Inflation and Economic Growth:

Threshold Effects and Transmission Mechanisms

Min Li

- **Department of Economics, University of Alberta, 8-14 HM Tory Building, Edmonton, Alberta, Canada, T6G 2H4**

Email address: minl@ualberta.ca

Contents

PAGE

ABSTRACT ……………………………………………………………….Ц

SECTION

1. Introduction………………………………………………… ….…………………….1
2. Literature Review……………………………………………………….……………10
3. Data and summary statistics…………………..……………..............................20
4. Analysis of the Growth-Inflation Relationship…...………………………………….23
5. Analysis of the Transmission Mechanism between Inflation and Growth…..………39
6. Conclusions and Proposals for Further Research……………………......................46

TABLES

1. Decadal Summary Statistics on Inflation, Growth…………………………………..52
2. Quartile Averages Dataset Sorted by Inflation Means (Growth Expenditure Equation) ……………………………………..53
3. Quartile Averages Dataset Sorted by Inflation Means (Growth Accounting Equation) ……………………………………...53
4-1. Linear Estimation Results with Growth Exp. Equation (Full Sample) ………………………………………54
4-2. Linear Estimation Results with Growth Exp. Equation (Developing Countries and Developed Countries) ……………………………………..55

5-1. Linear Estimation Results with Growth Accounting Equation (Full Sample) ……………………………………...54
5-2. Linear Estimation Results with Growth Accounting Equation (Developing Countries and Developed Countries) ………………………………………56
6. Estimation and Test Results of Threshold Effects…………………………………..57
7. Estimations with Threshold Effects: Growth Expenditure Equation………………..58
8. Estimations with Threshold Effects: Growth Accounting Equation………………...59
9. Linear Estimation of Investment-Inflation Relationship……………………………60
10. Linear Estimation of TFP growth-Inflation Relationship…………………………...61
11. Estimation of Investment-Inflation Relationship with Thresholds…………………62
12. Estimation of TFP growth- Inflation Relationship with Thresholds………………..63

REFERENCES ……………………………………………………………………………64

APPENDIX

Complete List of Countries………………………………………………………...…….69

ABSTRACT

Currently, economists seem to agree that high rates of inflation cause “problems,” not just for some individuals, but for aggregate economic performance. However, much less agreement exists about the precise relationship between inflation and economic performance, and the mechanism by which inflation affects economic activity.

Motivated by these questions, this paper first examines the relationship between inflation and economic performance by using data for 90 developing countries and 28 developed countries over the period 1961-2004. The evidence strongly supports the view that the relationship between inflation and economic growth is nonlinear. Further investigation suggests that developing countries and developed countries show different forms of nonlinearity in the inflation-growth relationship. For developing countries, the data suggest the presence of two thresholds in the function relating economic growth and inflation. The nonlinear mechanism works as follows: at the rates of inflation lower than those of the first threshold, the effects of inflation on growth are insignificant and even positive; at moderate rates of inflation, which are between the two threshold levels, the effects of inflation are significantly and strongly negative; at extremely high rates of inflation, the marginal impact of additional inflation on economic growth diminishes rapidly but is still significantly negative. However, for developed countries, only one threshold is detected and proved significant. The nonlinear mechanism works as follows: the magnitude of the negative effect of inflation on growth declines as the inflation rate increases.

The second part of this paper attempts to find the mechanism through which inflation affects long-run economic growth in a nonlinear fashion. Two possible channels, the capital accumulation channel and the Total Factor Productivity (TFP) channel are examined by using a linear model and a model with threshold effects. The interesting finding is that, for both developing and developed countries, the TFP growth, but not the level of investment (Investment/GDP), which is the channel hypothesized by existing theoretical models, is the channel through which inflation adversely and nonlinearly affects economic growth. Moreover, at low to moderate inflation, inflation even has a significantly positive effect on the level of investment.

1. Introduction

The conventional view in macroeconomics holds that permanent and predictable changes in the rate of inflation are neutral: in the long term, they do not affect real activity. However, a substantial body of evidence suggests that sustained high rates of inflation can have adverse consequences for real economic growth even in the long run. Nowadays, a consensus among economists seems to be that high rates of inflation cause "problems," not just for some individuals, but for aggregate economic performance. However, there is much less agreement about the precise relationship between inflation and economic performance, and the mechanism by which inflation affects economic activity is.

The effects of permanent increases in the inflation rate for long-run activity seem to be quite complicated. The consensus about the adverse effect of inflation on real economic growth reveals only a small part of the whole picture. Recently, intensive research has focused on the nonlinear relationship between these two variables. That is, at lower rates of inflation, the relationship is not significant or even positive; but at higher rates, inflation has a significantly negative effect on growth. Bruno and Easterly (1998) demonstrated that a number of economies have experienced sustained inflations of 20 percent to 30 percent without suffering any apparently major adverse consequences. However, once the rate of inflation exceeds some critical level (which Bruno and Easterly estimated to be about 40 percent), significant declines occur in the level of real activity. More recently, Khan and Senhadji (2001) used an unbalanced panel with 140 countries over 40 years to precisely examine the nonlinear relationship between inflation and growth. The estimate of the threshold level was 1-3% for industrial countries and 11-12% for developing countries.

These empirical findings do not agree with standard macroeconomic models. However, recent empirical studies suggest financial markets might be an important channel through which inflation can affect growth in a nonlinear fashion. Regarding the inflation-finance nexus, evidence suggests that two threshold levels exist in the relationship between inflation and financial development.[1] The first threshold is a certain critical rate, beyond which inflation has a significantly negative effect on financial markets, but below which inflation has no significant effect on financial markets. The second threshold level was proposed by Boyd and Smith (1998) and Huybens and Smith (1998, 1999). They argued that another critical rate exists in some cases. Once the rate of inflation exceeds this critical level, all the damage to the financial system has already been done. Further increases in inflation will have no additional consequences for the financial sector performance or economic growth (Boyd et al., 2001).

If the hypothesis that the financial market is the channel through which inflation can affect long-run economic growth is true, we may expect that the effect of inflation on economic growth shows a similar pattern to that of inflation on financial market performance. Existing empirical studies suggest that at moderate rates of inflation, a

[1] Financial development is measured by both banking development and stock market development. Generally speaking, banking development is measured by the ratio of liquid liabilities of the financial sector to the GDP, the ratio of total assets of "deposit money banks" divided by the GDP, and the ratio of the banking institution credits to the private sector as a percent of GDP. Stock market development also can be measured by several variables such as the total value of domestic shares traded divided by the total value of domestic shares, the value of listed domestic company shares on each country's major stock exchange as a percent of GDP.

strong negative correlation exists between inflation and financial market performance and also between inflation and economic growth. In addition, the first threshold level discussed above was also detected both in the finance-inflation and the growth-inflation relationship (Boyd et al. 1997; Khan et al., 2001; Bullard and Keating 1995; Bruno and Easterly, 1998; Khan and Senhadji, 2001). Now the only question left is if a second threshold exists in the inflation-growth relationship, above which the marginal effect of inflation on growth diminishes.

Although no consensus yet exists about the precise structure of the threshold effects in the relationship between inflation and economic performance, there seems to be little doubt about that inflation and real activity are negatively and nonlinearly associated. However, the mechanism that gives rise to a negative and nonlinear correlation between inflation and long-run growth is far from clear. The empirical findings of the inflation-growth relationship do not agree with conventional macroeconomic models. Typically, conventional monetary growth models share a variety of common features. First of all, monetary steady-state equilibria are generally unique, and unique dynamical equilibrium paths approach them. Second, these dynamical equilibria display monotonic convergence to the steady state, ruling out any endogenous economic fluctuations. Third, the steady-state equilibrium levels of per capita output and of the capital-labor ratio are either positively related to the steady-state rate of inflation, or else money is "super-neutral," and the level of real activity (in steady-state equilibria) is unaffected by changes in the rate of inflation. These features of conventional monetary growth models prevent them from being used either to explain the adverse effects of inflation on economic growth or to address the nonlinear issue in the inflation-growth relationship.

Nevertheless, the conventional monetary models can be modified to explain the negative correlation between inflation and growth, and further, to explain the nonlinearity in the inflation-growth effect. The popular way of modification is to introduce asymmetric information into a monetary growth model (Azariadis and Smith, 1996; Choi, et al, 1996; Huybens and Smith, 1999; Bose, 2002). In addition, the model is generally based on the empirical finding that a pronounced negative correlation exists between inflation and real equity returns (Nelson, 1976; Fama and Schwert, 1977; Gultekin, 1983; Boyd et al., 2001). The general mechanism works as follows: inflation reduces real returns to savings and, via this mechanism, exacerbates an informational friction afflicting the financial system. This financial market friction might result credit rationing and thus limit the availability of investment capital (the level of investment) and reduce the efficiency of the allocation of savings to investment projects (the efficiency of investment), and finally adversely affect the long-run economic growth. Regarding to the nonlinear effects of inflation on economic performance, Choi et al. (1996) further suggested that credit market frictions are potentially innocuous at low rates of inflation. Thus, in low inflationary environments, credit rationing might not emerge at all, and the negative link between inflation and capital accumulation vanishes. In such a case, higher inflation reduces the rate of return received by savers in all financial markets and consequently increases capital accumulation. When this result occurs, Choi et al.'s (1996) model possesses a standard Mundell-Tobin effect that makes higher inflation lead to higher long-run levels of real activity. However, once inflation exceeds a certain critical level, credit rationing must be observed, and higher rates of inflation can have the adverse consequences noted above. Models, which can successfully explain the negative and nonlinear correlation between inflation and economic performance, might differ in their sources of financial frictions and the specifications of an adverse selection problem in capital markets. However, existing literature basically suggests the following transmission mechanism (Figure1) from inflation to economic growth.

