaning as following:

If \( G=0 \), the baseline model (1) is shorten to a linear Vector Autoregressive Regression (VAR) only with parameter \( \alpha \), it interpreted the economy in an extreme recessionary periods

If \( G=1 \), can be seen as the linear model associated with great expansions.

The time variation captured through the logistic specification in STR model as formula (2).

\[
G(s_t) = (1 + \exp(-\gamma \sum_{k=1}^{K} (s_t - c_k)))^{-1}, \gamma > 0
\]  

(2)

The most common choice for \( K \) is \( K=1 \) (LSTR1) and \( K=2 \) (LSTR2), where \( (s_t - c) \) is the switching expression. The model smoothly approximates from the middle ground to any of the extreme situations represented by equaling \( G(s_t) \) to one.

The transition variable \( s_t \) can be part of \( z_t \) or the trend or constant. The slope parameter \( \gamma \) stands for the speed of the transition. The vector \( c \) is the location parameters where the transition occurs.

In extreme expansions(contractions) the transition variable \( s_t \) is higher(lower ) enough than the threshold \( c \) in LSTR models, and the actual data corresponding to the dependent variables \( y_t \) is less(greater) enough than a linear path in logistic smooth transition regressive(LSTR) model for keeping the transition function close to one(zero). Thus, the transition function locates the model either near to or far from recessions, depending on the switching expression’s value \( s_t \), for the more threshold parameter \( c \).

The STR-SV model is test based on the following data and representative variables.

3. DATA AND VARIABLES

The survey data which we used in the STR-SV model to test the nonlinear connections are named entrepreneurs’ over confidence (EC) and bankers’ over confidence (BC) about the future economy, and the risk of economic prosperity (EP). The index is calculated by the method of the Diffusion index as follows.

The related confidence survey data (EC and BC) are obtained based on the questions from the People’s Bank of China. The managers in the bankers and entrepreneur are asked two questions: (1) What about the economy this quarter, is it overheated, normal or depressed? (2) What about the economy in the next quarter, will it be overheated, normal or depressed? The score for each question is calculated as the percentage of “normal” answers divided by the sum of all the responses. The score are calculated based on this quarter and next quarter separately. Then the two data are sum up and divided by 2, we get the index of the related confidence from the managers.

The survey of entrepreneurs’ confidence (EC) started from 1992 quarterly, questionnaires are sent to more than 5,000 large and medium-size enterprises in almost all provinces of mainland in China(except for Tibet). The managers are asked about their insights on the overall production, productive factors, market demand, capital statement, cost and profit, investment decision, expectations about future macroeconomic conditions and so on. More detail information about the methods and survey may be get from the website of the People’s Bank of China.

The survey of bankers’ confidence (BC) started in 2004 and covered approximately 3,100 financial institutions in China. The institutions sample included large-size commercial banks, joint-stock commercial banks, city commercial banks and rural financial institutions. The survey data are collected from the executive officers at the head offices and branches of the underlying banks about their options and insights on the conditions of operation and competition of China’s banking industry.
Then the average of the scores for the two questions composes the index of entrepreneurs’ and bankers’ confidence, named here EC and BC. The confidence index ranges from 0 to 100, and a larger number represents higher confidence in the economy among entrepreneurs and bankers.

The survey of EP is the managers’ judgment about the economic prosperity in economy this quarterly. The calculation is made from the percent of “overheat” and “normal” in the all survey samples, after weight 1 and 0.5 respectively, then sum up to get the EP index.

Here we provide the original series of EC and BC and EP in Figure 1.

![Figure 1](image.png)

Figure 1  Confidence and Economic prosperity

The fact shows in Fig. 1 indicates the confidence maybe connected with the economic property. Over 2008 financial crisis, the bankers’ and entrepreneurs’ confidence are all going down, and recover up to the top level from 2009 to 2010. The economic prosperity also goes up in 2011. Sometime around 2013, the bankers’ confidence surpass the business managers one. The trends of the three series become slowing down by the end of 2015, they all recover recently from 2016. We will test this kind of context based on the related variables.

