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Inflation and Economic Growth in China: An Empirical Analysis

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Abstract

Using official provincial data for gross provincial product, consumer price index and other explanatory variables from 1986 to 2006, the present paper investigates the nonlinear effects of inflation on economic growth in China. The main finding of the study is that the inflation threshold effect is highly significant and robust in China. Above the 2.50 percent threshold, every 1-percentage point increase in the inflation rate impedes economic growth by 0.61 percent; below this threshold, every 1-percentage point increase in the inflation rate stimulates growth by 0.53 percent. This indicates that high inflation harms economic growth, whereas moderate inflation benefits growth. We suggest that China should maintain a moderate inflation rate for long-run growth.

Key words: China, growth, inflation, nonlinearity, threshold effect

JEL codes: C33, E31, O53

I. Introduction

Persistent growth with price stability is the primary purpose of macroeconomic policy. Economists broadly agree that low but positive inflation is helpful for economic development. Inflation may “grease the wheels” of the labor market, but it causes menu costs and price distortion. Therefore, the question arises of “How much inflation is good for economic growth?”

Since 1980, China has suffered four periods of major inflation, where the yearly inflation rate has been above 5 percent. Each of these episodes has significantly threatened economic growth. High inflation in 1980, 1985, 1988 and 1994 was followed by a slowdown of economic growth in the following year. The growth rates for these 4 years were 7.8, 13.5, 11.3 and

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12.6 percent, respectively, but growth slumped to 5.2, 8.8, 4.1 and 10.5 percent, respectively, in the years immediately following each of the four high inflation years (NBS, 1999).

Although these figures show that a negative relationship exists between inflation and economic growth in China, this issue is still debated in the literature related to China's economy. In the case of China, some evidence supports the notion that inflation has a negative impact on economic growth (e.g. Wang, 1996), but some does not (e.g. Liu and Zhang, 2004). With the exception of Kong (2007), it is rare to find empirical studies on China's economy concerning the nonlinear inflation–growth linkage. Therefore, the present study tests the existence of the nonlinear nexus between inflation and growth in China. Understanding this relationship in a large country like China might be helpful in verifying the growth theory and is also relevant for policy decisions.

The purpose of the present study is to examine the threshold effect of inflation on China's economic growth. We use a set of annual pooling data for provinces in China and the spline function method to estimate inflation turning points, a method suggested by Sarel (1996). The current paper re-examines the threshold effect of inflation on China's economic growth and finds contrary results to Kong (2007). It is the first empirical study to address whether high inflation harms China's economic growth and moderate inflation benefits growth.

The rest of this paper is organized as follows. Section II reviews the related published literature and Section III provides an overview of China's inflation and economic growth in the post-opening up era. Section IV presents the model used in the present paper and Section V analyzes results relating to the inflation threshold effect on China's economic growth. Finally, conclusions are provided and policy implications are discussed in Section VI.

II. Literature Review

Theoretical debate on the relationship between inflation and growth has been going on for several decades. Some theoretical studies find that inflation benefits long-run growth by raising capital accumulation (Mundell, 1963; Tobin, 1965). Some authors prove that money expansion pushes up inflation and impedes growth in the long run by lowering the marginal product of capital, tax credits or the saving rate (Stockman, 1981; Cooley and Hansen, 1989; Haslag, 1995; Jones and Manuelli, 1995). Other papers show that inflation has nonlinear effects on growth through the channels of different attitudes to risk (e.g. Espinosa-Vega and Yip, 1999) or information asymmetry of financial markets (Hung, 2001). Although the effect of inflation on output growth is a fundamental issue in macroeconomics, the associated debate has not generated consistent results.

In the empirical research, very different findings have been reached. Before the two oil shocks in 1973 and 1979, many researchers believed that the inflation–growth relationship was either positive or insignificant.[1] After the stagflation of the 1970s, this idea was challenged by new macroeconomic data. Economists have found that inflation retards growth (Barro, 1995; Kim and Willett, 2000; Apergis, 2005). Coinciding with theoretical development in the 1990s, some economists have found that low inflation might be helpful for employment and economic development. These economists strive to adopt various empirical methods to verify their hypotheses and establish a new approach to empirical work concerning the inflation–growth relationship (Fischer, 1993; Sarel, 1996; Khan and Senhadji, 2001; Pollin and Zhu, 2006).[2] Because the inflation–growth relationship is one of the most important concerns of central bank in every country, some economists have estimated the inflation turning points for single countries (Singh and Kalirajan, 2003; Sweidan, 2004; Mubarik, 2005).

Although some researchers have investigated similar issues with respect to China, disagreement still exists among them because of different data coverage and regression specifications. On the one hand, Wang (1996) adopts 1978–1993 annual data to examine the relation between inflation and economic growth in China and shows that inflation has an insignificant effect on economic growth in one year but has a negative impact on growth in the next year. Chen (2007) uses the generalized autoregressive conditional heteroskedasticity in mean model and confirms that inflation impedes economic growth during 1952–2004. Narayan *et al*. (2009), using the exponential general autoregressive conditional heteroskedastic model, find that increasing inflation uncertainty lowers average inflation and that inflation volatility reduces economic growth. On the other hand, some papers use monthly data to evaluate the short-run inflation–growth nexus and find that inflation promotes economic growth (Liu and Xie, 2003; Liu and Zhang, 2004).