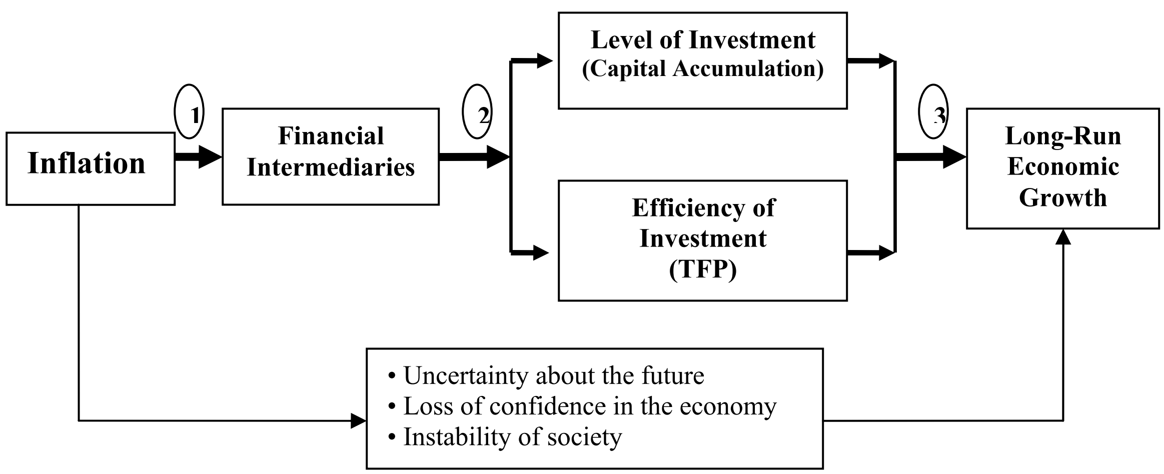

Figure1. Transmission Mechanism from Inflation to Economic Growth

As Figure 1 reveals, inflation can affect economic growth through financial intermediaries and has a direct effect on growth as well. Since the direct effect of inflation on growth is trivial and difficult to model, most theoretical studies have focused on the main channel, which is shown by the bold lines with arrows in Figure 1. To precisely examine this theoretically hypothesized channel, we divide it into three parts: the inflation-finance nexus, the finance-investment nexus, and the investment-growth nexus, which are represented in Figure 1 as ①, ② and ③, respectively. The inflation-finance nexus (①), which is the starting point of the channel through which inflation affects economic growth, has been well examined, and it has been proved to be that even predictable increases in the rate of inflation can impede financial market development. In addition, as we mentioned previously, empirical studies have identified two thresholds in the inflation-finance nexus. For the last two parts of the channel (② and ③) from finance to real economic performance, empirical studies have found that different measures of financial market development are strongly and positively correlated with the level of investment, the efficiency of investment and real economic growth (King and Levine, 1993a, b; Levine and Zervos, 1998; Atje and Jovanovic, 1993). Furthermore, Xu (2000) demonstrated that investment is an important channel through which financial development affects growth.

As we mentioned previously, the empirical findings of the inflation-finance and inflation-growth nexus seem to suggest that the financial market is the channel through which inflation affects economic growth. However, research so far has no consensus on whether the effect of inflation on economic growth is through the channel of either the level and/or the efficiency of investment. Barro (1995) suggested that a likely channel by which inflation decreases growth is through a reduction in the propensity to investment. Barro (1995)'s further estimation shows that the impact effects from an increase in average inflation by 10 percentage points per year are a decrease in the ratio of investment to GDP by 0.4-0.6 percentage points and a reduction of the real per capita GDP by 0.2-0.3 percentage points per year. Barro's (1995) study supports the hypothesized mechanism that inflation reduces the level of investment and that a reduction in investment adversely affects economic growth. However, Barro (1995) used a pooled dataset and assumed that a linear relationship exists between inflation and economic growth and also between inflation and investment. In contrast, recent studies have suggested the significant nonlinear effect of inflation on economic performance, so we may expect that a threshold effect also exists in the inflation-investment relationship if the hypothesized transmission mechanism is valid. To our knowledge, research so far has not dealt with this issue. In addition, further research might also concentrate on the link between inflation and the efficiency of investment, to examine if inflation affects economic growth through the efficiency of investment as well as the level of investment.

To sum up, two research topics as follows have been raised based on the existing literature. The first topic deals with the inflation-growth nexus; the second topic attempts to find the transmission mechanism between inflation and economic growth.

1) Does a second threshold exist significantly in the inflation-growth relationship, above which the marginal effect of inflation on growth diminishes?

2) What is the precise relationship between inflation and capital accumulation, or the level of investment? What is the relationship between inflation and the efficiency of investment? Do the effect of inflation on capital accumulation and the efficiency of investment show a similar pattern to that of inflation on economic growth?

Motivated by these questions, this present paper first examines the relationship between inflation and economic performance and attempts to estimate precisely the nonlinear features of this relationship. Then the paper carries out some preliminary examinations on the relationship between inflation and investment (in terms of both the level and the efficiency) in an attempt to identify the mechanism through which inflation has a negative and nonlinear effect on economic performance.

Data for 90 developing countries and 27 developed countries over the period 1961-2004 are used to address the first two questions. Except for using a pooled dataset, developing countries and developed counties are analyzed separately to examine if the effects of inflation on both economic growth and investment (in terms of level and efficiency) show different patterns between developing and developed countries. This paper uses five-year average data to eliminate the fluctuations of the business cycle and focus on the medium- and long-term relationships between inflation and growth, and between inflation and investment. The threshold effects are examined by allowing the discrete slopes to differentiate high, middle and low rates of inflation. Different estimation methods and model specifications are used to test the sensitivity of the threshold estimates and coefficient estimates of inflation.

Some interesting findings as follows are obtained by carrying out preliminary estimations:

- The evidence strongly supports the view that the relationship between inflation and economic growth is nonlinear. In particular,

  1) for developing countries, the data suggest the presence of two thresholds in the function relating economic growth and inflation. When the rates of inflation is below the first threshold, the effects of inflation on the economic growth rate are insignificant or even positive; at moderate rates of inflation, that is, rates of inflation between the two thresholds, the effects of inflation are significantly and strongly negative; at extremely high rates of inflation, the marginal impact of additional inflation on the economic growth diminishes rapidly but is still significantly negative. Furthermore, the first threshold level of inflation is estimated at 14 percent per year, and the second threshold level is estimated at 38 percent per year.

2) for developed countries, only one threshold is detected and proved to be significant. This unique threshold is estimated to be at 24 percent per year and works the same way as the second threshold for developing countries.

- Data suggest that for both developing and developed countries, the efficiency of investment (measured as the growth rate of the TFP), but not the level of investment (measured as the Investment/GDP ratio), is the channel through which inflation adversely and nonlinearly affects economic growth. Moreover, at low to moderate inflation, specifically, below 65% for developing countries and below 42% for developed countries, inflation even has a significantly positive effect on the level of investment.

The remainder of this paper proceeds as follows. Section 2 briefly reviews some empirical evidence and the theoretical literature on the relationship between inflation, financial development, capital accumulation, and long-run economic growth. Section 3 describes the data and presents the summary statistics. Section 4 performs some estimations and applies some econometric techniques to uncover the nonlinear features of the growth function in an attempt to find the precise threshold levels. Section 5 undertakes some preliminary analyses in an attempt to find the transmission mechanism through which inflation affects long-run economic growth. Section 6 offers some concluding remarks and also proposes possible future research on the second topic.

2. Literature Review

2.1 Some Empirical Evidence on the Inflation-Growth Relationship

The investigations into the existence and nature of the link between inflation and growth have experienced a long history. Although economists now widely accept that inflation has a negative effect on economic growth, researchers did not detect this effect in data from the 1950s and the 1960s. A series of studies in the IMF Staff Papers around 1960 found no evidence of damage from inflation (Wai, 1959; Bhatia, 1960; Dorrance, 1963, 1966). Johanson (1967) found no conclusive empirical evidence for either a positive or a negative association between the two variables. Therefore, a popular view in the 1960s was that the effect of inflation on growth was not particularly important.

This view prevailed until the 1970s, when many countries, mainly in Latin America, experienced hyperinflation or chronic inflation. Numerous empirical studies were devoted to finding the effects of inflation in high-inflation countries. These studies repeatedly confirmed that inflation had a significant negative effect on economic growth, at least at sufficiently high levels of inflation. Therefore, today, the dominant view regarding the effects of inflation has changed dramatically. Fisher (1993) found negative associations between inflation and growth in pooled cross-section, time series regressions for a large set of countries. He argued that inflation impedes the efficient allocation of resources by obscuring the signaling role of relative price changes, the most important guide to efficient economic decision-making. Later, a famous paper by Barro (1995) more precisely examined the five-year average data of 100 countries over the period of 1960-90 by using the Instrumental Variable (IV) estimation method. Using different instrumental variables, he obtained a robust estimation result showing that an increase in average inflation by 10 percentage points per year would slow the growth rate of the real per capita GDP by 0.2-0.3 percentage points per year. He argued that although the adverse influence of inflation on growth appeared small, the long-term effects on standards of living were actually substantial. Nevertheless, some other empirical and theoretical studies argued that the inflation-growth relationship is fragile. Levin and Zervos (1993) showed that the cross-section correlation between inflation and growth depends on extreme inflation observations with high-frequency data. Bruno and Easterly (1998) and Bullard and Keating (1995) found support for the notion that this negative relationship emerges only when rates of inflation exceed some threshold. Levine and Renelt (1992) and Clark (1997) also questioned whether a uniformly negative relationship exists between inflation and real activity independently of the prevailing rate of inflation.

Recently, intensive research has focused on the nonlinear relationship between these two variables. That is, at lower rates of inflation, the relationship is positive or not significant, but at higher rates, inflation has a significantly negative effect on growth. In terms of nonlinearity, explaining why views on the inflation-growth relationship have changed dramatically over the past forty years is not difficult. Table 1 shows the means and medians across the countries of the inflation rates in five decades: 1960-1969, 1970-1979, 1980-1989, 1990-1999 and 2000-2002. The median inflation rate was only 2.6% per year in the 1960s and rose rapidly to 9.2% per year in the 1970s, and then 10.3% per year in the 1980s. In addition, the median growth rate decreased dramatically from 8.8% per year in the 1960s to 2.3% per year in the 1970s. The negative effects of inflation on economic growth are very clear. Therefore, since during the 1960s most countries experienced low inflation below the threshold level, it is not surprising that no evidence supported the negative inflation-growth relationship. As the median inflation rates rose dramatically in the 1970s, a significantly negative relation occurred between the two variables.

The nonlinear view with respect to the inflation-growth relationship not only can convincingly explain the empirical findings but also has a strong policy implication: keep inflation below the structural break! This implication could be the reason why, since the 1990s, numerous economists have been trying to find the exact threshold level. Such a nonlinear relationship was first detected by Fischer (1993). Sarel (1996) used OLS with fixed effects to examine a sample with 87 countries (including both industrial countries and developing countries) over the period 1970-1990. He specifically tested the existence of a structural break point and found evidence of a significant structural break in the relationship between the two variables. Moreover, he estimated the inflection point, or threshold, to be at an 8% annual inflation rate. Ghosh and Phillips (1998) reexamined the issue of the existence of threshold effects, using a larger sample than Sarel (1996). Surprisingly, they found a substantially lower threshold effect at a 2.5% annual inflation rate. Christoffersen and Doyle (1998) estimated the threshold level at 13% for transition economies. Khan and Senhadji (2001) used an unbalance panel with 140 countries for 40 years to estimate the threshold for industrial and developing countries. Using the nonlinear least squares (NNLS) estimation technique, Khan and Senhadji (2001) estimated that the threshold levels for industrial countries and developing countries were at 1-3% and 11-12%, respectively.