The original data of BC, EC, EP are all first difference and logarithmic. After we reform the original data, the economic meaning is also changed. BC and EC mean the change of confidence, it describes difference between the present confidence and the previous confidence. Briefly, it reflects the over confidence, and the EP is the economic volatility or risk behind the economic prosperity.

The dependent variable \( y_t \) in model (1) is used as the EP to test the economic risk. Explanatory variable \( z_t \) is the over confidence from the managers in banking and industry like BC and EC respectively.

4. **Empirical output**

After the explanatory and dependent variables are defined and pre reformed, the STR-SV model implement through three steps. It includes: specification, estimation and evaluation.

4.1 **Specification**

The model starts specification with VAR framework as a linear model. After testing for nonlinearity and choosing transition variable \( s_t \), we decide whether LSTR1 or LSTR2 should be used.

Firstly, The VAR model is used to test the stationary and suitable lags. After the first difference and logarithmic of EC, BC, EP, the three series are stationary, the trend parameter is not included in linear or nonlinear part. As stationary test is mostly common in econometric study, the result from the unit root test is omitted in this paper.

Secondly, after searched up to 4 lags of levels in VAR model, the optimal number of lags through Akaike Info Criterion and Final Prediction Error is 1 for the independent variable, so we choose one quarterly lags for the examination procedure. The constant variable is always included.
Thirdly, we test linearity and determine the transition variable for the STR-SV model. The transition variable must be part of the selected or lags of these variables. The following auxiliary regression (3) is applied if \( s_t \) is an element of \( z_t \), with \( z_t = (1 + z_t^1)^t \):

\[
y_t = \beta_0 z_t + \sum_{j=1}^{3} \beta_j s_j^t + u_t^*
\]

(3)

The null hypothesis of linearity is \( H_0: \beta_1 = \beta_2 = \beta_3 = 0 \), and the linear restriction is checked by applying an \( F \) test. The test is executed for each of the potential transition variables among dependent or independent variables' lags.

Once linearity has been rejected, one has to specify LSTR1 or LSTR2 model. The choice can be based on the same auxiliary regression as the linearity test. The test sequence test \( F_4: \beta_3 = 0 \); test \( F_3: \beta_2 = \beta_3 = 0 \); test \( F_2: \beta_1 = 0 | \beta_2 = \beta_3 = 0 \).

The corresponding \( F \)-statistics of the null hypothesis is stated in Table 1.

<table>
<thead>
<tr>
<th>Transition</th>
<th>F</th>
<th>F4</th>
<th>F3</th>
<th>F2</th>
<th>type</th>
</tr>
</thead>
<tbody>
<tr>
<td>BC(t)</td>
<td>0.500</td>
<td>0.853</td>
<td>0.250</td>
<td>0.265</td>
<td>Linear</td>
</tr>
<tr>
<td>EC(t)*</td>
<td>0.047</td>
<td>0.035</td>
<td>0.265</td>
<td>0.301</td>
<td>LSTR1</td>
</tr>
<tr>
<td>BC(t-1)</td>
<td>0.666</td>
<td>0.282</td>
<td>0.949</td>
<td>0.509</td>
<td>Linear</td>
</tr>
<tr>
<td>EC(t-1)</td>
<td>0.174</td>
<td>0.492</td>
<td>0.353</td>
<td>0.050</td>
<td>Linear</td>
</tr>
<tr>
<td>TREND</td>
<td>0.223</td>
<td>0.373</td>
<td>0.130</td>
<td>0.417</td>
<td>Linear</td>
</tr>
</tbody>
</table>

In our research in Table 1, the variable with the smallest \( P \)-value is the strongest test rejection, it is tagged *. The smooth transition variable \( s_t \) can thus be determined as \( EC(t)^* \). That is mean the entrepreneurs’ over confidence is a crucial transition variable for the relationship between the over confidence and the economic risk of prosperity. Then, the LSTR1 type of model with one threshold \( c \) is suggested in this paper.