Kong (2007) estimates the inflation threshold effects on growth using the bootstrapping method and finds that the turning points are 3.9 and 6.5 percent in two different scenarios.[3] Kong (2007) does not support that the threshold effects change from positive to negative when inflation rates get higher than the turning points. The effects of inflation on growth are uniformly negative (or uniformly positive) when using 3.9 percent (or 6.5 percent) as

[1] See Bruno and Easterly (1998) for a detailed discussion.

[2] There are four ways to capture turning points of inflation in the nonlinear effect of inflation on economic growth: arbitrarily choosing certain benchmarks of inflation (e.g. Fischer, 1993); using the spline function method (e.g. Sarel, 1996); using the bootstrapping method (e.g. Khan and Senhadji, 2001); and by adding a quadratic term of inflation rate (e.g. Pollin and Zhu, 2006).

[3] Kong (2007) divides the estimation into two scenarios according to the two alternative proxy variables to represent financial development: the growth rate of Credit Funds of Financial Institutions and the growth rate of M2. Kong (2007) finds that the inflation threshold is 3.9 percent when the growth rate of Credit Funds of Financial Institutions is used, whereas the inflation threshold equals 6.5 percent when the growth rate of M2 is used.

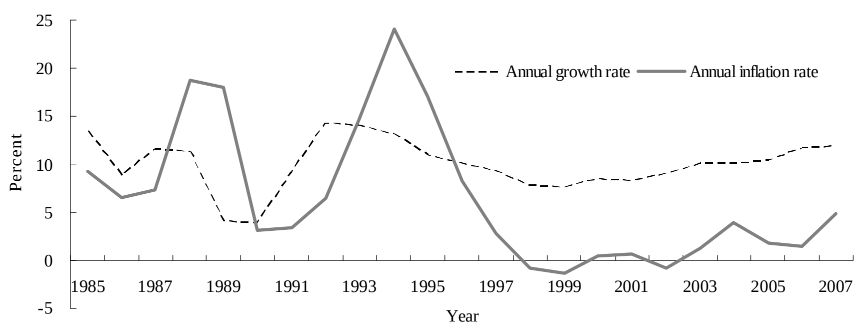
the inflation threshold. What differs from other papers concerning the linear inflation–growth nexus is that Kong (2007) confirms that even though the marginal effects of inflation on growth change, the estimated signs of coefficients stay the same. Therefore, that high inflation harms China's economic growth, whereas moderate inflation benefits growth is not confirmed.[4]

The abovementioned literature presents no consensus on the algebraic signs of the coefficient of inflation on economic growth. In the case of China, no one has directly confirmed the nonlinear relationship between inflation and economic growth. Therefore, the inflation threshold estimate remains inconclusive and is worth further research. The present paper attempts to explore this issue with respect to China and provides a criterion to evaluate China's economic operation and development.

III. China's Inflation and Economic Growth during 1985–2007

Before conducting our empirical study, it is necessary to look at inflation and growth in post-reform China. We depict the time series for the annual inflation rate and the annual economic growth rate during 1985–2007 in Figure 1. This figure shows that each inflation peak (bottom) is often followed by a growth bottom (peak) in the subsequent year during 1985–2007.[5]

Figure 1. Annual Inflation Rate and Annual Growth Rate for China, 1985–2007



Sources: NBS (1999, 2008).

[4] In most empirical papers (including the present study), the nonlinear effect (or the threshold effect) means that there exists some inflation rate turning point above which inflation has a negative effect on economic growth but below which has a positive effect on growth.

[5] We describe Chinese inflation during 1985–2007 to coincide with the empirical data in this paper.

There have been four peaks of high inflation in China since 1985 (Wang, 2005a, b). The first peak in inflation (9.3 percent) occurred in 1985. To inhibit high inflation, in March of 1985, the State Council of China issued an urgent Circular of the State Council Concerning Tightening the Price Control and Supervision and Inspection asking local governments to strengthen price controls. Three major policy measures were announced successively: adjustment of interest rates (both deposit and lending); moderation of investment; and overall credit restraints by the People's Bank of China (PBOC). However, loose policy execution failed to address the overheating of the economy.