2.2 Theoretical Considerations about the Nonlinear Growth-Inflation Relationship

The finding of nonlinearity in the relationship between inflation and growth does not accord well with standard macroeconomic models. However, recent studies provide some interesting insights about this relationship. Huybens and Smith (1998, 1999) argued that even predictable increases in the rate of inflation could impede economic growth by interfering with the ability of the financial sector to allocate resources effectively. In addition, an increasing number of theoretical studies have attempted to explain how predictable changes in the rate of inflation affect the financial system and, therefore, long-term growth in a nonlinear way. In particular, Azariadas and Smith (1996) and Choi et al. (1996) demonstrated that only when inflation exceeds certain "critical" rates do informational frictions necessarily play a substantial role. In the following, we will focus on these theoretical mechanisms to demonstrate how predictable changes in the rate of inflation affect the financial system in a nonlinear way and thus explain the nonlinearity in the relationship between inflation and growth.

• Adverse Selection and Moral Hazard Problems in Credit Markets[2]

Consider a typical economy with two sets of agents, one set called "natural lenders" and the other called "natural borrowers." "Natural lenders" have funds available to invest, but lack projects, while "natural borrowers" have access to projects that efficiently convert current resources into future capital, but lack available funds. The fundamental role of the financial system is to channel funds from the natural lenders to natural borrowers.

Since higher rates of inflation act like a tax on real balances or bank reserves, we make an assumption[3] that an increase in the rate of inflation drives down the real rate of return not just on money, but on assets in general. In particular, higher rates of inflation reduce savers' real rates of return and lower the real rates of interest that borrowers pay. By itself, this effect makes more people want to be borrowers and fewer people want to be savers. However, people who were not initially getting credit represent "lower quality borrowers" or, in other words, higher default risks. Investors will be uninterested in making more loans to lower quality borrowers at lower rates of interest and therefore must do something to keep them from seeking external finance. The specific response here is that markets ration credit, and that more severe rationing accompanies higher inflation. Since the credit rationing limits the availability of investment capital, the financial system makes fewer loans, resource allocation is less efficient, and financial intermediary activity diminishes. Consequently, long-term economic growth declines as the rates of inflation increase.

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[2] This part is based on the selected materials in Azariadis and Smith (1996), Choi. et al. (1996) Boyd, Choi, and Smith (1997), and Paal and Smith (2000).

[3] Empirical investigations strongly support the assumption that a pronounced negative correlation exists between inflation and real equity returns (Nelson, 1976; Fama and Schwert, 1977; Gultekin, 1983; Boyd et al., 1996).

However, if the rate of inflation is sufficiently low, and if real rates of return on savings are sufficiently high, credit rationing is not required to induce natural lenders to lend rather than borrow. If this situation exists, then at low enough rates of inflation, the credit market operates in a totally Walrasian way.[4] Then, in a model that generates a Mundell-Tobin effect[5] in the absence of credit rationing, the following can occur: an increase in the rate of inflation causes agents to substitute away from cash into investments in physical or/and human capital. As a result, long-run growth is stimulated (Azariadas and Smith, 1996; Choi et al., 1996). Once the rate of inflation exceeds the threshold level, further increases in inflation will lead to credit rationing and will have the negative consequences described previously for the financial system and real economic growth. Thus, a critical rate of inflation exists. Below this rate, modest increases in inflation can stimulate real activity and promote financial depth. Above this threshold, increases in the rate of inflation interfere with the efficient allocation of investment capital and consequently have negative growth effects.

2.3 Empirical Evidence for the Mechanism through which Inflation can Adversely and Nonlinearly Affect Inflation

Since an extremely strong positive correlation exists between measures of financial market development and real economic performance (King and Levine, 1993a, b; Levine and Zervos, 1998; Atje and Jovanovic, 1993), a substantial body of empirical studies

[4] Specifically, the total wealth in the economy equals the total value of all assets, and the total value of any individual's asset holdings must equal his or her total wealth. Thus, if the market for every asset but one clears, the market for the remaining asset must clear as well (Romer, 2001).

[5] The Mundell-Tobin effect is that nominal interest rates would rise less than one-for-one with inflation because in response to inflation, the public would hold less in money balances and more in other assets, and would drive interest rates down(Online Economics Glossary).

work on the relationship between financial market development and inflation in an attempt to justify the conclusion that financial markets are an important channel through which inflation can affect growth adversely and also nonlinearly.

Boyd et al. (2001) examined five-year average data on bank credit extension to the private sector, the volume of bank liabilities outstanding, stock market capitalization and trading volume (all as ratios to GDP), and inflation for a cross-sectional sample over 1960-1995. Boyd et al. (2001) found that, at low-to-moderate rates of inflation, increases in the rate of inflation lead to markedly lower volumes of bank lending to the private sector, lower levels of bank liabilities outstanding, and significantly reduced levels of stock market capitalization and trading volume. In addition, Boyd et al. (2001) found that the relationship between inflation and financial development is nonlinear. The adverse effects of inflation on growth become "flatter" as inflation increases up to a critical level: that is, a given percentage-point increase in the rate of inflation has a much larger effect on financial development at low than at high rates of inflation. However, Boyd et al. (2001) did not estimate the exact threshold level. They experimented with critical values ranging from a 7.5 percent to 40 percent inflation rate and then chose a 15 percent inflation rate as representative.

Khan et al. (2001) examined an unbalanced panel including 168 countries and generally covering the period 1960-1999. Using NLLS estimation both with and without instrumental variables, Khan et al. (2001) found another threshold level of inflation, beyond which inflation had powerful negative effects on all measures of financial depth[6] and below which inflation had insignificant or even positive effects on financial depth. This threshold was estimated to be in the range of 3 to 6 percent.

By combining the analyses of Boyd et al. (2001) and Khan et al. (2001), we can depict the whole picture of the inflation-finance relationship. The threshold estimated by Khan et al. (2001) seems like a lower threshold level, and the threshold presented by Boyd el al. (2001) seems like an upper threshold level. The negative inflation-finance relation is significant when the rate of inflation is between the lower and upper threshold levels. The inflation exceeding the upper threshold impedes the economy with diminishing marginal impact, while the inflation below the lower threshold does not impede and can slightly stimulate financial depth (Khan et al., 2001). Given the features of the inflation-finance relationship, we can reasonably expect that the inflation-growth relationship behaves with the same features. Khan and Senhadji (2001) detected a threshold in the inflation-growth nexus at 1-3% for industrial countries and 11-12% for developing countries. These threshold estimates fall within the range of threshold estimates for the relationship between inflation and financial depth (Khan et al., 2001). The combined results from Khan and Senhadji (2001) and Khan et al. (2001), to some extent, provide a strong support for the view that financial markets are an important channel through which inflation affects growth in a nonlinear fashion. However, research so far did not explicitly

[6] Financial depth is measured by several alternative indicators: (1) fd1: domestic credit to the private sector as a share of GDP; (2) fd2: fd1 plus stock market capitalization as a share of GDP; (3) fd3：fd2 plus private and public bond market capitalization as a share of GDP.

test for the presence of the second threshold level in the relationship between inflation and economic growth. We will turn our attention to that task in Section 4.

A similar pattern for the inflation-growth relationship and inflation-finance relationship strongly supports that financial markets are an important channel through which inflation can affect growth adversely and also nonlinearly. A further question is how the financial market performance affects real economic activity. Existing theoretical models with money and an active credit market suggest that capital accumulation connects inflation and real economic performance through the financial market. Essentially, the models propose the mechanism that inflation exacerbates adverse selection in the financial market, diminishes financial intermediary activity, and then limits the availability of capital investment and finally reduces real long-run economic growth. Since in the theoretical models, the effect of inflation on capital accumulation is assumed to occur through the channel of the financial market, the empirical findings of a strong correlation between inflation and financial market activities to some extent support the existing theoretical models.

Now the question is whether the empirical findings of inflation-investment and investment-growth relationships support the existing theoretical models. On the one hand, both conventional growth models and empirical studies consistently suggest a very significantly positive correlation between investment and real economic performance. Empirically, Barro (1995) run a regression of per capita GDP growth rate on the investment/GDP ratio and some control variables by using data for around 100 countries from 1960 to 1990. The estimation results suggested a very significantly positive effect of the investment/GDP ratio on growth. In particular, an increase in investment ratio by 10 percentage points per year will be associated by an increase in the growth rate of real per capita GDP by 0.2-0.24 percentage points per year.

On the other hand, empirical studies on the relationship between inflation and capital accumulation are surprisingly scarce compared to the studies on the inflation-finance relationship. Barro (1995) suggested that a likely channel by which inflation decreases growth is through a reduction in the propensity to investment. A further estimation showed that the impact effects from an increase in average inflation by 10 percentage points per year are a decrease in the ratio of investment to GDP by 0.4-0.6 percentage points and a reduction of real per capita GDP by 0.2-0.3 percentage points per year. McClain and Nichols (1994) used newly developed time series techniques to test for a long-run relationship between inflation and investment by using U.S. time series data from 1929 to 1987. Surprisingly, these authors found that investment and inflation are positively correlated to each other. They argued that this finding is consistent with the interpretation that the income effect of inflation increases savings, the incomplete Fisher effect lowers the real cost of funds, and that bond price movements from inflation increase real corporate wealth, all leading to higher real investment, not lower. These mixed empirical results suggest that the relationship between inflation and investment is far from clear. In addition, all existing studies assume a linear relationship between inflation and investment. Thus, in the following (Section 5), this paper will precisely examine the relationship between investment and inflation by taking nonlinear effects into account.

3. Data and Summary Statistics

To investigate the inflation-growth relationship and further analyze the mechanism through which inflation affects long-run economic growth, two sets of data have been used. Both datasets were collected based on longitudinal availability.

The first dataset is based on the growth equation from the expenditure side[7] and includes 117 countries[8]: 90 developing countries and 27 developed countries. This dataset generally covers the period from 1961 to 2004. The second dataset is based on the growth accounting equation[9] and includes 90 countries: 63 developing countries and 27 developed countries. Based on the data availability,[10] the second dataset generally covers the period from 1961 to 1990 for developing countries and from 1961 to 2004 for developed countries. Data for a number of developing countries, however, have a shorter span. Because of the uneven coverage, the analysis is conducted by using unbalanced panels.

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[7] The growth expenditure function can be expressed as Y=C+I+G+NX, where Y denotes GDP growth rate, I denotes investment, G denotes government expenditure, and NX denotes the net import.

[8] See Appendix: Complete Country List for detail information.

[9] Growth accounting equation is based on the Cobb-Douglas production function $Y = AK^{\alpha}L^{\beta}$. Taking the log and then the derivatives on both sides of the production function, we can get the growth accounting equation: $g_Y = g_A + \alpha * g_K + \beta * g_L$, where g_Y denotes the growth rate of GDP, g_A denotes the growth rate of TFP (total factor productivity), g_K denotes the growth rate of capital stock, and g_L denotes the growth rate of labor.

[10] Since the data for total factor productivity (TFP) used in the growth accounting dataset cover a short span for developing countries, the data for developing countries generally cover the period from 1961 to 1990, while for developed countries generally cover the period from 1961 to 2004..

