3. Methodology and Data

3.1 Framework for China's Regional Growth

3.1.1 Equation of Growth Accounting

Before the specification of regression, we refer to the work of Fischer (1993) and employ growth accounting equation as the basis of our theoretical analysis.[15] Start from a Cobb-Douglas production function, that is

$$Y = F(A, K, L) = AK^{\alpha_1} L^{\alpha_2}, \tag{1}$$

in which Y is output, A level of technology, K capital stock, L quantity of labor. After differentiating Eq. (1) with respect to time and rearrangement, we obtain the conventional growth accounting equation:

$$(\dot{Y}/Y) = (\dot{A}/A) + \alpha_1(\dot{K}/K) + \alpha_2(\dot{L}/L), \text{ or} \tag{2}$$

$$\Delta \ln Y = \Delta \ln A + \alpha_1 \Delta \ln K + \alpha_2 \Delta \ln L, \tag{3}$$

where $\dot{Y}/Y$ is output growth rate, $\dot{A}/A$ technology progress rate, $\dot{K}/K$ capital growth rate, $\dot{L}/L$ labor growth rate, Greek letter α_i is production elasticity of corresponding factor, Δ difference. Eq. (3) restated suitable presentation for regression yields:

$$\Delta \ln Y = \alpha_0 + \alpha_1 \Delta \ln K + \alpha_2 \Delta \ln L + \varepsilon, \tag{4}$$

where $\alpha_0 \equiv \Delta \ln A$. ε is an error term, with zero mean and finite variance.

However, Eq. (4) tends to provides weaker prediction capacity if we fail to control for possible structural variables which may not be attributed to technological progress, e.g. macroeconomic environment, social human capital, and geographical condition. Hence, to test the nonlinear effect of inflation on provincial economic

[15] As Barro (1999) indicates that "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."

growth, we take inflation into account. On the basis of traditional Phillips Curve, there exists trade-off between inflation and unemployment. If so, higher inflation has correspondence with higher employment, which goes along with higher output growth as usual. That also implies inflation is in accordance with economic growth. Whereas some economists, see section 2, assert that, through cash-in-advance constraint, tax system, deposit reserve regulation, etc., inflation should be detrimental to capital accumulation as well as steady-state output. Seeing this disagreement, more and more works try to prove inflation-growth nexus ought to be nonlinear due to risk preference and adverse selection. That is the main aim of this paper, to examine this statement of nonlinear effect.

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

Nevertheless, aside from inflation and human capital, we also use two dummy variables to capture possible effect of location and time. The first one is a location dummy used to distinct coastal provinces from inland ones; the other one is time dummy for eliminating trend interference. Because of superior geographic condition and long-run policy favor, the coastal provinces enjoy better infrastructure and earlier access to advanced know-how from abroad over recent decades. Additionally, plenty of well-skilled people also crowds into the prosperous eastern regions; it likely improves the productivity of labor. Therefore, we suppose that location difference may affect regional growth through changing marginal productivity of factors.

Given the theoretical linkages between economic growth and inflation, human capital, location disturbance, respectively, Eq. (4) can be written as below:

$$\Delta \ln Y_{i,t} = \alpha_{0i} + \alpha_1 (\Delta \ln K)_{i,t} + \alpha_2 (\Delta \ln L)_{i,t} + \sum_{j=1}^{6} \beta_j (X_j)_{i,t} + \varepsilon_{i,t}, \quad (5)$$

where X_j includes: $X_1 \equiv$ capital growth rate ($\Delta \ln K$) multiplied by location dummy (D^L, set to be one for coastal provinces, zero otherwise), $X_2 \equiv$ labor growth rate ($\Delta \ln L$) multiplied by location dummy the same as previous, $X_3 \equiv$ human capital growth rate ($\Delta \ln H$), $X_4 \equiv$ time trend dummy (T, set to be positive integrals, using one till twenty-one to represent years from 1986 to 2006), $X_5 \equiv$ inflation rate (π), and $X_6 \equiv$ excess inflation rate multiplied by inflation threshold dummy, i.e. $D^{\pi}(\pi - \pi^*)$, in which π^* inflation threshold rate, and D^{π} dummy to indicate threshold effect, which equals one if the term $(\pi - \pi^*)$ is positive and equals zero otherwise. Subscript i represents cross-sectional index, t time series index.