The second inflation shock occurred in 1988. Against this wave of inflationary pressure, the State Council reissued the notice for supervision on tax evasion, finance and price in September 1988. In March 1989, the Chinese Government reaffirmed its determination to eliminate inflation. In the fall of the same year, the Plenary Session of the Thirteenth Central Committee of the Chinese Communist Party passed a series of measures to keep aggregate demand down and to constrain fiscal expenditure and credits. As a result of the authorities' firm attitude, the inflation rate drastically dropped to 2.9 percent in 1990, from 17.8 percent in the preceding year (NBS, 1999). Nevertheless, the tough measures applied, the authorities' so-called "one-knifed cut" approach, led to a hard landing of the economy.[6]

The third inflation threat broke out in 1993 and, in 1994, the yearly inflation rate rose to the highest level in post-reform China, 24.1 percent. On 24 June 1993, China announced Opinions of the Central Committee of Communist Party of China and the State Council on Current Economic Circumstances and Strengthening Macroeconomic Control (the so-called sixteen terms), which featured "tight but adequate" fiscal and monetary policies. Finally, inflation was brought down to 8.3 percent in 1996 and, this time, the economy achieved a soft-landing.

In 2003, inflation reared its head yet again. In response, the PBOC raised the deposit reserve ratio to 7 percent in August 2003. In October 2004, the PBOC lifted both deposit and lending rates.[7] From 2005 to 2007, China frequently raised interest rates to restrain possible inflationary pressures caused by the huge trade surplus and other relevant factors. In December 2001, when China joined the WTO, the trade surplus was US$22.54bn. Since then, this figure has increased every year. It increased to US$25.47bn, US$32.10bn and US$102.00bn in 2003, 2004 and 2005, respectively, and reached US$261.83bn in 2007 (NBS,

[6] The real GDP growth rates for 1988, 1989 and 1990 were 11.3, 4.1 and 3.8 percent, respectively (NBS, 1999).

[7] In October 2004, the deposit and lending interest rates were raised from 1.98 and 5.31 percent to 2.25 and 5.58 percent, respectively. The interest rates for 2003 and 2004 are cited from the PBOC website (http://www.pbc.gov.cn/publish/zhengcehuobisi/361/index.html).

2008). The rapid growth of the trade surplus has resulted in increasing money supply and excess liquidity. The Beijing Olympic Games and the Shanghai World Exposition gave an impetus to domestic investments, and the price problem became serious. Facing the price fluctuation resulting from rising aggregate demand, China's financial authorities had to raise interest rates in 2006 and 2007. The deposit reserve ratio and deposit and lending rates were raised several times. These three rates were adjusted upwards from 8.00, 2.25 and 5.58 percent to 14.50, 4.14 and 7.47 percent, respectively, during 2006–2007.[8]

IV. Empirical Model and Data Sources

As mentioned above, the aim of the present paper is to examine the possible threshold effect of inflation on economic growth in China. In this section, we will introduce our regression specification and the data sources for our research.

1. Regression Specification

We refer to Fischer (1993) and use a growth accounting equation as the basis of our model.[9] We start with a Cobb–Douglas production function:

$$Y = F(A, K, L) = AK^{a_1}L^{a_2}, \tag{1}$$

where Y is output; A is level of technology; K is capital stock; and L is quantity of labor. a_1 and a_2 stand for product elasticity of physical capital and labor. After differentiating Equation (1) with respect to time and rearrangement, we obtain the conventional growth accounting equation:

$$(\dot{Y}/Y) = (\dot{A}/A) + a_1(\dot{K}/K) + a_2(\dot{L}/L) \qquad \text{or} \tag{2}$$

$$\Delta \ln Y = \Delta \ln A + a_1 \Delta \ln K + a_2 \Delta \ln L, \tag{3}$$

where $\dot{Y}/Y$ is the output growth rate, $\dot{A}/A$ is the technology progress rate, $\dot{K}/K$ is the capital growth rate and $\dot{L}/L$ is the labor growth rate. a_i is the production elasticity of capital or labor and Δ denotes difference. According to Equation (3), we establish the primitive regression model:

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[8] These three interest rates are cited from the PBOC website (http://www.pbc.gov.cn/publish/zhengcehuobisi/361/1376/13765/13765_.html and http://www.pbc.gov.cn/publish/zhengcehuobisi/361/1377/13770/13770_.html).

[9] As Barro (1999, p. 119) points out: "Generally, the accounting exercise is viewed as a preliminary step for the analysis of fundamental determinants of economic growth. … growth-accounting exercise can be particularly useful if the fundamental determinants that matter for factor growth rates are substantially independent from those that matter for technological change."

$$\Delta \ln Y = a_0 + a_1 \Delta \ln K + a_2 \Delta \ln L + e \ , \tag{4}$$

where $a_0 \equiv \Delta \ln A$. e is an error term with zero mean and finite variance.

In Equation (4), we also consider other important explanatory variables that impact the macroeconomic environment: human capital and geographical location. First, to test the nonlinear effect of inflation on economic growth, we take inflation into account. On the basis of the Phillips Curve, there exists a short-run trade-off between inflation and unemployment. Higher employment accompanies higher output growth. This also implies that inflation is in accord with economic growth. However, some economists assert that, under assumptions such as cash-in-advance constraints and deposit reserve regulations, inflation is detrimental to capital accumulation and steady-state output (Stockman, 1981; Cooley and Hansen, 1989; Jones and Manuelli, 1995). Taking this into account, some researches believe that a nonlinear inflation–growth nexus might exist (Espinosa-Vega and Yip, 1999; Hung, 2001). The debate inspires us to examine the nonlinear effects of inflation on growth.