The data come primarily from the World Development Indicators (WDI) database. The two datasets share some data for the following variables: the growth rate of the real per capita GDP based on constant local currency, inflation computed as the growth rate of the CPI index[11], gross fixed capital formation (formerly gross domestic fixed investment) as a share of GDP. The first dataset also includes the following variables: the initial income level measured as the first year of GDP per capita in 2000 constant U.S. dollars during the five-year period, government consumption expenditure as a share of GDP, and the growth rate of income terms of trade. The second dataset additionally includes the following variables: the growth rate of the total factor productivity (TFP) and the growth rate of employment. For developing countries, the TFP is calculated by using a constant returns to scale Cobb-Douglas production function with imposed factor shares[12], while for developed countries, the growth rate of TFP is directly obtained from the Total Economy Database[13] and the Total Factor Productivity Measures for the G-7 Countries, provided by the Department of Economics at University of Glasgow. The growth rate of employment is derived from the total employment provided by the Total Economy Database.

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[11] In a few cases that the CPI index is not available, the data for the GDP deflator are used as inflation rates.

[12] Based on the Constant Return to Scale production function $Y = AK^{\alpha}L^{1-\alpha}$, the TFP growth rate for developing countries are calculated by using residual method, that is, *TFP Growth*= $g_Y - \alpha * g_K - (1-\alpha) * g_L$, where g_Y denotes the growth rate of GDP, g_K denotes the growth rate of total physical capital stock, and g_L denotes the growth rate of labor. In practice, we impose $\alpha = 0.4$; g_Y and g_L are calculated by using data from WDI and Total Economy Database, respectively; g_K is calculated based on the total physical capital stock provided by Nehru and Dhareshwar Database (1993). Since Nehru and Dhareshwar (1993)'s database covers the period until 1990, the accounting growth dataset for developing countries has a short time span from 1961 to 1990.

[13] The Total Economic Database is provided by the GGDC (Groningen Growth and Development Centre and The Conference Board).

In order to smooth out the business cycle fluctuations and focus on the medium- and long-term relationship between inflation and growth, the growth equation has been estimated by using five-year averages of the panel data based on the annual observations. Therefore, the time dimension is reduced to nine observations: 1961-65, 1966-70, 1971-75, 1976-1980, 1981-1985, 1986-1990, 1991-1995, 1996-2000, and 2001-04 (the last observation is an average over four observations only). Potentially, the dimension of the panel would be $117 \times 9 = 1053$ observations for the growth expenditure equation and $90 \times 9 = 810$ observations for the accounting growth equation. However, because of missing observations, the dimension of the unbalanced panel is a little smaller.

Table 2 and Table 3 present means and medians after sorting by inflation and creating quartile groups for the first and the second dataset, respectively. The first noteworthy feature is that the average inflation rate in the highest inflation quartile dramatically exceeds that in the rest of the sample. The second noteworthy feature is that as inflation rises across quartiles, the growth rates tend to fall from the second quartile and dramatically decease from the third to the fourth quartile. Moreover, the middle quartile groupings do not exhibit much difference in the growth rates, and we can observe that the growth rates even slightly increase from the first to the second quartile. Therefore, the evidence suggests a negative correlation between inflation and the growth rate. In addition, the data strongly suggest that the inflation-growth relationship may be nonlinear. Two structural break points are expected to exist in the inflation-growth relationship: one threshold inflation rate may occur between the first and the middle quartiles, ranging below or around 10%; the other may occur somewhere in the last quartiles.

We will now investigate the relationship between growth, investment/GDP, and TFP growth. The most striking point is that the TFP growth shows a similar pattern to that of the growth rates as inflation rises across quartiles. In particular, the TFP growth increases slightly from the first to the second quartile, then start falling and decrease dramatically from the third to the fourth quartile. Regarding to the level of investment, things seem to be different. The investment/GDP ration increases significantly from the first to the second quartile, and then keep steady or even still increases from the second to the third quartile, finally decreases significantly but not dramatically from the third to the fourth quartile. These preliminary examinations suggest that the TFP growth is more likely to be the channel through which inflation affects long-run economic growth. However, the level of investment works as a channel between inflation and economic growth only when inflation increases to extremely high.

4. Analysis of the Growth-Inflation Relationship

The preliminary examination in Section 3 suggests a negative relationship between inflation and growth. This relationship also might be nonlinear. In addition, two structural break points are expected to exist and can be roughly identified. To further explore the empirical association between inflation and growth, we carry out two types of regressions. First, to gauge the independent partial correlation between inflation and economic growth, we use simple linear regressions that control for other economic factors that may be associated with it. Second, we allow for two breaks in the relationship between inflation and growth. Such breaks might occur if the threshold effects are associated with the rate of inflation exceeding some critical level $Pistar2^*$ or being below some critical level $Pistar1^*$. In Section 4.1, we will focus on the simple linear regressions and then in Section 4.2, will discuss the regressions with two structural breaks. Again, two growth equations will be used in the following analyses in an attempt to test the robustness of the coefficient and threshold estimates.

4.1 Linear Estimate of the Growth Equation

The main objective of the simple linear regressions was to uncover the general shape of the growth function relating the inflation rate and economic growth. The following model was estimated:

$$growth_{it} = \beta_0 + \beta_1 * Inflation_{it} + \theta' * X_{it} + \eta_i + \nu_t + e_{it} \quad , \qquad (1)$$

where the dependent variable, $growth_{it}$, is the growth rate of the real per capita GDP, measured by constant local currency, and the explanatory variables include the constant (β_0), the inflation rate ($Inflation_{it}$) and a vector of the control variables (X_{it}), which depend on the specification of the growth equation. If the growth expenditure equation is used, then X_{it} includes the logarithm of the initial income per capita, the investment share of the GDP, the government consumption expenditure share of the GDP, and the growth rate of income terms of trade (TOT). The growth rates of the terms of trade (TOT) data were used as a control variable in order to eliminate the negative correlation between the growth and inflation caused by external supply shocks (Sarel, 1996). If the accounting growth equation is used, then X_{it} [14] includes the growth rate of the total factor productivity (TFP), the investment as a share of the GDP, and the growth rate of employment. η_i is a time-invariant country-specific intercept that captures omitted fixed effects, υ_t is a country-invariant time-specific intercept that captures omitted time effects, and u_{it} is the error term.. The index "i" is the cross-sectional index, and "t" is the time-series index.

Since panel estimation may be quite sensitive to the use of different estimation methods, equation (1) [15] is estimated by using different methods and control variables to test the robustness of the results. Table 4-1 and Table 5-1 provide the full-sample estimation results obtained from the fixed-effects method by using the growth expenditure equation and accounting growth equation, respectively. For the purpose of comparison, we also include the simple OLS estimation results in the first column of each table. In addition, developing countries and developed countries are estimated separately to see if any

[14] The human capital stock, which can be measured by the secondary school enrollment rate, the average years of secondary schooling of the total population etc., is an important explanatory variable in the growth accounting equation. However, the existing datasets for education, such as Barro-Lee dataset, Nehru and Dhareshwar's dataset, and World Development Indicators Dataset, cover only a short period of time for cross sectional countries. Therefore, we drop this control variable due to the data limitation.

[15] The equation (1) is also estimated by using Instrumental Variable (IV) estimation method to solve the possible endogeneity problem between inflation and economic growth. Two instrumental variables are used in IV estimation: lagged inflation rates and standard deviation of inflation, which is calculated as the square root of the average squared difference of the annual inflation rate from the five-year average mean. However, the comparison of the estimation results between the fixed-effects and 2SLS does not reveal a serious causation problem from inflation to growth, so that most of the estimated negative relation between inflation and growth does not represent a reversal of the short-term negative effects of growth on inflation. In addition, Durbin-Wu-Hausman tests also confirm this finding. The null hypothesis of no endogeneity cannot be rejected even at the 15 percent significance level. Since no major differences in the estimation results occur by using fixed-effects or 2SLS (IV) estimation, in the following, we present the fixed-effects estimation results only. The endogeneity problems for the other control variables, such as capital accumulation (INV), the growth rate of TFP, and the growth rate of employment, also might occur. We will address these endogeneity problems in the future research by using the prior or lag value of each endogenous variable.

significant difference exists in the growth-inflation relationship between developing countries and developed countries. The first columns of Table 4-2 and Table 5-2 provide the estimation results for developing countries, and the second columns are for developed countries.

The most striking point of the different estimations is that the coefficient of inflation is estimated to be significantly negative, and, in addition, the negative value is stable at -0.001 in all regressions by using a full sample. This finding suggests that an increase of 10 percentage points in the annual inflation rate will be associated with a decline of 0.01 percentage points in the annual growth rate of per capita GDP. Further investigation shows that the estimations using the sub-sample of developing countries do not show much difference from those using the full sample. However, the estimations of developed countries shown in the second columns of Table 4-2 and 5-2 consistently suggest that inflation in developed countries has a much more negative effect on economic growth than in developing countries. However, this relationship is not very significant in some cases.

Moreover, consistent with the existing literature, the investment as a share of GDP has a powerful positive effect on growth. The coefficient of the investment/GDP ratio is estimated to be significantly positive at a 1 percent significance level in all regressions. The data indicate that a 1-percentage-point increase in investment will cause a 0.16-0.20-percentage-point increase in growth. In addition, the results suggest that the effect of investment on economic growth is higher in developing countries and lower in developed countries. The growth rate of the TFP is another powerful variable which has a significant effect on growth. The data suggest that a 1-percentage-point increase in the growth rate of the TFP will cause around a 0.8-percentage-point increase in growth. Further investigation shows that the TFP growth has almost a one-for-one effect on growth in developed countries.[16]

The estimation results from the simple regression model (1) are, to some extent, consistent with the existing literature. The signs of the explanatory variables are exactly the same, whereas the coefficient of inflation estimated above (0.001) is much smaller than Barro's (1995) results (0.02-0.03). Because of the nonlinear features of the relationship between inflation and growth, the simple regression model could not account for the whole picture of the inflation-growth relationship. Sarel (1996) demonstrated that if the existence of the structural break is ignored, the estimated effect of higher rates of inflation on economic growth decreases by a factor of three. Taking the structural break into account in the next section, we expect to obtain a more reasonable and meaningful coefficient of inflation.

4.2 The nonlinear effects of inflation on growth

4.2.1 Nonlinear Model Specification

[16] This estimation results seem to support the specification of the accounting growth equation. However, on the other hand, this finding could come from the fact that the data of the growth rate of the TFP are derived as Solow Residues and based on a Cobb-Douglas production function, which imply the growth rate of TFP has a one-for-one effect on economic growth.

