Economic Effect of Ecological Reconstruction in Poyang Lake

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Abstract: It is difficult to show the economic value of environment improvement. By using the counter factual policy evaluation method, we evaluated the economic value of the ecological reconstruction project in Poyang Lake. Our results show that the economic effect of the implementation of environmental projects is significant. After the implementation of the project, Jiangxi Province economic growth rate increased by 3 percentage points from the 1 quarter of 2014 to the 4 quarter of 2013.

1 INTRODUCTION

With the improvement of people's living standard and the enhancement of environmental protection consciousness, people put forward higher and higher request to the environment quality. Scientific evaluation of the economic benefits of improving environmental quality has attracted wide attention of policy makers and researchers. As early as in 2002, China has promulgated the "People's Republic of China Environmental Impact Assessment Law", which requires strict assessment of the economic value of environmental changes.

Although the improvement of the ecological quality is very important for improving the welfare of the residents, but it is difficult to show the economic value. Therefore, in order to help policy makers to better formulate the environmental policy, it is necessary to actively explore a reasonable environmental assessment methods, and construct the system of cost - income evaluation.

By using "hedonic price method", researchers have studied the influence of air quality improvement on the housing price in Qingdao (Yongwei Chen and Lizhong Chen, 2012). They found that air pollution 1 indices decrease, consumers are willing to pay 99.785 yuan more per square meter. There are others use the "hedonic price method" to study the impact of air quality on the real estate price (Bender et al., 1980; Brucato et al. 1990) by using the method of DID and transformation of distribution function, researchers have studied the influence of environmental improvement of power plant relocation on the housing market (Guoying Deng et al., 2013). They found that after the relocation of power plants, housing transaction volume in that district increased by 54.6% compared to other areas, the average transaction price significantly increased by 6.8%-10.3%. To study the economic effect of air pollution, some others used "natural experiment" method (Chay and Greenstone, 2005). The results show that during 1970-1980, the U.S. government's governance of air quality has brought about 45 billion dollars of housing asset premium. In addition, scholars have studied the coordination between carbon emission and GDP growth in the process of urbanization (Boqiang Lin and Xiying Liu, 2010). They examined the long-term equilibrium relationship between carbon dioxide emissions and the main economic variables by using cointegration method.

All of the above studies show that improving environmental quality is conducive to the improvement of economic efficiency, but the above research is not perfect, the main problem is: first of all, although "Hedonic price model" can measure the impact of various properties on housing prices, it is inevitable that there is endogeneity problem in the empirical analysis, and the "hedonic price model" tends to ignore the correlation of house price in space, which results in the error of the estimation. Second, the use of "natural experiments" requires detailed microscopic data, but the data are often not available. Last, the above research has not made an

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accurate assessment of the impact of environmental quality improvement on economic growth, but only in a certain part of the economic benefits, such as housing market.

In view of the above mentioned problems, this paper will introduce a new method of policy evaluation to make an accurate assessment of the economic effect of Poyang Lake ecological construction. Our method can well solve the above three problems mentioned.

2 MODEL SETTING

Based on the appraisal method for counterfactual policies (Cheng, H., Ching, H. S., and Shui, K. W., 2012), this paper will construct reasonable comparison targets of the experimental group, overcoming the difference problem between the experimental group and the control group. In this process, we need to seek a reasonable control group to appraise the counterfactual GDP growth rate of Jiangxi Province. The developments of different economy are mutually connected, and influenced by some common factors, such as economic cyclical changes and technological progress, etc. Thus, we can construct the counterfactual state of the economy of Jiangxi Province by using the linear combination of the growth rate of the economy that aren't influenced by the transformation of Poyang Lake. This counterfactual state can be regarded as the economy that Jiangxi Province hasn't carried out the transformation of Poyang Lake.

2.1 Model Settings

y_{it}^0 represent the GDP growth rate of region i at time t without Poyang Lake reconstruction, and y_{it}^1 represents the GDP growth rate while the reconstruction being not implemented by region i at time t. Since y_{it}^1 and y_{it}^0 cannot be observed and recorded simultaneously, the actual-observed data y_{it} can be recorded as:

$$y_{it} = d_{it}y_{it}^1 + (1 - d_{it})\ y_{it}^0 \qquad (1)$$

$d_{it} = 1$ represents the GDP growth rate of the Poyang Lake reconstruction being implemented by area i at time t, and $d_{it} = 0$ represents the GDP growth rate of the Poyang Lake reconstruction not being implemented by area i at time t.