Moreover, on account of the endogenous growth theory, human capital is highly emphasized to explain growth. It softens the drawback of decreasing returns to physical capital accumulation in the growth model of Solow (1956). Human capital can be accumulated from acquired knowledge and intelligence and can improve output levels.

Aside from inflation and human capital, we use two dummy variables to capture the possible effect of location on physical capital and labor. These location dummies are used to distinguish coastal provinces from inland areas. In recent decades, with superior geographic positions and favorable long-term policy regimes, coastal provinces have enjoyed better infrastructure and access to advanced know-how from abroad. Additionally, there has been heavy migration of well-skilled people into the prosperous eastern regions, which has likely improved the productivity of labor. Therefore, we suppose that location might affect regional growth through differences in the marginal productivity of factors.

Because of some time-series properties in panel data, a time variable is added to remove the potential influence of time trend. We put the time trend in our regression as one control variable.

Given the theoretical linkages of economic growth and inflation with human capital and location factors, respectively, Equation (4) can be written as:

$$\Delta \ln Y_{i,t} = a_{0i} + a_1 (\Delta \ln K)_{i,t} + a_2 (\Delta \ln L)_{i,t} + \sum_{j=1}^{6} b_j (X_j)_{i,t} + e_{i,t}, \tag{5}$$

where X_j includes: $X_1 \equiv$ the capital growth rate (ln K) multiplied by the location dummy (D^L, set to one for coastal provinces, zero otherwise), $X_2 \equiv$ the labor growth rate (ln L) multiplied by the location dummy set the same as previously, $X_3 \equiv$ the human capital growth rate (ln *H*), $X_4 \equiv$ the time trend (*T*, set to be positive integrals in order, using 1–21 to represent the years 1986–2006), $X_5 \equiv$ the inflation rate (p) and $X_6 \equiv$ the inflation threshold effect. The inflation threshold effect is defined as the excess inflation rate multiplied by the inflation threshold dummy, denoted by D^p multiplies ($p - p*$), where $p*$ is the inflation threshold rate, and D^p is a dummy to demonstrate the threshold effect, which equals one when $p - p*$ is positive, and zero otherwise. *i* represents a cross-sectional index, *j* stands for the rest of the independent variables excluding the growth rates of physical capital and labor, and *t* is a time-series index.

In the final step of our empirical study, the sensitivity of the estimation result will also be tested. If the results of the estimation are robust, then the original coefficients of the explanatory variables will remain statistically significant after inserting additional explanatory variables into Equation (5). The extra variable we select is the ratio of international trade to output (*TR*) (i.e. the degree of external trade dependence).[10] According to the endogenous growth theory, international trade has positive effects on economic growth. International trade tends to professionalize production and causes prompt accumulation of capital and know-how, through "learning by doing;" this has been confirmed by previous studies (Grossman and Helpman, 1990; Levine and Renelt, 1992). In the robustness test, Equation (5) can be modified as below:

$$\Delta \ln Y_{i,t} = a_{0i} + a_1(\Delta \ln K)_{i,t} + a_2(\Delta \ln L)_{i,t} + \sum_{j=1}^{6} b_j (X_j)_{i,t} + g_1 TR_{i,t} + e_{i,t} . \tag{6}$$

The inflation threshold, a rate above which inflation begins to impede growth in China, is to be derived empirically. To find the threshold, spline function regression is used in the present paper.[11] First, we select an appropriate inflation rate interval according to available inflation data, and then divide the interval into numerous tiny subsamples by knots. Then, we treat each knot as a potential inflation threshold for the Chinese economy. By subtracting every trial threshold iteratively from the actual inflation rate, the excess between the actual inflation rate and the trial threshold is worked out. Third, we substitute the excess values into Equation (5) and generate the sum of squared error and goodness of fit for each excess value. Finally, we choose one inflation threshold for which the excess yields the smallest

[10] Levine and Renelt (1992) test robustness on regressors frequently to explain economic growth in their empirical paper. They suggest that the ratio of trade to output is robust in explaining growth. In China, it is broadly accepted that the vast export processing industries provide a sound environment to "learn by doing." That is why we selected the trade–output ratio for the test.
[11] See Greene (2008), for a discussion on spline regression.

sum of squared error or the highest goodness of fit ($\overline{R}^2$).

For the regression, output (Y), physical capital (K) and human capital (H) are extracted from real gross provincial product, total investment in fixed assets, and government expenditure on culture, education, science and health care.[12] Labor (L) is measured by the population of employees. The annual growth rates for these four variables are obtained by differentiated logarithm. The inflation rate (p) is measured by the growth rate of the consumer price index (CPI) per year. The trade–output ratio is calculated as the proportion of total trade in real gross provincial product. In the present paper, nominal variables are adjusted to real amounts at 1984 price and valued in the domestic currency unit (yuan).[13] Moreover, aside from the dummy variables, we convert the rest of the variables to percentages, so that we have uniform measures. The descriptive statistics for the major variables are presented in Table 1.