As discussed above, some theoretical models and empirical data predict that threshold effects are associated with a rate of inflation exceeding some "critical value" or below some "critical value." we now allow discrete slopes to differentiate high, middle and low rates of inflation. We then estimate the equation:

$$\begin{aligned} Growth_{it} &= \beta_0 + \beta_1 * Inflation * I(Inflation < Pistar1) \\ &+ \beta_2 * Inflation * I(Pistar1 \le Inflation \le Pistar2) \\ &+ \beta_3 * Inflation * I(Inflation > Pistar2) + \theta' X_{it} + \alpha' T_{it} + \lambda' N_{it} + e_{it} \end{aligned} \tag{2}$$

where the dependent variable $growth_{it}$ and the vector of control variables X_{it} are defined as the same as they are in Equation (1), and $Pistar1$ and $Pistar2$ are two threshold levels of inflation. $I(Inflation < Pistar1)$, $I(Pistar1 \le Inflation \le Pistar2)$ and $I(Inflation > Pistar2)$ are indicator functions which take the value of one if the term between parentheses is true, and are zero otherwise. This model specifies the effects of inflation with three coefficients: β_1, β_2 and β_3. β_1 denotes the effect of inflation below the first threshold level $Pistar1$, β_2 denotes the effect of inflation between $Pistar1$ and $Pistar2$, and β_3 denotes the effect of inflation exceeding the second threshold level $Pistar2$.Thus, the five-year average dataset is divided into three subsets: the low-, middle-, and high- inflation subsets. β_1, β_2 and β_3 present the effect of inflation on growth for each subset, respectively.

4.2.2 Estimation Method and Inference

1) Estimation Method

The fixed-effects estimation is used in order to control for the individual effects for each country and the time effects for each period. Therefore, time (T_{it} [17]) and country dummies (N_{it} [18]) are added to Equation (2). For any set of ($Pistar1$, $Pistar2$)[19], the Equation (2) is estimated by using the widely used fixed-effects estimation, which yields the error sum of squares (ESS) as a function of $Pistar$. The least squared estimate of $Pistar^*$ [20] is found by selecting the value of $Pistar$ which minimizes ESS, thus maximizing R^2 [21]. Stacking the observation in vectors yields the following compact notation for Equation (2):

$$growth_{it} = Z\gamma_{(Pistar)} + e \tag{3}$$

$$Pistar = (\underline{Pistar},......,\overline{Pistar}).$$

where $\gamma_{(Pistar)}$ =($\beta_0, \beta_1, \beta_2, \beta_3, \theta', \alpha', \lambda'$) is the vector of the parameters and Z is the corresponding matrix of observations on the explanatory variables. Note that the coefficient vector $\gamma_{(Pistar)}$ is indexed by $Pistar$ to show its dependence on the threshold

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[17] $T_{it} = \begin{cases} 1, period_{it} = t \\ 0, otherwise \end{cases}$, where T_{it} denotes the time dummies. $period_{it}$ denotes the nine periods from 1961-65 to 2001-04, each of which is assigned a number from 1 to 9. For example, number 1 denotes the period 1961-65, 2 denotes the period 1966-1970 and so on. The time dummy T_{it} is equal to 1 when $period_{it}$ equals t, and is zero otherwise. In such a way, a time dummy T_{it} carries the information for the period t.

[18] $N_{it} = \begin{cases} 1, country_{it} = i \\ 0, otherwise \end{cases}$, where N_{it} denotes the country dummies. $country_{it}$ is assigned a number from 1 to the total number of countries. This number would differ if different growth equations were used. The country dummy N_{it} equals 1 when $country_{it}$ equals i and is zero otherwise. In such a way, a country dummy N_{it} will carry the information for the country indexed by i.To avoid multicollinearity, We drop one time dummy and one country dummy in the fixed-effects estimation.

[19] In the following, the $Pistar$ is used to denote the vector of ($Pistar1$, $Pistar2$).

[20] The $Pistar^*$ denotes the vector of ($Pistar1^*$, $Pistar2^*$).

[21] The estimation technique for the pair of ($Pistar1^*$, $Pistar2^*$) is based on the idea presented by Khan and Senhaji (2001).

levels of inflation, the range of which is given by $\underline{Pistar}$ and $\overline{Pistar}$. Define $ESS(Pistar)$ as the error sum of squares with the threshold level fixed at $Pistar$. Then, the threshold estimates $Pistar^*$ are chosen by minimizing $ESS(Pistar)$ that is

$$Pistar^* = \underset{(Pistar)}{\arg\min} \{ESS(Pistar)\}$$

$$Pistar = (\underline{Pistar},......,\overline{Pistar}). \tag{4}$$

2) Inference

It is important to determine whether the threshold effect is statistically significant. The hypothesis of no threshold effect in (2) can be represented by the linear constraint $H_0 : \beta_1 = \beta_2 = \beta_3$ .Under the null hypothesis, the thresholds $Pistar^*$ are not identified, so classical tests, such as the Wald-test and Likelihood Ratio (LR) test, have nonstandard distributions. Since the original model (1) could have no thresholds, one threshold or two thresholds, Hansen (1996, 1999) suggested a bootstrapping method with two steps to test the significance of the existence of two thresholds.

The first step is to test the null hypothesis of no threshold against the alternative of one threshold. The test proceeds as follows:

♦ First, estimate the Equation (1) with one threshold (π^*), that is, the following equation:

$$Growth_{it} = \begin{matrix} \varphi_0 + \varphi_1 * Inflation * I(Inflation \le \pi^*) \\ + \varphi_2 * Inflation * I(Inflation > \pi^*) + \theta' X_{it} + \alpha' T_{it} + \lambda' N_{it} + e_{it} \end{matrix}. \tag{5}$$

♦ Second, estimate π^* by using the same techniques discussed above.

♦ Finally, carry out a significance test of no threshold against one threshold π^* by using a bootstrap method to simulate the asymptotic distributions of the following likelihood ratio test of $H_0 : \varphi_1 = \varphi_2$

$$LR_1 = (S_0 - S_1) / \hat{\sigma}^2 , \tag{6}$$

where S_0, and S_1 are the error sum of squares under $H_0 : \varphi_1 = \varphi_2$, and $H_1 : \varphi_1 \neq \varphi_2$, respectively; and $\hat{\sigma}^2$ is the residual variance under H_1. In other words, S_0, and S_1 are the residual sum of squares for equation (1) without and with one threshold, respectively. The asymptotic distribution of LR_1 is nonstandard and strictly dominated the χ^2 distribution. In particular, the distribution of LR_1 depends in general on the moments of the sample; thus critical values cannot be tabulated. Hansen (1999) showed how to bootstrap the distribution of LR_1.

If in the first step, we rejects the null of no threshold, then the second step is to test one versus two thresholds based on Equations (5) and (2) by using the following approximate likelihood ratio test

$$LR_2 = (S_1 - S_2) / \hat{\sigma}^2 , \tag{7}$$

where S_1 and S_2 are the minimizing sum of squared errors under $H_0 : \mathit{OneThreshold}$ (Equation 5), and $H_1 : \mathit{TwoThresholds}$ (Equation 2), respectively; and $\hat{\sigma}^2$ is the residual variance under H_1. In other words, S_1 and S_2 are the minimizing residual sum of squares for (1) with one threshold (Equation 5) and two thresholds (equation 2), respectively. Again, the null asymptotic distribution of the likelihood ratio test is non-pivotal, Hansen (1999) suggested using the same bootstrap procedure as in the first step to approximate the sampling distribution.

3) Confidence Intervals

Another interesting question is whether an inflation threshold, for example, of 10 percent is significantly different from a threshold of 8 percent or 15 percent. In other words, can the concept of confidence intervals be generalized to threshold estimates? Hansen (1999) suggested that the best way to form confidence intervals for *Pistar* is to form the "no-rejection region" using the likelihood ratio statistic for tests on *Pistar*. To test the hypothesis $H_0 : Pistar^* = Pistar$, the likelihood ratio test is to reject for large values of $LR(Pistar^*)$, where $Pistar$ is the true value of $Pistar^*$;

$$LR(Pistar^*) = (S_2(Pistar) - S_2(Pistar^*)) / \hat{\sigma}^2 . \qquad (8)$$

Hansen (1999) showed that the asymptotic distribution of the likelihood ratio statistics $LR(Pistar^*)$ is non-standard yet free of nuisance parameters. In addition, Hansen (1999) formed asymptotic confidence intervals by using the inverse of the asymptotic distribution function of $LR(Pistar^*)$:

$$c(\alpha) = -2\log(1 - \sqrt{1-\alpha}) . \qquad (9)$$

In such a way, it is easy to calculate critical values. For example, the 10% critical value is 6.53, the 5% is 7.35 and the 1% is 10.59. A test of $H_0 : Pistar^* = Pistar$ rejects at the asymptotic level α if $LR(Pistar^*)$ exceeds $c(\alpha)$. To form an asymptotic confidence interval for $Pistar^*$, the "no-reject region" of confidence level $1-\alpha$ is the set of values of $Pistar^*$ such that $LR(Pistar^*) \le c(\alpha)$.

4.2.3 Estimation and Inference Results

1) Test for the Existence of Threshold Effects

The existence of two thresholds in the relationship between growth and inflation is tested by using the two-step method proposed by Hansen (1999). This process involves estimating Equation (2) and computing the sum of the square of errors (SSE) for threshold levels of inflation ranging from $\underline{Pistar}$ to $\overline{Pistar}$. The threshold estimate is the one that minimizes the sequence of ESSs. The test for the existence of threshold effects has been conducted by using the full sample and two sub-samples (developing countries and developed countries). The results are summarized in Table 6.

The second column of Table 6 gives the range over which the search for the threshold effect is conducted. For the full sample, ($\underline{Pistar1}$, $\overline{Pistar1}$) = (1%, 20%), ($\underline{Pistar2}$, $\overline{Pistar2}$) = (25%, 70%), and the increment for each threshold level is 1 percent. The minimization of the vector or ESSs occurs, in most cases, at the threshold point (14%, 38%). Repeating the same procedure for the sub-samples yields a threshold estimate of (14%, 38%) for developing countries and (5%, 24%) for developed countries. Note that both thresholds for developed countries are much lower than those for developing countries. The column LR_1 and LR_2 give the observed value of the likelihood ratios for testing the hypotheses of no threshold against one threshold and one threshold against two thresholds respectively. The significance levels followed by LR_1 and LR_2 have been computed by using the bootstrap distributions (corresponding to the three samples) of LR_1 and LR_2, respectively. The null hypothesis of no threshold effects can be rejected, at least at a 5 percent significance level for all three samples. Thus, the data strongly support the existence of threshold effects. The further test of one threshold against two thresholds can be rejected at a 10% significance level for developing countries. However, for the developed countries, this hypothesis cannot be rejected even at the 15% significance level. If we also take into account the great differences in the threshold estimates for developing and developed countries, we can conclude that developing and developed countries have significant differences in the growth-inflation relationship. Thus, in the following, developed countries and developing countries will be analyzed separately.

2) Confidence Intervals

In the previous sub-section, we found the existence of threshold effects for all three samples; now we will determine how precise these estimates are. This determination requires the computation of the confidence region around the threshold estimates. While the existence of threshold effects in the relationship between inflation and growth is well accepted, the precise level of the inflation threshold is still subject to debate. Indeed, as discussed earlier, based on existing studies, the range for the first threshold could be between 2.5 percent and 40 percent. If the confidence region shows that the threshold estimate is not significantly different from a large number of other potential threshold levels, the implication is that substantial uncertainty exists about the threshold level. Interestingly, the confidence intervals for the estimated thresholds shown in Table 6 are all proved to be tight[22] except for the first threshold for developed countries. This finding implies the thresholds, which significantly exist, are precisely estimated.