Generally, i=1 represents Jiangxi Province. From the first quarter of 2013, Poyang Lake reconstruction began in Jiangxi Province, labeled as $T_1 + 1$. Therefore,

$$y_{1t}=y_{1t}^0,\ t = 1,\ldots,\ T_1 \qquad (2)$$

$$y_{1t}=y_{1t}^1,\ t = T_1+1,\ \ldots,T \qquad (3)$$

Since other provinces (or cities) have not implement the Poyang Lake reconstruction, thus,

$$y_{it}=y_{it}^0,\ i =2,\ldots,N,\ t = 1,\ldots,T \qquad (4)$$

If y_{1t}^1 and y_{1t}^0 can be observed simultaneously, then, at time t, the effect of the Poyang Lake reconstruction on the economic growth in Jiangxi Province can be recorded as:

$$\Delta_{1t}= y_{1t}^1 - y_{1t}^0,t = T_1+1,\ \ldots,T \qquad (5)$$

The question is how to estimate Δ_{1t}. Because y_{1t}^0 cannot be observed afterT1 +1 , we cannot calculate Δ_{1t} directly.

As discussed above, the economic growth of provinces (cities) are affected by common factors, such as the business cycle, technological progress, etc. Thus, according to Gregory and Head (1999) and Forni and Reichlin(1998), y_{it}^0 is determined by a factor model：

$$y_{it}^0 = b_i^{'}f_t + \alpha_i + \varepsilon_{it},i=1,\ldots,N,\ t=1,\ldots,T \qquad (6)$$

Here ,ft is the unobservable and observable common factor changing with time in the K×1 dimension; b'i is the coefficient of the 1×K dimension that varies with individuals; $b_i \neq b_j$, implies that the influence of common factors on each economy can be different; α_i is the heterogeneity of individual characteristics; ε_{it} is the random heterogeneous component of individual i, and $E(\varepsilon_{it}) = 0$。

We could rewrite (6) as a vector form:

$$y_t^0 = Bf_t + \alpha + \varepsilon_t, \qquad (7)$$

where $y_t^0 = (y_{1t}^0, \ldots, y_{Nt}^0)'$, $\alpha = (\alpha_1, \ldots, \alpha_N)'$, $\varepsilon_t = (\varepsilon_{1t}, \ldots, \varepsilon_{Nt})'$, and $\varepsilon_t \sim I(0)$, $E(\varepsilon_t) = 0$, $E(\varepsilon_t\varepsilon_t')=V$, $E(\varepsilon_t f_t') = 0$. $B=(b_1, \ldots, b_N)'$ is a N×K dimensional factor loading matrix, and $\|b_i\| = c < \infty$, Rank(B)= K, allowing the common factor dimension being less than the number of observed individuals. There is a very important hypothesis, $E(\varepsilon_{jt}|d_{it})= 0$, where $j \neq i$, implying that the heterogeneity of the individual j is independent of d_{it}. Economically, it ensures that other province economy will be independent of the economic changes after the implementation of the Poyang Lake reconstruction in Jiangxi Province.

Further, supposing vector $a' =(1, -\tilde{a}')$ is an element in the zero-dimensional space of matrix, namely , $a'B = 0$. Multiply a' for both sides of equation (7):

$$y_{1t}^0 = \bar{\alpha} + \tilde{a}'\tilde{y}_{-1t} + \varepsilon_{1t} - \tilde{a}'\tilde{\varepsilon}_t \qquad (8)$$

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Where $\bar{\alpha} = a'\alpha$, $\tilde{y}_{-1t} = (y_{2t}, \ldots, y_{Nt})'$, $\tilde{\varepsilon}_t = (\varepsilon_{2t}, \ldots, \varepsilon_{Nt})'$ .There is a clear linear correlation between $\tilde{\varepsilon}_t$ and $\tilde{y}_{-1t}$, so we rewrite (8) as:

$$y_{1t}^0 = \bar{\alpha} + \tilde{a}^{*\prime}\tilde{y}_{-1t} + \varepsilon_{1t}^* \quad (9)$$