The panel dataset in the present paper includes 29 provinces (see Table 2) for the period from 1986 to 2006.[14] All data are collected from the China Compendium of Statistics 1949–2004 (NBS, 2005), Comprehensive Statistical Data and Materials on 50 Years of New China (NBS, 1999) and 2006 and 2007 statistical yearbooks of bureaus of statistics in various provinces.[15]

V. Empirical Results

In this section, we report the results of the spline regression for an inflation threshold and discuss all estimated coefficients in the empirical model.

1. Where is the Inflation Threshold?

First, according to the historical inflation rates for China, the interval of our inflation rate is

[12] We take fiscal expenditure on culture, education, science and health care as a proxy to measure human capital. When there is high mobility of residents, this is more suitable than the enrolment rate, the commonly used proxy in empirical studies of cross-country growth, to gauge human capital for each province.

[13] In 1985, China switched its computation system of the national account from the Material Product System to the System of National Accounts. To avoid possible data error and loss, we select post-1985 data for our panel dataset and deflate our nominal variables using 1984 prices.

[14] Because of the incomplete span of consumer price indices in some provinces, we replace provincial consumer price indices with city consumer price indices. However, in Anhui, it is replaced by the retail price index. Because of a severe shortage of key variables, Chongqing and Tibet are excluded from our observations.

[15] The reader can refer to Table 2 for a complete list of these 29 provinces and cities. To save space, the bibliography will not include these references. Further information is available from authors upon request.

Table 1. Descriptive Statistics for Primary Variables

Variable	Description	Sample size	Mean (%)	Median (%)	Standard deviation (%)	Expected sign of coefficient
$\Delta\ln Y$	Growth rate of output	609	8.84	8.77	5.82	NA
$\Delta\ln K$	Growth rate of capital	609	11.21	11.81	13.87	+
$\Delta\ln L$	Growth rate of labor	609	1.77	1.63	2.53	+
$D^L(\Delta\ln K)$	Coastal effect (capital)	609	4.79	0.00	11.03	+
$D^L(\Delta\ln L)$	Coastal effect (labor)	609	0.72	0.00	1.97	+
$\Delta\ln H$	Human capital growth	609	8.43	9.00	9.45	+
p	Inflation rate	609	7.32	5.10	7.71	–
TR	Trade–output ratio	609	23.73	11.02	32.02	+

Note: All variables are deflated using 1984 prices. NA, not available.

Table 2. Provinces and Cities Included in the Sample

Number	Province/City	Location	Number	Province/City	Location
1	Beijing	Coastal	16	Henan	Inland
2	Tianjin	Coastal	17	Hubei	Inland
3	Hebei	Coastal	18	Hunan	Inland
4	Shanxi	Inland	19	Guangdong	Coastal
5	Inner Mongolia	Inland	20	Guangxi	Coastal
6	Liaoning	Coastal	21	Hainan	Coastal
7	Jilin	Inland	22	Sichuan	Inland
8	Heilongjiang	Inland	23	Guizhou	Inland
9	Shanghai	Coastal	24	Yunnan	Inland
10	Jiangsu	Coastal	25	Shaanxi	Inland
11	Zhejiang	Coastal	26	Gansu	Inland
12	Anhui	Inland	27	Qinghai	Inland
13	Fujian	Coastal	28	Ningxia	Inland
14	Jiangxi	Inland	29	Xinjiang	Inland
15	Shandong	Coastal			

Note: Chongqing and Tibet are excluded from this table due to a lack of relevant data.

between 0 and 22 percent.[16] We divide this interval by 89 inflation rate knots: the beginning is inflation rate 0 percent, followed by 0.25, 0.50 and 0.75 percent, and so forth. The rest of

[16] There are no more than 30 of 609 inflation rate observations above 23 percent in our case.

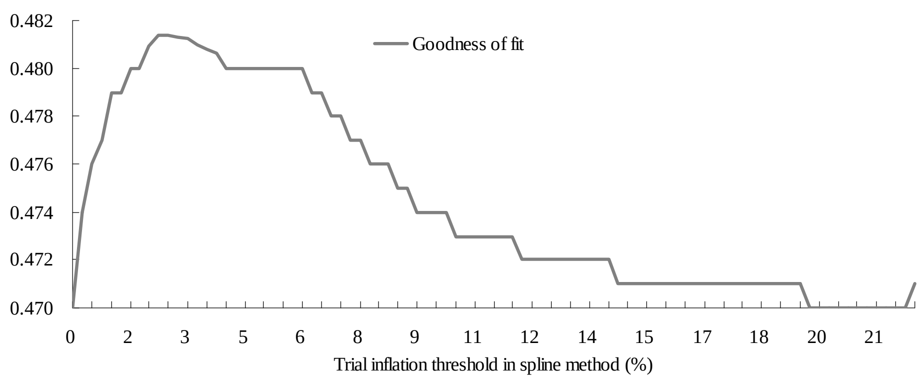
the knots can be deduced by analogy: every 0.25 percent is a knot, until 22 percent is reached. Then, we treat each knot as one trial point for estimation of the inflation threshold. We obtain 89 sets of $(p - p^*)$ based on each trial threshold by subtracting the actual inflation rate from each knot. We obtain 89 sets of results, which means we can collect 89 sets of $\overline{R}^2$ by substituting every set of trial $(p - p^*)$ into Equation (5). All the $\overline{R}^2$s are plotted in Figure 2.