Finally, the cross plot of the transition variable EC and the \( G(EC) \) function is plotted in Fig. 2. The EC is the nonlinear relation with the \( G \) function. After the threshold of EC, the transition function came up to one from zero.

Except for the dependent variables EP, that is the economic risk. The independent variables include in AR part: Constant, BC(t), EC(t), BC(t-1), EC(t-1) and the trend variables. The sample range is from 2007 Q3 to 2016 Q4.

![Fig.2 Cross plot of EC and G(EC)](image)

### 4.2 Estimation

The estimation of starting values for the algorithm to work is crucial. The grid search was used to search the start values before estimate the STR-SV model. Grid search method calculate the likelihood for a range of possible parameter values. In order to find appropriate starting values for \( \gamma \) and \( c \). Provided a known \( s_t \) based on the linearity test, the parameters of the STR-SV model are estimated by a nonlinear optimization routine.

Based on the Terasvirta’s suggestion[5] the grid value ranges are searched based on the statistical methods. It creates a linear grid in \( c \in [-0.3,0.2] \) and a log-linear grid in \( \gamma \in [0.5,150] \). The STR-SV grid search result from 2007 Q3
to 2016 Q4. For each value of $\gamma$ and $c$ the residual sum of squares (SSR) is computed. Here the grid search results with transition variable EC(t) and transition function LSTR1 the SSR is 0.0124.

The values that correspond to the minimum of that sum are taken as starting values. In order to make $\gamma$ scale-free, it is divided by $\sigma_s^K$ the K th power of the sample standard deviation of the transition variable.

The starting values through grid search are calculate and suggested as $\gamma=13.34$ and $c = -0.033$

The data of the explanatory variable and dependent variables are input for the estimation of the STR-SV model. By using starting values ($\gamma=13.34$, $c = -0.033$) found in grid search, the unknown parameters $c, \gamma, \alpha, \beta$ can be estimated through the Newton-Raphson algorithm to maximize the conditional maximum likelihood function.

The estimated STR-SV model is separated for the linear and the nonlinear part as Tab.2 after the comprehensive tests.

Tab.2 STR-SV estimation

<table>
<thead>
<tr>
<th>variable</th>
<th>linear part</th>
<th>nonlinear part</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>estimate</td>
<td>t-stat</td>
</tr>
<tr>
<td>CONST</td>
<td>-0.005</td>
<td>-0.385</td>
</tr>
<tr>
<td>BC(t)</td>
<td>-0.105*</td>
<td>-1.869</td>
</tr>
<tr>
<td>EC(t)</td>
<td>0.533***</td>
<td>4.497</td>
</tr>
<tr>
<td>BC(t-1)</td>
<td>-0.009</td>
<td>-0.158</td>
</tr>
<tr>
<td>EC(t-1)</td>
<td>-0.236</td>
<td>-1.468</td>
</tr>
<tr>
<td>Gamma</td>
<td>13.727</td>
<td></td>
</tr>
<tr>
<td>C1</td>
<td>-0.033*</td>
<td>-1.869</td>
</tr>
</tbody>
</table>

Note: * or *** represent the 90% or 99% confidential. AIC=-7.399,SC=-6.883,HQ=-7.215,$R^2=0.814$. transition variable: Variance=0.009,SD=0.093. residuals: Variance=0.001,SD=0.022

Through the linear part in the left of table 2, we get that, the bankers’ over confidence release the economic risk with 90% confidential level. Bankers’ over confidence deduce to the banking system risk over 2008, then the economic risk will be lighten based on the financial risk occurred. The entrepreneurs’ over confidence linked with the economic risk with 99% confidential level, the entrepreneurs’ over confidence is more important than the bankers’ over confidence in the effects on the economic risk. It is the direct crucial affect factors for the economy, whereas the bankers’ over confidence is the indirect factor through the entrepreneurs’ effect.