Where $\tilde{a}^* = \tilde{a}'(IN\text{-}1 - cov(\tilde{\varepsilon}_t, \tilde{y}_{-1t})var(\tilde{y}_{-1t})\text{-}1)$, $\varepsilon_{1t}^* = a'\varepsilon_t + \tilde{a}'cov(\tilde{\varepsilon}_t, \tilde{y}_{-1t})var(\tilde{y}_{-1t})\text{-}1\,\tilde{y}_{-1t}$. Now, there is no longer linear correlation between ε_{1t}^* and $\tilde{y}_{-1t}$. According to Hsiao et al. (2012), it means $E(\varepsilon_{1t} - \tilde{a}'\tilde{\varepsilon}_t|\tilde{y}_{-1t})$ is a linear function of $\tilde{y}_{-1t}$, and $E(\varepsilon_{1t}^*|\tilde{y}_{-1t}) = 0$ can be guaranteed. The OLS estimation parameters of (9) keep consistent. The same discussion about this hypothesis can be found in Bai et al. (2014) and Ouyang and Peng (2015).

Because other provinces economy are not affected by the Poyang Lake reconstruction, we use the GDP growth rates $\tilde{y}_{-1t}$of other provinces to substitute the common factor ft ,throughout T period, in order to estimate the situation of Jiangxi Province without the implement Poyang Lake reconstruction during the time t.

According to (9), we estimate Δ_{1t} as the following steps: First, before time T_1, we conduct be the regression of y_{1t}^0 for $\tilde{y}_{-1t} = (y_{2t}, \ldots, y_{Nt})'$ following (9), to get parameter estimates$\hat{\bar{\alpha}}$ and $\hat{\tilde{a}}^{*\prime}$.Then, after the time$T_1 + 1$, we use these parameter estimates and $\tilde{y}_{-1t} = (y_{2t}, \ldots, y_{Nt})'$ following (9) to construct the GDP growth rate of Jiangxi Province $\hat{y}_{1t}^0 = \hat{\bar{\alpha}} + \hat{\tilde{a}}^{*\prime}\tilde{y}_{-1t}$（$t \geq T_1 + 1$）under the counterfactual situation, and finally we get $\hat{\Delta}_{1t} = y_{1t}^1 - \hat{y}_{1t}^0$（$t \geq T_1 + 1$）.Under normal conditions, $\hat{\Delta}_{1t}$ and Δ_{1t} keep consistent.

Since there may be serial correlation in $\hat{\Delta}_{1t}$. we can use Box-Jenkins method to create an ARMA model:

$$\tilde{\alpha}(L)\hat{\Delta}_{1t} = \tilde{\mu} + \tilde{\theta}(L)v_t, \quad (10)$$

Furthermore, we can use $\tilde{\alpha}(L)^{-1}\tilde{\mu}$ to express the long-run effect following Poyang Lake reconstruction, and use t-test to check whether the effect is significant.

2.2 Model Selection

Step1: Starting from j=1, select totally j components from N-1 provinces, C_{N-1}^j combinations can be obtained. Conducting the regression of y_{1t}^0（$t \leq T_1$）for each combination according to (9), so as to select the combination with the highest R2 and then label it $M(j)^*$.

Step2: Select a combination from $M(1)^*$, $M(2)^*$, …, $M(N-1)^*$ that minimizes the AIC or AICC information criterion1, and label it $M(m)^*$, where:

$$AIC(p) = T_1 \ln(\frac{e'e}{T_1}) + 2(m+2)$$

$$AICC(p) = T_1 \ln(\frac{e'e}{T_1}) + 2(m+2) + \frac{2(m+2)(m+3)}{T_1 - (m+1) - 2}$$

p is the number of provinces in the control group and e is the residual of the OLS regression.

Step3: Using the optimal $M(m)^*$ to construct $\hat{y}_{1t}^0$（$t \geq T_1 + 1$）, we get the GDP growth rate of Jiangxi province in the counterfactual situation.