In Figure 2, each $\overline{R}^2$ against the trial inflation threshold rate is estimated using Equation (5) with the random effect model. The inflation rate of 2.5 percent strikes the highest $\overline{R}^2$ (=0.4814); so this point is the most likely inflation threshold rate in China (with *t*-statistic 3.59).[17] All the $\overline{R}^2$ for various inflation threshold levels can be found in Table 3.

2. Results of Regression Excluding Both Inflation and the Inflation Threshold

In this subsection, we will estimate the linear and nonlinear effects of inflation on growth to distinguish the different results for models including and not including the threshold effect of inflation. The regression results are presented with and without controlling for the inflation rate and the excess inflation rate multiplied by the inflation threshold dummy, respectively. Initially, we run Equation (5) excluding p and $D^p(p - p^*)$ and obtain:

Figure 2. Goodness of Fit against Each Trial Inflation Threshold Rate



Note: The maximum of $\overline{R}^2$ (=0.48141) is against the trial inflation threshold rate of 2.5 percent.

[17] This estimation result is very similar to the finding of the cross-country study conducted by Ghosh and Phillips (1998).

Table 3. Goodness of Fit against Each Trial Inflation Threshold Rate

p^*	$\bar{R}^2$	p^*	$\bar{R}^2$	p^*	$\bar{R}^2$	p^*	$\bar{R}^2$	p^*	$\bar{R}^2$
0.00	0.470	5.00	0.480	10.00	0.473	15.00	0.471	20.00	0.470
0.25	0.474	5.25	0.480	10.25	0.473	15.25	0.471	20.25	0.470
0.50	0.476	5.50	0.480	10.50	0.473	15.50	0.471	20.50	0.470
0.75	0.477	5.75	0.480	10.75	0.473	15.75	0.471	20.75	0.470
1.00	0.479	6.00	0.480	11.00	0.473	16.00	0.471	21.00	0.470
1.25	0.479	6.25	0.479	11.25	0.473	16.25	0.471	21.25	0.470
1.50	0.480	6.50	0.479	11.50	0.473	16.50	0.471	21.50	0.470
1.75	0.480	6.75	0.478	11.75	0.472	16.75	0.471	21.75	0.470
2.00	0.48093	7.00	0.478	12.00	0.472	17.00	0.471	22.00	0.471
2.25	0.48138	7.25	0.477	12.25	0.472	17.25	0.471		
2.50	0.48141	7.50	0.477	12.50	0.472	17.50	0.471		
2.75	0.48130	7.75	0.476	12.75	0.472	17.75	0.471		
3.00	0.48124	8.00	0.476	13.00	0.472	18.00	0.471		
3.25	0.48101	8.25	0.476	13.25	0.472	18.25	0.471		
3.50	0.48078	8.50	0.475	13.50	0.472	18.50	0.471		
3.75	0.48065	8.75	0.475	13.75	0.472	18.75	0.471		
4.00	0.480	9.00	0.474	14.00	0.472	19.00	0.471		
4.25	0.480	9.25	0.474	14.25	0.471	19.25	0.470		
4.50	0.480	9.50	0.474	14.50	0.471	19.50	0.470		
4.75	0.480	9.75	0.474	14.75	0.471	19.75	0.470		

Notes: Each $\bar{R}^2$ is from Equation (2), disregarding the trade–output ratio for the given inflation threshold. The p^* is in terms of percentage. The annual inflation rate of 2.5 percent strikes the highest $\bar{R}^2$ (=0.48141). Some $\bar{R}^2$ values near the maximum are rounded to 0.00001.

$$\begin{aligned}\Delta\ln Y = {} & \underset{(6.52)^{***}}{3.06} + \underset{(9.99)^{***}}{0.18\Delta\ln K} + \underset{(1.33)}{0.13\Delta\ln L} + \underset{(2.21)^{**}}{0.05 D^L (\Delta\ln K)} + \underset{(0.66)}{0.08 D^L (\Delta\ln L)} + \\ & \underset{(3.50)^{***}}{0.08\Delta\ln H} + \underset{(6.04)^{***}}{0.24T} ,\end{aligned} \tag{7}$$

$$\text{Samples} = 609;\ \bar{R}^2 = 0.47;\ F = 16.15;\ \text{Hausman} = 3.91$$

where the number in parentheses is the *t*-statistic underlying its coefficient; ***, ** and * represent significance levels at the 1, 5 and 10-percent level, respectively.