[22] Indeed, the 95 percent confidence intervals for the whole sample (two thresholds), developing countries (two

3) Estimation Results

Table 7 and Table 8 present the estimation results of Equation (2) with the estimated threshold *Pistar** by using the growth expenditure equation and the growth accounting equation, respectively. In addition, Equation (5), which contains only one threshold, is estimated for developed countries since the hypothesis of one threshold against two thresholds can not be rejected at a 15% significance level. Each table includes three columns[23], which present the estimation results for the full sample, developing countries, and developed countries, respectively. Table 7 and Table 8 reveal that the coefficients of inflation have different signs and significances across the low-, moderate- and high-inflation groups. However, developing countries and developed countries show significantly different patterns across the three inflation groups.

Let us first look at the developing countries. The estimation results are presented in the second column of Table 7 and Table 8. An interesting finding is that for the low-inflation group (in which five-year average inflation rate is below 14% per year）, the coefficient of inflation (β_1) is strongly positive in all regressions. This result shows that a 1-percentage-point increase in inflation will cause a 0.02-0.14-percentage-point increase in economic growth. However, this positive relationship is not significant in all cases. In the middle-inflation group, which contains the observations for the groups with inflation rates between 14% and 38%, the coefficient of inflation is significantly negative at a 1 percent level in all regressions. The data also suggest that an increase in average inflation

thresholds), and developed countries (one threshold), are all in the range between the estimated thresholds minus 1.0 and those plus 1.0.

[23] The last column for developed countries is extended to provide the estimation results with one threshold.

by 10 percentage points per year is associated with a reduction of the growth rate of the real per capita GDP by 0.2-0.4 percentage points.[24] In the extremely high inflation group, which has the observations with inflation rates exceeding 38%, the coefficient of inflation is still significantly negative at the 1 percent level. However, this negative effect is much smaller than that in the middle-inflation group. A 10-percentage-point increase in the inflation rate will cause only a 0.01[25]-percentage-point decrease in the economic growth rate.

The two threshold inflation levels divide the axes of inflation into three parts. As inflation rises from zero percent, first, the effect on economic growth is obscure or even positive. As inflation rises up to 14 percent per year, the obscure effect changes into a significantly negative one. Although the coefficient of inflation is estimated to be in the range of -0.02 to -0.04, which seems small, the long-term effects on standards of living are substantial. Barro (1995) estimated that a shift in monetary policy that raises the long-term average inflation by 10 percentage points per year lowers the level of the real GDP after 30 years by 4-7%. Therefore, moderate inflation in the long run is very harmful to economies. As inflation continues to increase over the second threshold, the marginal adverse impact of inflation on growth diminishes rapidly. The coefficient estimate of inflation is still significant, but the value reduces to -0.001 (versus -0.04). The smaller negative coefficient illustrates that the inflation-growth relation flattens when the economy has extremely high inflation. Intuitively, we can say that once inflation exceeds a threshold

[24] This estimation result is consistent with the empirical results presented by Barro (1995).
[25] This estimated coefficient (0.001) is the same as the coefficient of inflation estimated from the simple linear regression model because a regression of the real GDP growth rate on the level of inflation would give much weight to the extreme inflation observations.

level, all of the damage to the financial system has already been done, and then perfect foresight dynamics come into being. When these occur, further increases in inflation have no additional detrimental effects on economic growth.

Next, we will look at the estimation results for the developed countries. The third column of Table 7 and Table 8 present those results. The most striking difference between developing countries and developed countries is that the coefficients of inflation are all significantly negative for all inflation groups, while for developing countries, as we discussed above, the coefficient of inflation is positive for the low inflation group. Indeed, this finding suggests that the first threshold, under which inflation has either no significant or even a positive effect on growth and above which inflation has a significantly negative effect on growth, does not exist for developed countries at all. Khan and Senhaji (2001) estimated this threshold for industrial countries at 1 percent and further presented the confidence interval [0.89, 1.11] for this threshold. However, even by extending the searching range for the first threshold from [1%,….., 15%] to [0.1%,…,15%], we do not find the threshold suggested by Khan and Senhaji (2001).

However, the second threshold, which is estimated at 24%, is very significant and robust to the model specifications. Further investigation shows that in developed countries, low to moderate inflation has a very significant adverse effect on economic growth. In particular, the coefficient of inflation is estimated to be in the range of 0.08 to 0.15. It suggests that an increase in average inflation by 10 percentage points per year is associated with a reduction of the growth rate of the real per capita GDP by 0.5-1..6

percentage points. This negative effect of moderate inflation on growth is much greater than that in developing countries. As the inflation rate exceeds the second threshold, developed countries show a similar pattern to that of developing countries: the negative effect of inflation is still significant, but the marginal effect of inflation on growth diminishes dramatically. A 10-percent- point increase in the inflation rate will cause only a 0.02-0.08-percentage-point decrease in the economic growth rate.

Essentially, the comparisons between the results from the developed and developing countries suggest two important points. First, the developed countries seem to show a different form of nonlinearity in the inflation-growth effect. That is, the magnitude of the negative effect of inflation on growth declines as the inflation rate increases. Such nonlinearity was noted by Chari et al. (1996) in their models and was also present in the model of Gillman and Kejak (2000a). Moreover, Gillman and Kejak (2000b) presented a micro-foundation based explanation for this form of nonlinearity. Second, inflation has a greater adverse effect on economic growth in developed countries than in developing countries. Many possible explanations might be made for this difference. Here, we just explore some of them. First, the long history of inflation in many developing countries led them to adopt widespread indexation systems to negate, at least partially, the adverse effects of inflation. Once in place, these indexation mechanisms enable the governments in these countries to run higher rates of inflation without experiencing adverse growth effects (because relative prices do not change much). This statement is also confirmed by our previous finding that in developing countries, inflation starts significantly affecting economic growth only as the inflation rate rises up to 14 percent per year. Second, to the extent that inflation is viewed as a tax on financial intermediation, governments in developing countries, when faced with a target level of expenditure, will levy the inflation tax in the absence of conventional taxes. Thus, while relatively small increases in inflation in developed countries adversely affect investment (by raising the effective cost of capital goods), productivity, and growth, in developing countries, with relatively low levels of conventional taxes, the small increases in inflation has much less effect on investment, productivity and growth.

5. Analysis of the Transmission Mechanisms between Inflation and Growth

As we mentioned in Section 2 of the literature review, the theoretical literature has suggested that the level of capital accumulation might be the channel from inflation to real economic growth. In addition, the preliminary examinations in Section 3 show that the efficiency of investment, which is measured as the growth rate of the TFP, shows a similar pattern to that of the growth rates as inflation rises across quartiles. Therefore, in the following, this paper will focus on the inflation-investment/GDP and inflation-TFP growth relationships in an attempt to find the transmission mechanism through which inflation adversely affects growth in a nonlinear fashion.

5.1 Linear Analysis

The analysis is based on a dynamic equation that includes the inflation rates along with a set of time and fixed-effects dummy variables. The linear model specifications[26] are shown as follows.

$$INV_{it} = \beta_0 + \beta_1 * Inflation_{it} + \beta_2 * INV_{i,t-1} + \eta_i + \upsilon_t + u_{it} \quad (10)$$

$$TFP_{it} = \beta_0 + \beta_1 * Inflation_{it} + \beta_2 * TFP_{i,t-1} + \eta_i + \upsilon_t + u_{it} \quad (11)$$

where the dependent variable INV_{it} in Equation (10) is the gross fixed capital accumulation as a share of GDP, and $INV_{i,t-1}$, the first lag of INV_{it} , is included to control the economic conditions in the last period. In Equation (11), the dependent variable TFP_{it} is the growth rate of the Total Factor Productivity (TFP), and $TFP_{i,t-1}$, the first lag of TFP_{it} , is included to control the trend of the TFP growth rate. In both equations, η_i is a time-invariant country-specific intercept that captures omitted fixed effects, υ_t is a country-invariant time-specific intercept that captures omitted time effects, and u_{it} is the error term.

Table 9 and Table 10 present the estimated coefficients of inflation by estimating Equation (10) and (11), respectively. Each table includes three columns, which present the estimation results for the full sample, developing countries, and developed countries, respectively. OLS and fixed-effects estimation are both applied to test the robustness of the results. The evidence shown in Table 9 suggests that inflation has a significantly negative effect on the Investment/GDP ratio only for the full sample and the sub-sample

[26] Ramsey RESET specification tests suggest that the model (10) and (11) are appropriate at a 5 percent significance level.

of developing countries. In particular, a 10-percent-point increase in the inflation rate will cause a 0.01 percentage-point decrease in the investment/GDP ratio in developing countries. However, for the sub-sample of developed countries, the effect of inflation on the investment/GDP ratio is not significant in all regressions. Since we have found a significantly negative effect of inflation on economic growth for developed countries in section 4, this finding actually does not support the belief that the level of investment has a transmission role.

The results of further investigation into the relationship between inflation and the TFP growth are shown in Table 10. The evidence suggests that inflation has a significantly negative effect on the TFP growth for the full sample and the two sub-samples. A 10-percent-point increase in the inflation rate will cause a 0.01-percentage-point decrease in the TFP growth in developing countries, while in developed countries, this increase will cause about a 0.06-0.16-percentage point decease in the TFP growth. Thus, the magnitude of the adverse effect of inflation on the TFP growth is greater in developed countries than in developing countries. Since the previous estimations (Section 4) also show that inflation in developed countries has a much more negative effect on economic growth than in developing countries, this finding, to some extent, supports the argument that the TFP growth is a channel through which inflation can adversely affect economic growth.

The preliminary linear analysis of the inflation-investment/GDP and inflation-TFP growth relationships suggests that developed countries and developing countries might have different transmission mechanisms between inflation and economic growth. The evidence shows that for developing countries, inflation probably affects economic growth through the level of investment and also the TFP growth, while, for developed countries, inflation probably affects economic growth only through the TFP growth since we have not found any significant relationship between inflation and the investment/GDP ratio. However, this linear analysis may not be reliable since we have detected a nonlinear effect in both the inflation-investment/GDP and the inflation-TFP growth relationships in Section 3 (Summary Statistics). Therefore, in the next subsection, this paper will further estimate these relationships with threshold effects by using the same techniques described in Section 4.2.2.

5.2 Analysis with Threshold Effects

Table 11 presents the estimation results of the inflation-investment relationship with threshold effects. By estimating Equation (10) by using the fixed-effects estimation method, two thresholds are estimated at (13%, 65%) for the full sample, (11%, 65%) for the sub-sample of developing countries, and (13%, 42%) for the sub-sample of developed countries. Furthermore, the approximate likelihood ratio tests using bootstrap distribution suggest that the model (10) with two thresholds is preferred to that with only one threshold, at least, at the 10 percent significance level (in most cases, at the 1 percent significance level). In other words, the estimated thresholds shown in Table 11 are statistically significant at the 10 percent level.