Step4: According to $\hat{\Delta}_{1t} = y_{1t}^1 - \hat{y}_{1t}^0 (t \geq T_1 + 1)$, we can get result of the economic effect on Jiangxi Province following the Poyang Lake reconstruction.

3 EMPIRICAL RESULT

We use 25 other province economy to construct the counterfactual economic growth rate of Jiangsu province: Peking, Tientsin, Hebei, Shanxi, Liaoning, Jilin, Heilongjiang, Shanghai, Jiangsu, Zhejiang, Anhui, Fujian, Shangdong, Henan, Hubei, Hunan, Guangdong, Hainan, Chongqing, Sichuan, Guizhou, Yunnan, Shanxi, Gansu, Qinghai, which are not influences by the alteration of Poyang Lake. Those provinces and cities are inextricably linked with Jiangxi Provinces in the aspect of economy and geography. The data of quarter nominal GDP and the CPI is from Ner Statistics Bureau and the period is from the first quarter(January) in 2005 to the fourth quarter (December) in 2014.

There are tow ways to calculate the quarter growth rate of actual GDP, one is on year-on-year basis the other is on quarter-on-quarter. In this paper, we adopt the second one. One one hand, it can avoid the seasonal adjustment. On the other hand ,it is conducive for us to estimate the long-term effect of the transformation of Poyang Lake on economy of Jiangxi Province.

According to the modeling strategy and the AICC criteria, Shangxi, Hubei, Hunan, Guangdong, Shanxi, Qinghai, are selected. Then, we can use the GDP growth rate of these areas to construct the counterfactual growth rate of GDP in Jiangxi.

The T value in table 1 shows each coefficient is significant, R2 is 0.97. The coefficient only refers to the correlation of economic growth determined by common factors between different countries or regions, which has no cause and effect significance. In figure 2, solid line represents the GDP growth charts of Jiangxi Province from the first quarter in 2006 to the fourth quarter in 2012, the dotted line represents the GDP growth charts of Jiangxi Province predicted by regression equation. It can be seen directly from figure 2, the GDP growth rate data of selected province and region well fit the

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Jiangxi Province's GDP growth rate. Therefore, in the forecast period, the provinces' GDP growth rate can well help to construct counterfactual GDP growth rate in Jiangxi Province.

Table 1: AICC: Regression equation of optimal control group 2006:Q1-2012:Q4

Control group	Coefficient	SD	T-Value
Intercept	-0.0231	0.0244	-0.9471
Shanxi	0.5684	0.1080	5.2614
Jilin	-0.8576	0.1780	-4.8186
Jiangsu	1.1274	0.2514	4.4844
Shandong	-0.6234	0.1604	-3.8856
Hubei	0.2390	0.0879	2.7189
Hunan	0.4373	0.1179	3.7103
Guangdong	-0.2980	0.1310	-2.2742
Shanxi	0.8294	0.1588	5.2235
Qinhai	-0.4434	0.1599	-2.7735

R^2=0.9675

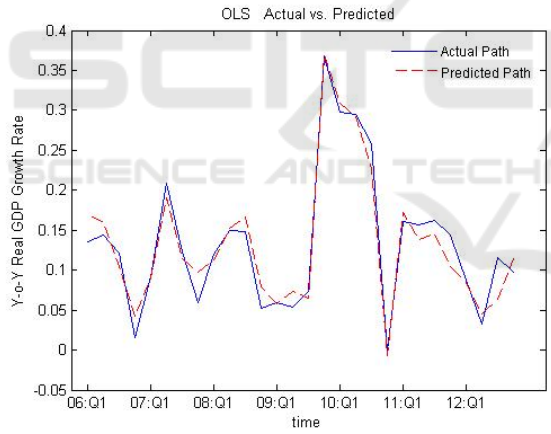

Figure 1 : Actual path vs predicted path of GDP growth rate in JiangXi 2006:Q1-2012:Q4

Table 2 compares the differences of real GDP growth rate and encounter-factual growth rate in condition of reconstruction of the Poyang lake in Jiangxi Province and no reconstruction of Poyang lake in Jiangxi Province. The second line in table is the real GDP growth rate in Jiangxi Province during the first quarter in 2006 and the fourth quarter in 2012. The third line in table is the real GDP growth rate in Jiangxi Province, namely the GDP growth rate when there is no transformation of Poyang lake in Jiangxi Province. The fourth line in table is the transformation effect of Poyang lake, namely the difference of actual value and the encounter-factual value.