In Equation (7), all coefficients of independent variables have the expected signs and are significant, except for the labor growth rate (*t*-statistic equals 1.33) and coastal effect on the labor growth rate (*t*-statistic equals 0.66). These results indicate four main features of the determinants of Chinese economic growth.

First, the growth of physical capital spurs economic growth. The estimated production elasticity of physical capital is approximately 0.16–0.18. However, the marginal contribution of capital to output is not large. One possible reason is overlapping investment. Because of the influence of the planned economy and due to the partly integrated market in China, overlapping investment remains serious and results in capital usage inefficiency. Therefore, the present paper suggests that the Chinese Government should continue to undertake market reform and integrate interprovincial economic development. In addition, it is important for the Chinese central government to avoid grading its local officers' performance only according to the growth rates of investment and output.

Second, consistent with our expectation, geographical location plays an important role in economic growth through the channel of improving the marginal product with respect to physical capital and labor. This result reflects the principal development strategy in China: to increase exports and to attract foreign direct investment (FDI). To achieve its development goals, China has placed more economic resources in coastal regions than in inland regions, which has led to higher productivity in the coastal areas in particular.

Third, Equation (7) indicates that, in the long run, more investment in education and other human capital can promote economic growth. According to the results of Equation (7), the elasticity of human capital equals nearly half that of physical capital. However, assuming the marginal product of capital is diminishing, a relatively lower level of human capital stock might have a relatively higher influence on economic growth in the future. Therefore, the Chinese Government should pay more attention to human capital in the regions with less investment and encourage investment of domestic capital in educational and R&D activities.

In addition, the time trend coefficient is significant and positive, which indicates that China's output level grows more rapidly as time proceeds. This finding might result from technology progress in China. Since 1979, the educational standard in China has been improved with increasing incomes. According to the NBS (2008), the population of college graduates in 1985, 1995 and 2005 was 316 000, 805 000 and 3 068 000 persons, respectively. More highly-educated workers entering the workforce benefits the technology progress in China, which helps to accelerate economic growth.

3. Results of Regression Including Inflation but Excluding the Inflation Threshold

In this subsection, we will include inflation in our regression to observe what coefficients of Equation (7) will change or fix in response to inflation.

We estimate Equation (5) excluding the term $D^p(p - p^*)$ and obtain:

$$\Delta \ln Y = \underset{(5.11)^{***}}{3.24} + \underset{(9.53)^{***}}{0.17}\Delta \ln K + \underset{(1.34)}{0.13}\Delta \ln L + \underset{(2.22)^{**}}{0.05} D^L(\Delta \ln K) + \underset{(0.66)}{0.09} D^L(\Delta \ln L) +$$

$$\underset{(3.39)^{***}}{0.08}\Delta \ln H + \underset{(5.61)^{***}}{0.23} T - \underset{(0.43)}{0.01} p \quad . \tag{8}$$

$$\text{Samples} = 609;\ \bar{R}^2 = 0.47;\ F = 15.67;\ \text{Hausman} = 3.89$$

Equation (8) demonstrates that all coefficients of Equation (7) remain the same after adding inflation into the regression. It is found that inflation has a small negative effect on economic growth, which is statistically insignificant. This result indicates that inflation is not influential in explaining China's economic growth (as the inflation threshold effect is omitted).

4. Results of Regression Including Both Inflation and the Inflation Threshold

In this subsection, we attempt to include both inflation and the inflation threshold in our regression to show the threshold effect on growth.

Adding inflation and the inflation threshold into our regression, we obtain:

$$\Delta \ln Y = \underset{(3.64)^{***}}{2.43} + \underset{(8.44)^{***}}{0.16}\Delta \ln K + \underset{(1.43)}{0.13}\Delta \ln L + \underset{(2.34)^{**}}{0.05} D^L(\Delta \ln K) + \underset{(0.76)}{0.10} D^L(\Delta \ln L) +$$

$$\underset{(3.58)^{***}}{0.08}\Delta \ln H + \underset{(6.34)^{***}}{0.27} T - \underset{(3.45)^{***}}{0.53} p - \underset{(3.59)^{***}}{0.61} D^p(p - p^*) \quad , \tag{9}$$

$$\text{Samples} = 609;\ \bar{R}^2 = 0.48;\ F = 15.93;\ \text{Hausman} = 4.16;\ p^* = 2.5\%$$

where p^* (the estimated inflation threshold rate in this paper) equals 2.5 percent.

The estimation results in Equation (9) confirm that both inflation and the inflation threshold have significant influence on economic growth. The results also indicate that, ceteris paribus, China should seek a moderate annual inflation rate of 2.5-percent, to maintain its growth in the long run. From these results, the study extracts two important findings.