By the way, in the last empirical phase, we are going to test the sensitivity of the estimation result. If the result of estimation is robust, then coefficients should still remain significant after adding extra one explanatory variable into Eq. (5). The extra variable we select is ratio of international trade to output (TR), namely degree of trade dependence.[16] On account of endogenous growth theory, it is broadly-discussed that international trade has positive effects on economic growth. International trade tends to professionalize production, to prompt accumulation of capital and know-how, to bring "learning by doing" benefit, etc.; it is confirmed by lots of studies (Grossman and Helpman, 1990; Levine and Renelt, 1992). In the robustness test, Eq. (5) can be modified a little as below:

$$\Delta \ln Y_{i,t} = \alpha_{0i} + \alpha_1 (\Delta \ln K)_{i,t} + \alpha_2 (\Delta \ln L)_{i,t} + \sum_{j=1}^{6} \beta_j (X_j)_{i,t} + \gamma_1 TR_{i,t} + \varepsilon_{i,t}. \quad (6)$$

3.1.2 Regression for Panel Data

[16] Levine and Renelt (1992) proceed to test robustness on those regressors which are frequently used to explain economic growth in empirical papers. They suggest ratio of trade to output is really robust to explain growth. In China, it is broadly accepted that vast industries of export processing provide a good environment to "learn by doing." That is why we select trade-output ratio for test.

First of all, panel data, which combine time series and cross sections, are used to analyze threshold effect of inflation on China's regional growth over time. The basic form of regression for panel data can be presented as

$$y_{i,t} = \alpha_i + \beta' \mathbf{x}_{i,t} + \varepsilon_{i,t} . \tag{7}$$

in which α_i is the individual effect, one constant term over time *t* and specific to the individual cross-sectional unit *i*. We can use fixed and random effect approaches to generalize such model. The former approach takes α_i to be one group of specific constant corresponding to different observations in the regression model; the later one specifies that α_i is one group of specific disturbance, similar to $\varepsilon_{i,t}$ except that for each group, there is but a single draw that enters the regression identically in each period.

However, neither fixed effect nor random effect model is perfect. In the former model, degree of freedom tends to decrease due to dummy variable used. But, in the other model, it is required that individual effects are uncorrelated with the other regressors. To solve the problem, we determine which approach is better by Hausman specification test.[17]

3.1.3 Technique for Spline Function

Nevertheless, how much the inflation threshold, above which inflation becomes harmful to provincial growth in China and below which inflation turns harmless? If the threshold cannot be identified here, then the term $D^{\pi}(\pi - \pi^*)$ becomes unknown and the estimation cannot proceed. To find the threshold, spline function regression is employed in this paper.[18]

For the method, first, select an appropriate interval of inflation according to the

[17] We refer to Greene (2000) and provide detailed mathematical discuss in Appendix 1.
[18] See Greene (2000) for spline regression discussion.

history of inflation rate ever occurring. After that, divide the interval into numerous tiny subsamples by knots; every knot must be a point of inflation rate within the interval. Next, treat each knot as a trial inflation threshold for whole economy, i.e. China; by subtracting every trial threshold iteratively from the real inflation rate, work out the excess between real inflation rate and trial threshold.[19] Next, substitute every set of excess into Eq. (5) and generate sum of squared error and goodness of fit for each excess. At last, find out one inflation threshold whose excess yields the smallest sum of squared error (SSE) or the highest goodness of fit ($\overline{R}^2$).

3.2 Data and Descriptive Statistics

Concerning data for regression, output (Y), physical capital (K), human capital (H) are extracted from real gross provincial product (GPP), total investment in fixed assets, and government expenditure on culture, education, science, and health care, respectively.[20] Labor (L) is measured by population of employee. Annual growth rate of these four variables are obtained by differentiated logarithm. Inflation rate (π) is measured by rate of customer price index growth per year. Trade-output ratio is calculated by total trade amount over GPP. In this paper, nominal variables are adjusted to real amounts (in 1984 price) and valued in domestic currency unit (yuan). Moreover, aside from dummy variables, we uniform the rest of variables in terms of percentage (%). The descriptive statistics of major variables are organized as Table 1.

The panel dataset, in this paper, includes 29 provinces (see Appendix 2 for a full list) and covers the duration from 1986 to 2006.[21] All of them are collected from

---

[19] Sometimes, the subtraction results in a non-positive number. The economic interpretation is that "no inflation threshold effect happens," The threshold dummy (D^{π}) ensures (π – π^*) to vanish as real inflation rate is not greater than the threshold level.

[20] We take fiscal expenditure on culture, education, science, and health care as a proxy to measure human capital. For high mobility of population, it seems more suitable than enrolment rate, the commonly used proxy in empirics of cross-country growth, gauge human capital for each province.

[21] Sichuan's data of government expenditure on culture, education, science, and health (CESH) is

China Compendium of Statistics 1949-2004, *Comprehensive Statistical Data and Materials on 50 Years of New China*, and *Statistical Yearbook* of various provinces, totally published by central or local government authorities of China, either.

Table 1: Descriptive Statistic 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	
$\Delta\ln K$	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	+
$D^K(\Delta\ln K)$	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	+
π	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 at 1984 price, if necessary.

estimated by an annual change rate -3.19% in CESH as a share of government expenditure after 1994. Due to incomplete span of CPI in a few provinces, if necessary, we replace the provincial CPI with citizen CPI. However, in Anhui, it is replaced by retail price index. For awful shortage of key variables, Chongqing and Tibet are culled out from our observations.