As shown in Table 11, for the full sample and two sub-samples, the coefficients and significances of inflation are different across the low-, moderate- and high inflation groups. The most surprising finding is that, for the full sample and two sub-samples, the coefficients of inflation are significantly positive in the first two inflation groups. In addition, for both developing and developed counties, the magnitudes of these positive effects diminish as inflation increases. However, as inflation rates exceed the second threshold level, the effect of inflation on the level of investment shows different patterns for two sub-samples: for developing countries, the effect of inflation converts to be significantly negative with a small magnitude, while for developed countries, the effect of inflation is still positive but becomes insignificant. Essentially, the evidence suggests that only for developing counties and during a period of high inflation (above 65 percent), will the level of investment be adversely affected by inflation. Indeed, these estimation results do not support those from the existing theoretical models, which suggest that inflation adversely affects long-term economic performance by adversely affecting capital accumulation. However, this surprising finding is consistent with the results proposed by McClain and Nichols (1994), who used recent developed time series techniques to test for a long-term relationship between inflation and investment by using U.S. time series data from 1929 to 1987.

Table 12 presents the estimation results of the inflation-TFP relationship with the threshold effects for the full sample (first column) and the two sub-samples (second and third columns). The second column of this table shows the estimation results for the sub-sample of developing countries. It shows that, as inflation rises across inflation groups, the TFP growth shows a similar pattern to that of the growth rate: the effect of inflation on the TFP growth is insignificant and even positive at low inflation, significantly negative with a large magnitude (around 0.05) at moderate inflation, and still significantly negative but with a very small magnitude (0.001) at high inflation. In addition, the approximate likelihood ratio test using bootstrap distribution rejects the null hypothesis of one threshold against two thresholds at the 15 percent significance level. This evidence strongly supports that for developing countries, the TFP growth is a channel between inflation and growth.

For the sub-sample of developed countries, the coefficients of inflation are all significantly negative across the three inflation groups. However, the magnitude of this negative effect of inflation on the TFP growth rate declines as the inflation rate increases: at low inflation, which is below 5%, the coefficient of inflation is estimated to be at 0.24-0.26; at moderate inflation, which is between 5% and 21%, the coefficient of inflation is estimated to be around 0.1; while, as inflation exceeds the second threshold of 21%, the negative effect of inflation on the TFP growth is still significant, but the marginal effect diminishes dramatically: only a 0.10-0.15 percentage point reduction in the TFP growth is associated with a 10 percentage point increase in inflation. Essentially, this pattern is exactly the same as that of economic growth in response to inflation increases (which we discussed in Section 4). Therefore, the evidence strongly suggests that, as we concluded for developing countries, the TFP growth is also the channel through which inflation adversely affects economic growth in developed countries.

5.3 Conclusions

The interesting finding in this section is that, for both developing and developed countries, inflation has a much more negative impact on the efficiency of investment than on the level of investment. In addition, further investigation reveals that the TFP growth shows a similar pattern to that of the growth rate as inflation rises. Basically, these findings suggest that the TFP growth (the measure of the efficiency of investment), but not the investment/GDP (the measure of the level of investment), is the effective channel through which inflation adversely and nonlinearly affects economic growth. The negative effect of inflation works through the investment/GDP ratio only for developing countries and during a period of high inflation (above 65%).

Moreover, at low to moderate inflation, specifically, below 65% for developing countries and below 42% for developed countries, inflation even has a significantly positive effect on the level of investment. This finding might be explained by the same reasons used to explain the Mundell-Tobin effect. That is, higher inflation reduces the rate of return received by savers in all financial markets and consequently increases capital accumulation. Another explanation could be that investment responds slowly to inflation due to the uncertainty and loss of credibility created by the previous inflation. Therefore, it is hard to find the negative effect of inflation on investment by regressing the investment/GDP ratio on the contemporaneous inflation rate. This slower response of investment compared to growth was also noted by Bruno and Easterly (1998), Pindyck and Solimano (1993), and Serven and Solimano (1993). Blomstrom et al. (1996) further suggested that investment follows growth rather than the other way around.

6. Conclusions and Possible Future Research

6.1 Conclusions

The first part of the paper examined the impacts of the inflation rate on economic performance in both developing countries and developed countries, by using the growth expenditure equation and the growth accounting equation. The results strongly and consistently supported the existence of a nonlinear relationship between inflation and growth. In addition, developing counties and developed countries show significantly different forms of nonlinearity in the inflation-growth relationship. In particular, for the developing countries, the data suggested that two thresholds exist in the function relating economic growth and inflation. The first threshold level was estimated to be 14 percent, and the second threshold was estimated to be 38 percent. At the rates of inflation lower than those of the first threshold, the effect of inflation on economic growth is obscure and even positive; at moderate rates of inflation, which are between the two threshold levels, the effect of inflation is significant and strongly negative; at extremely high rates of inflation, the marginal impact of additional inflation on economic growth diminishes rapidly but is still significantly negative. For the developed countries, only one threshold is detected and proved to be significant. This threshold is estimated at 24 percent, which is robust to model specifications and estimation methods. This unique threshold for developed countries works in the same way as the second threshold for the developing countries, that is, at the rates of inflation below this threshold (24%), inflation has a significantly negative effect on economic growth, while the magnitude of this negative effect diminishes dramatically as inflation exceeds this threshold.

The existing literature emphasized only one threshold level (beyond which inflation impedes growth, but below which inflation has no significant or even positive effects on growth), whereas this paper detected a second threshold level (above which a large discrete drop in the marginal effects of inflation occurs) for both developed and developing countries. In addition, this paper further suggested that developed countries have a different form of nonlinearity from developing countries in the inflation-growth relationship.

These findings provide some strong policy implications. For developing counties, first, the marginal negative effect of moderate inflation in the range of 14 to 38 percent is pronounced. An increase in inflation by 10 percentage points per year will reduce economic growth by about 0.2-0.4 percentage points. This adverse influence of moderate inflation on growth will lead to a substantial negative effect on economies in the long term. Second, policymakers should not exert efforts to keep the inflation rate at zero percent since single-digit inflation (below the first threshold of 14%) does not impede and can even stimulate economic performance. Third, hyperinflation does not have hyper-negative effects on economic growth because the marginal impact of hyperinflation is much lower than that of moderate inflation. Empirically, we can observe that reductions in the hyperinflation rate have never had significant effects on economic growth. Therefore, controlling moderate inflation should be the main goal for policymakers in developing countries.

Since the developed countries show a different pattern of nonlinearity in the inflation-growth relationship: the magnitude of the negative effect of inflation on growth declines as the inflation rate increases, and even the low level inflation rate has a strong negative effect on economic growth, policymakers in developed countries, unlike those in developing countries, should exert efforts to keep the inflation rate at zero percent since a small amount of increase in inflation will cause a significant reduction in economic growth. This finding, to some extent, supports the inflation-targeting monetary policy adopted by New Zealand, Canada, the United Kingdom, and some other countries.

The second part of this paper attempted to find the mechanism through which inflation affects long-run economic growth in a nonlinear fashion. Two possible channels, the level of investment and the efficiency of investment, were examined by using the linear model and the model with threshold effects. The interesting finding is that, for both developing and developed countries, the TFP growth, but not the level of investment (Investment/GDP), which is the channel, hypothesized by existing theoretical models, is the channel through which inflation adversely and nonlinearly affects economic growth. Moreover, at low to moderate inflation, specifically, below 65% for developing countries and below 42% for developed countries, inflation even has a significantly positive effect on the level of investment.

Most existing studies emphasize the transmission role of the level of investment (capital accumulation) between inflation and long-run economic growth. However, few studies deal with the impact of inflation on the efficiency of investment (the TFP growth) and its transmission role in the inflation-growth relationship. Thus, one of this paper's contributions is to detect that the TFP growth is an important channel, actually the only channel for developed countries, through which inflation affects long-run economic growth in a nonlinear fashion.

6.2 Possible Future Research on the Second Topic

The finding of a positive correlation between inflation and the level of investment is inconsistent with theoretical models and Barro (1995)'s finding that an increase in average inflation by 10 percentage points per year results in a decrease in the ratio of investment to GDP by 0.4-0.6 percentage points. Therefore, further research might concentrate on the issue of the sluggish response of investment to inflation in attempt to reconcile the mixed empirical findings. Time series analysis techniques can be used to examine the nature of the statistical causality between the level of capital accumulation, inflation, and economic growth. In particular, multivariate vector-autoregressive (VAR), which allows for dynamic interactions among these variables, could be a good choice for examining the long-term cumulative effects of inflation on the level of capital accumulation. Since the long-term effect of inflation might be completely different from the short-term contemporaneous effects, some interesting findings might be found.

Our baseline VAR in levels takes the forms as follows:

$$Inflation_t = \alpha_{1,0} + \sum_{i=1}^{k} \alpha_{1,i} Inflation_{t-i} + \sum_{i=1}^{k} \beta_{1,i} Inv_{t-i} + \sum_{i=1}^{k} \gamma_{1,i} Growth_{t-i} + \mu_{1,t}, \quad (12)$$

$$Inv_t = \alpha_{2,0} + \sum_{i=1}^{k} \alpha_{2,i} Inflation_{t-i} + \sum_{i=1}^{k} \beta_{2,i} Inv_{t-i} + \sum_{i=1}^{k} \gamma_{2,i} Growth_{t-i} + \mu_{2,t}, \quad (13)$$

$$Growth_t = \alpha_{3,0} + \sum_{i=1}^{k} \alpha_{3,i} Inflation_{t-i} + \sum_{i=1}^{k} \beta_{3,i} Inv_{t-i} + \sum_{i=1}^{k} \gamma_{3,i} Growth_{t-i} + \mu_{3,t}, \quad (14)$$

where $Inflation$, Inv and $Growth$ are defined as the same as in previous sections, and k is the lag order as selected by Schwarz's Bayesian Criterion (SBC) and Akaike Information Criterion (AIC). Techniques for time series analysis, such as the Augmented Dickey Fuller (ADF) and Phillips & Perron (PP) tests for testing stationarity (unit roots), the Johansen (1991) test for cointegration, and, if necessary, the Vector Error Correction Model (VECM), will be used to precisely analyze this trivariate VAR model.

This VAR framework has the following advantages as compared to the existing cross-sectional and panel data analysis. First, this framework allows for different economic and institutional arrangements in each country. Second, this framework can deal with the simultaneity problem between capital accumulation and economic growth, thus avoiding the difficult task of determining which variables are truly exogenous. Third, this framework allows us to identify not only the short-term effects but also the long-term cumulative effects of inflation on capital accumulation and economic growth by allowing for interactions among these variables, including both the contemporaneous correlation and the dynamic feedback. The third advantage is really important to our analysis since investment might have a sluggish response to inflation, as suggested in the preliminary examinations in Section 5.