From the chart 2 , it can be seen that if Jiangxi Province did not remould Poyang Lake ,its counterfactual grow rate of average GDP would be 4.10% ,which was lower than the growth rate of effective GDP,from first quarter in 2013 to fourth quarter in 2014.The reform of Poyang Lake has considerablely promoted the economic growth of Jiangxi ,increasing 3.04%averagely.Comparing with this situationg , the average rate of Poyang Lake transformation effet reached 3.04% , during the same period.

Table 2: AICC: Economic effect of ecological improvement in Poyang Lake 2013:Q1-2014:Q4

Time	Actual value	Anti-factual value	Economic effect
2013Q1	0.0776	0.0419	0.0357
2013Q2	0.0580	0.0479	0.0101
2013Q3	0.0722	-0.0277	0.0999
2013Q4	0.0927	0.0510	0.0417
2014Q1	0.0560	0.0061	0.0499
2014Q2	0.0704	0.0524	0.0180
2014Q3	0.0643	0.0697	-0.0054
2014Q4	0.0802	0.0871	-0.0069
Mean	0.0714	0.0410	0.0304

In the line chart 2,the solid line is the growth rate of actual GDP after alteration of Poyang Lake in Jiangxi while the dotted line indicates the trend of counterfactual growth rate of GDP.The point line representes the confidence intervals which the rate is at the siginifcance level of 95%.If the actual path is not in the confidence intervals ,it means that in the meaning of statistics,the transformation of Poyang Lake has notable effect on economy in Jiangxi.

4 CONCLUSION

The construction of the Poyang Lake eco-economic zone dose not solely focuses on the amelioration of the ecological environment; its economic effect can not be ignored, However, so far there are no closely related researches on it or only one aspect of economic effects is involved. In this paper, the economic effect of the ecological environment construction in Poyang Lake was evaluated

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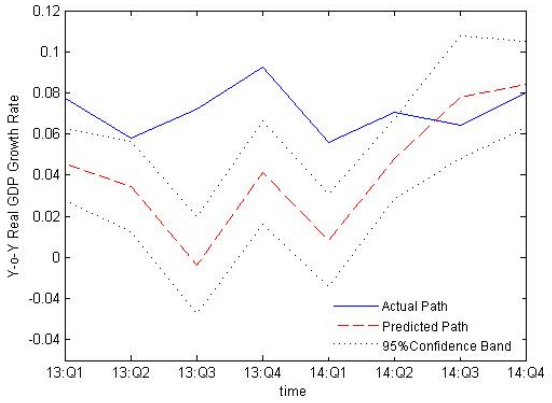

Figure 2 AICC: Actual path vs anti-factual path of GDP growth rate in JiangXi 2013:Q1-2014:Q4

comprehensively employing the counter-factual policy evaluation approach (Hsiao et al, 2012). With the study of the regional economic correlation, a control group was reasonably set, and the economic growth of Jiangxi Province was modeled under the condition of no Poyang Lake ecological construction project. The simulation results and the data of the actual economic growth in Jiangxi Province were compared so as to analyze the effect of the implementation of the ecological transformation project. Results reveal that the Poyang Lake eco-transformation Project exerts great influence on the economy of Jiangxi Province. From the first quarter of 2013 to the fourth quarter of 2014, the economic growth rate of Jiangxi Province increased by 3 percentage points on quarter-on-quarter basis, with the economic effect being remarkable. The analyses of our results show that the Poyang Lake ecological construction project not only improved the Jiangxi ecological environment, but also produced significant economic effects. On the one hand, the economic effect could be attributed to the increase of the government expenditure. On the other, the improvement of ecological environment will also enhance the utility of the consumers and the income of the producers, resulting in "indirect market value". Over the past few decades, China's economy has achieved great success, but in many other respects, challenges remain, in particular, environmental and ecological problems. On the way to further development, we must change the mode of economic development, and make efforts to realize the coordinated development of ecological environment and the sustainable economic growth.

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