The nonlinear part in table 2 show after the EC surpass the threshold as -0.033 with the 90% confidential level. The entrepreneurs’ over confidence in last quarter improve the economic risk. The bankers’ over confidence in present enhance the economic risk. It is also clear that entrepreneurs’ over confidence is more important than the bankers’ one.

From the fig. 3 we may find the linear and nonlinear part of variable EP.
Both the linear and nonlinear part indicates relationship between the explanatory variable \( z_t \) and explained variable \( y_t \). Nonlinear evidence is obvious.

We found the volatility is much larger over 2008 and 2009, after that, the linear and nonlinear part are represent the change of the economic prosperity. They are mostly compensative related each other.

4.3 EVALUATION

We use various tests for evaluation of the misspecification in the STR-SV results. The quality of the estimated nonlinear model should be checked against misspecification like in the linear case. Tests of STR-SV models are conducted at the last stage. There are three kinds of tests for evaluating the adequacy of the estimated STR-SV model. Specifically, a model with Serially Independent errors, with No Remaining Nonlinearity, with Parameter Constancy, may be considered as adequate for fitting the data. The test of no error autocorrelation, test of no additive nonlinearity and test of parameter constancy are briefly introduced as follows.

4.3.1 TEST OF NO ERROR AUTOCORRELATION

The procedure is to regress the estimated residuals on their lagged residuals and the partial derivatives of the log-likelihood function. The test statistic is

\[
F_{LM} = \left( \frac{SSR_0 - SSR_1}{q} \right) \left( \frac{SSR_1/k(T-n-q)}{SSR_0/qn} \right)
\]

Where \( n \) is the number of parameters in the model, \( SSR_0 \) the sum of squared residuals of the STR model and \( SSR_1 \) the sum of squared residuals from the auxiliary regression. The test results no error autocorrelation evidence can be seen in the first, second and third lags. The test result as Tab.3

<table>
<thead>
<tr>
<th>lag</th>
<th>F-value</th>
<th>df1</th>
<th>df2</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.6656</td>
<td>1</td>
<td>24</td>
<td>0.4226</td>
</tr>
<tr>
<td>2</td>
<td>1.1243</td>
<td>2</td>
<td>22</td>
<td>0.3428</td>
</tr>
<tr>
<td>3</td>
<td>1.0063</td>
<td>3</td>
<td>20</td>
<td>0.4105</td>
</tr>
</tbody>
</table>

4.3.2 TEST OF NO ADDITIVE NONLINEARITY

After the STR-SV model has been fitted, it should be checked whether there is remaining nonlinearity in the model. The test assumes that the type of the remaining nonlinearity is again of the model type. The alternative can be defined as formula (4)

\[
y_t = \alpha' z_t + \beta' z_t G(s_{1t}) + \psi z_t H(s_{2t}) + u_t
\]

Where \( H \) is another transition function. To test this alternative the auxiliary model is defined as formula (5)

\[
y_t = \alpha_0 z_t + \beta_2 z_t G(s_{1t}) + \sum_{j=1}^3 \beta_j' \tilde{z}_t H(s_{2j}) + u_t
\]

The test is done by regressing \( \tilde{u}_t \) on \( (\tilde{z}_t, s_{1t}^1, \tilde{z}_t, s_{1t}^2, \tilde{z}_t, s_{1t}^3, \tilde{z}_t, s_{2t}^1) \) and the partial derivatives of the log-likelihood function with respect to the parameters of the model. The null hypothesis of no remaining nonlinearity is that \( \beta_2=\beta_3=\beta_4=0 \). The choice of \( s_{2t} \) can be a subset of variables in \( z_t \) or it can be \( s_{1t} \). Here we get the test as table 4. It shows no more nonlinearity in the model after estimated.