First, the present paper confirms that the inflation threshold effect is crucial to explain China's economic growth. Conventionally, most of the existing published papers have assumed that the effect of inflation on growth is totally linear. In Equation (8), we drop the inflation threshold, which implies that the impact of inflation on growth is linear. Therefore, the estimation results indicate that inflation has a slightly negative influence on economic growth, leading us to a disputed and incorrect assertion. However, if the inflation threshold effect is considered, the estimation becomes quite different. In Equation (9), the inflation threshold is controlled, which implies that the nexus between inflation and growth is allowed to be kinked. Compared with Equation (8), not only is a higher $\bar{R}^2$ found in Equation (9), but the notion that the nonlinear influence of inflation on growth is statistically significant and depends onthe inflation rate. When inflation is above the inflation threshold, inflation has a negative impact on economic growth, but when inflation is below the threshold, inflation might stimulate economic growth.

Second, in the case of China, the present study confirms that the threshold effect of inflation is most likely to occur when annual inflation climbs over (or declines beneath) 2.5 percent. When inflation remains low, the impact of inflation on economic growth is positive: every 1-percentage-point increase in the inflation rate stimulates economic growth by 0.53 percent. When inflation remains high, the impact on growth is negative: every 1-percentage-point increase lowers growth by 0.61 percent.

5. Result of Sensitivity to Additional Explanatory Variable

The robustness of our estimation results is verified in this subsection. A sensitivity test is conducted by adding the trade–output ratio into our regression as another control variable, reported in Equation (10).

$$\begin{aligned}\Delta\ln Y = {} & \underset{(3.36)^{***}}{2.24} + \underset{(8.92)^{***}}{0.17}\,\Delta\ln K + \underset{(1.65)^{*}}{0.15}\,\Delta\ln L + \underset{(1.34)}{0.03}\,D^L(\Delta\ln K) + \underset{(0.25)}{0.03}\,D^L(\Delta\ln L) + \\ & \underset{(3.52)^{***}}{0.08}\,\Delta\ln H + \underset{(5.61)^{***}}{0.27}\,T - \underset{(3.40)^{***}}{0.53}\,p - \underset{(3.56)^{***}}{0.61}\,D^p(p-p^*) + \underset{(2.94)^{***}}{0.02}\,TR\end{aligned} \quad .(10)$$

$$\text{Samples} = 609;\ \bar{R}^2 = 0.49;\ F = 15.88;\ \text{Hausman} = 4.23;\ p^* = 2.5\%$$

Equation (10) shows that the estimation results for the nonlinear relationship between inflation and economic growth are robust. This means that the findings of this research remain reliable, even if another new explanatory variable (*TR*) is controlled in the regression. Equation (10) also indicates that openness is another dispensable element in the explanation of China's economic growth. Similar to the East Asian historical experience, China successfully utilizes foreign enterprises from its export-oriented neighbors to promote its industrial technology and innovation. Economic openness is helpful for attracting FDI and benefits economic growth. Therefore, how the successful experience of Southeastern China can be emulated to make inland provinces more attractive for international and interprovincial trade is expected to be an essential future task for the Chinese authorities.

VI. Conclusions and Policy Implications

The major objective of this study is to examine the inflation–growth nexus in China. The present study considers the nonlinear effect of inflation on economic growth in China. Using official provincial datasets for gross provincial product, CPI and other explanatory variables from 1986 to 2006, our empirical results show that the inflation threshold effect is highly significant and robust in China. Moreover, based on our estimation, when inflation is high (greater than 2.50 percent annually), every 1-percentage-point increase in inflation rate lowers economic growth by 0.61 percent; when inflation is low (less than 2.50 percent annually), every 1-percentage-point increase stimulates growth by 0.53 percent. This indicates that high inflation harms economic growth, whereas moderate inflation benefits growth. We suggest that China should maintain a moderate inflation rate to sustain long-run growth.

There are two major features of the present paper. First, we construct our regression using a growth accounting equation, which makes inflation–growth analysis clearer and more systematic. Second, the present paper distinguishes itself from earlier studies by applying the nonlinear inflation–growth relationship to examine regional growth. In contrast to previous studys, we demonstrate, using the provincial panel data, that there exists a nonlinear nexus in China.

It is worth noting that many economists are anxious about China's recent inflation and associated cool-down policies. In response to the global financial crisis, the PBOC resorted to loose monetary policy, and cut interest rates five times in the last 4 months of 2008. China has weathered the storm of the recession, with the growth rate remaining stable at around 9 percent in 2008 and 2009. However, China's monetary expansion and rapid growth have boosted inflation. In January 2010, the monthly CPI growth rate (year over year) was 1.5 percent, in June 2010 it rose to 2.9 percent, and in November of the same year it accelerated to 5.1 percent.[18] Some economists

[18] Consumer price index data are from the database of National Bureau of Statistics (http://www.stats.gov.cn/english/statisticaldata/).

have started to worry about inflationary pressures hurting the Chinese economy, although, in October 2010, the PBOC raised its benchmark lending and deposit rates for the first time since 2007. Based on our study, we suggest that the Chinese Government should continue to adopt macro-controls to ease the pressure of rising prices.

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