<table>
<thead>
<tr>
<th>transition variable</th>
<th>F</th>
<th>F4</th>
<th>F3</th>
<th>F2</th>
</tr>
</thead>
<tbody>
<tr>
<td>EC_log_d1(t)</td>
<td>0.766</td>
<td>0.581</td>
<td>0.940</td>
<td>0.301</td>
</tr>
</tbody>
</table>
4.3.3 Test of Parameter Constancy

The test is null hypothesis of constant parameters. Alternative is \( y_t = \alpha(t)'z_t + \beta(t)'z_t G(s_t) + u_t \), where \( \alpha(t) = \alpha + \lambda_\alpha(t)^*H_\alpha(t)^* \) and \( \beta(t) = \beta + \lambda_\beta(t)^*H_\beta(t)^* \) with \( t^* = t/T \). The null hypothesis of no change in parameters is \( \gamma = \gamma_0 = 0 \). The parameters \( \gamma \) and \( c \) are assumed to be constant. The nonlinear auxiliary regression is used:

\[
\gamma_t = \beta'_0 z_t + \sum_{j=3}^3 \beta'_j G(s_j)^*G(s_j)^* + u_t
\]

The F-test results are given as Tab.5

### Tab.5 Parameter constancy test

<table>
<thead>
<tr>
<th>Transition function</th>
<th>F-value</th>
<th>df1</th>
<th>df2</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1</td>
<td>1.024</td>
<td>8.000</td>
<td>16.000</td>
<td>0.457</td>
</tr>
<tr>
<td>H2</td>
<td>1.062</td>
<td>16.000</td>
<td>8.000</td>
<td>0.489</td>
</tr>
<tr>
<td>H3</td>
<td>0.000</td>
<td>24.000</td>
<td>0.000</td>
<td>NaN</td>
</tr>
</tbody>
</table>

Evidence of non-rejection of the assumptions of the three tests attests the propriety of the STR process.

4.3.4 Test of Remain Residuals

The violations of null hypotheses in the ARCH-LM Test and Jarque-Bera Test is 3.222 on the estimated residuals (skewness=-0.1,kurtosis=6.02). The ARCH-LM test and J-B test in Tab.6 suggested there are no more ARCH effect and nonlinearity exit in the STR residual.

### Tab.6 ARCH-LM and J-B test

<table>
<thead>
<tr>
<th>ARCH-LM TEST 3 lags</th>
<th>J-B test</th>
</tr>
</thead>
<tbody>
<tr>
<td>test statistic:</td>
<td>test statistic:</td>
</tr>
<tr>
<td>p-Value(( \chi^2 )):</td>
<td>3.222</td>
</tr>
<tr>
<td>F statistic:</td>
<td>0.358</td>
</tr>
<tr>
<td>p-Value(F):</td>
<td>1.84</td>
</tr>
<tr>
<td>skewness:</td>
<td>0.332</td>
</tr>
<tr>
<td>kurtosis:</td>
<td>2.445</td>
</tr>
</tbody>
</table>

The result of STR-SV model in Tab.6 show the ARCH effect and nonnormality are improved with STR-SV model. We don’t find any evidence of remaining nonlinearity, autocorrelation, instability of parameters, after SV process, the ARCH and nonnormality is rejected. In table 6, According to the Jarque-Bera static (2.087) and the skewness (-0.503) and kurtosis (2.455), the STR-SV residual almost belong to normality distribution which skewness is zero and kurtosis is three. Even under the BDS test, we do not reject the null hypothesis of having I.I.D. process in residuals of STR-SV model.

Finally, our model thus evolves into a STR-SV process which is valid for all diagnosis tests. The final estimating results and the tests of STR-SV model is presented in the above empirical output section. From fig 4, we see the fitted line with the original series, the estimation is well fit the original data through the STR-SV model.

![Fig 4 fitted and original outputs](image-url)
5. SUMMARY

The over confidence is related to the economic risk from business prosperity in China. In addition, when the entrepreneurs’ confidence surpassed to the threshold, the over confidence positively enhance the economic risk. So, the government need to pay attention to the bankers’ and entrepreneurs’ confidence, especially the over confidence. The governor may also set the estimated threshold level for the confidence index. Through the monetary and treasury policies, the moderated confidence level from the manager should be encouraged to lighten the risk and enhance the economic prosperity.

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