However, the research to date has not applied the VAR framework to analyze the transmission mechanism between inflation and economic growth. Future analysis will use quarterly data and take a **country-by-country approach** so that the channels between inflation and growth could be elucidated more clearly than might be possible in a cross-country framework where implicit homogeneity restrictions are usually imposed (Demetriades and Husein, 1996).

Table 1. Decadal Summary Statistics on Inflation, Growth (Annual Observations)

Variable	Mean	Median	Number of Countries	Number of Observations
1960-1969				
Inflation Rate	13.155	2.611	60	461
Growth Rate	2.824	8.819	60	461
1970-1979				
Inflation Rate	15.311	9.199	105	1019
Growth Rate	2.475	2.256	105	1019
1980-1989				
Inflation Rate	54.548	10.317	121	1159
Growth Rate	0.712	1.1039	121	1159
1990-1999				
Inflation Rate	126.867	8.971	146	1419
Growth Rate	0.719	1.384	146	1419
2000-2002				
Inflation Rate	11.269	4.226	146	437
Growth Rate	2.111	2.018	146	437

Notes: The inflation rate is computed on an annual basis for each country from data on consumer price indexes (from the World Bank, WDI database). The values shown for inflation and growth in this table are the mean or median across the countries of the decade-average inflation rates and growth rates.

Table 2. Quartile Averages Dataset Sorted by Inflation Means (Growth Expenditure Equation)

		Inflation	Growth	Investment	Initial Income	Gov	TOT	N
Full Sample	Median	7.62	1.83	21.11	1670	14.33	5.31	844
	Mean	37.84	1.86	21.25	5794	15.25	7.71	
First Quartile	Median	2.02	1.97	20.20	3365	15.41	4.95	211
	Mean	1.80	2.04	20.97	9970	15.96	10.89	
Second Quartile	median	5.35	2.18	22.20	2644	15.91	5.43	211
	mean	5.44	2.56	22.57	6485	15.87	7.77	
Third Quartile	median	10.39	2.19	22.12	1275	14.30	5.07	211
	mean	10.54	2.25	22.32	4045	15.64	6.04	
Fourth Quartile	Median	23.25	0.65	19.32	1302	12.48	5.90	211
	Mean	133.59	0.60	19.13	2674	13.54	6.16	

Table 3. Quartile Averages Dataset Sorted by Inflation Rates (Growth Accounting Equation)

		Inflation	Growth	TFP Growth	Investment	g(L)	N
Full	median	7.963	2.035	0.804	20.834	2.413	511
	mean	38.346	1.989	0.650	20.706	2.189	
First	median	2.119	2.525	1.204	20.052	2.229	128
	mean	1.861	2.646	1.089	20.093	2.115	
Second	median	5.281	2.272	1.012	21.742	1.851	127
	mean	5.501	2.671	1.183	21.788	1.815	
Third	median	10.772	2.363	0.752	22.457	2.657	127
	mean	10.915	2.261	0.567	22.390	2.400	
Fourth	median	23.261	0.489	0.111	19.168	2.510	129
	mean	133.889	0.399	-0.228	18.590	2.423	

Notes: Growth=the five-average growth rate of GDP per capita, Investment=Investment/GDP ratio, Gov=government consumption expenditure as a share of GDP, TOT=the growth rate of income terms of trade, g(L)= the growth rate of employment. The number of observations for the whole dataset and each quartile are shown in the last column "N".

Table 4-1 Linear Estimation Results with Growth Exp. Equation (Full Sample)

Explanatory Variables	OLS	OLS with Fixed Effects		
Country Dummies	No	No	Yes	Yes
Time Dummies	No	Yes	No	Yes
Inflation	-0.002*	-0.001*	-0.001*	-0.001*
	(-9.855)	(-10.630)	(-4.067)	(-4.169)
Investment	0.182*	0.190*	0.181*	0.194*
	(7.833)	(8.063)	(8.115)	(8.730)
log(Initial Income)	0.101	0.050	-3.120*	-3.643*
	(1.334)	(0.655)	(-9.079)	(-8.585)
Government Exp.	-0.074*	-0.048*	-0.111*	-0.066***
	(-3.452)	(-2.357)	(-3.283)	(-1.923)
Growth Rate of Terms of Trade	0.004	0.004	0.005*	0.005*
	(1.394)	(1.725)	(2.777)	(3.276)
R Square Adjusted	0.187	0.246	0.330	0.369
No. of Countries	117	117	117	117
No. of Observations	819	819	819	819

Table 5-1Linear Estimation Results with Growth Accounting Equation (Full Sample)

Explanatory Variables	OLS	OLS with Fixed Effects		
Country Dummies	No	Yes	No	Yes
Time Dummies	No	No	Yes	Yes
Inflation	-0.001*	-0.001*	-0.001*	-0.001*
	(-3.362)	(-3.543)	(-2.928)	(-2.511)
TFP	0.855*	0.885*	0.819*	0.840*
	(6.421)	(10.050)	(5.599)	(8.392)
INV	0.162*	0.198*	0.165*	0.203*
	(10.040)	(6.153)	(8.482)	(5.399)
g(L)	0.369*	0.422*	0.347*	0.392*
	(5.244)	(5.323)	(4.431)	(4.524)
R Square Adjusted	0.649	0.715	0.656	0.721
No. of Countries	90	90	90	90
No. of Observations	511	511	511	511

Table 4-2 Linear Estimation Results for Growth Expenditure Equation

(Developing Countries and Developed Countries)

	Developing Countries (90)				Developed Countries (27)			
Estimation Method	Simple OLS	OLS with Fixed Effects			Simple OLS	OLS with Fixed Effects		
Country Dummies	No	No	Yes	Yes	No	No	Yes	Yes
Time Dummies	No	Yes	No	Yes	No	Yes	No	Yes
Inflation	-0.002*	-0.001*	-0.001*	-0.001*	-0.007	-0.003	-0.012**	-0.006
	(-9.606)	(-10.310)	(-5.920)	(-5.748)	(-1.333)	(-0.781)	(-1.659)	(-1.084)
Investment	0.195*	0.212*	0.219*	0.230*	0.130*	0.121*	0.164*	0.207*
	(6.760)	(7.004)	(7.293)	(7.479)	(3.770)	(3.446)	(4.758)	(4.500)
log(Initial Income)	-0.140	-0.210	-4.425*	-4.557*	-0.695**	-0.572***	-0.692**	-2.324*
	(-0.898)	(-1.319)	(-5.165)	(-4.246)	(-2.432)	(-1.832)	(-2.184)	(-3.244)
Government Exp.	-0.090*	-0.068**	-0.142**	-0.098	-0.002	-0.001	-0.074***	-0.067
	(-2.855)	(-2.323)	(-2.115)	(-1.533)	-0.070	-0.037	(-1.724)	(-1.478)
Growth Rate of Terms of Trade	0.003	0.004***	0.004*	0.005*	0.175*	0.160*	0.192*	0.156*
	(1.409)	(1.781)	(2.985)	(4.175)	(4.822)	(3.900)	(6.310)	(4.489)
R Square Adjusted	0.176	0.238	0.320	0.361	0.457	0.494	0.580	0.606
No. of Countries	90	90	90	90	27	27	27	27
No. of Observations	611	611	611	611	208	208	208	208

Notes: The dependent variable is the five-year average growth rate of the real per capita GDP. Investment=Investment/GDP, Government Exp.=Government consumption expenditure as a share of GDP. The t-statistic for each coefficient, given in the parentheses, is computed from Heteroskedasticity-Consistent Standard Errors (HCSE). The asterisks "*", "**", "***" indicate statistical significance at 1, 5, 10 percent, respectively. The regressions of OLS with time and country dummies drop one time dummy and one country dummy to avoid multicollinearity. The number of countries and observations are shown in the last two rows.

Table 5-2 Linear Estimation Results for Growth Accounting Equation

(Developing Countries and Developed Countries)

	Developing Countries (63)				Developed Countries (27)			
Estimation Methods	Simple OLS	OLS with Fixed Effects			Simple OLS	OLS with Fixed Effects		
Country Dummies	No	Yes	No	Yes	No	Yes	No	Yes
Time Dummies	No	No	Yes	Yes	No	No	Yes	Yes
Inflation	-0.001*	-0.001*	-0.001*	-0.0004*	-0.010*	-0.001	-0.009*	0.003***
	(-3.400)	(-3.717)	(-2.628)	(-2.184)	(-3.102)	(-0.534)	(-2.388)	(1.513)
TFP Growth	0.822*	0.874*	0.791*	0.836*	1.017*	0.988*	0.947*	0.874*
	(5.733)	(9.326)	(5.046)	(7.819)	(11.480)	(13.320)	(11.070)	(12.470)
INVESTMENT	0.155*	0.235*	0.158*	0.245*	0.088*	0.089*	0.070*	0.056**
	(8.673)	(5.800)	(7.335)	(5.255)	(4.046)	(2.887)	(2.970)	(1.594)
g(L)	0.260	0.100	0.244	0.152	0.763*	0.679*	0.742*	0.633*
	(1.969)	(0.719)	(1.741)	(1.005)	(10.550)	(10.060)	(9.776)	(8.714)
R Square Adjusted	0.639	0.684	0.644	0.687	0.720	0.823	0.738	0.854
No. of Countries	63	63	63	63	27	27	27	27
No. of Observations	320	320	320	320	191	191	191	191

Notes: The dependent variable is the five-year average growth rate of the real per capita GDP. Investment=Investment/GDP, TFP growth=the growth rate of total factor productivity, g(L)=the growth rate of employment. The t-statistic for each coefficient, given in the parentheses, is computed from Heteroskedasticity-Consistent Standard Errors (HCSE). The asterisks "*", "**", "***" indicate statistical significance at 1, 5, 10 percent, respectively. The regressions of OLS with time and country dummies drop one time dummy and one country dummy to avoid multicollinearity. The number of countries and observations are shown in the last two rows.

Table 6. Estimation and Test Results of Threshold Effects

Sample	Search Range for Thresholds: Pistar1	Search Range for Thresholds: Pistar2	Growth Equation	Estimation Method	Threshold Estimate (%): Pistar1*	Threshold Estimate (%): Pistar2*	LR1	Sig. Level 1	LR2	Sig. Level 2
All Countries	{1,2,……,20}	{25,26,…..,70}	Growth Expenditure Equation	Fixed Effects	4%	51%	6.608	1%	1.6995	15%
				Fixed and Time Effects	16%	24%	9.7406	1%	2.0725	15%
			Growth Accounting Equation	Fixed Effects	14%	38%	7.0361	1%	3.2431	7%
				Fixed and Time Effects	14%	38%	4.4609	5%	3.5195	7%
Developing Countries	{1,2,……,20}	{25,26,…..,70}	Growth Expenditure Equation	Fixed Effects	15%	33%	7.2337	1%	1.9386	10%
				Fixed and Time Effects	16%	45%	15.373	1%	1.9784	10%
			Growth Accounting Equation	Fixed Effects	14%	38%	3.8783	5%	2.6989	10%
				Fixed and Time Effects	14%	38%	2.6159	5%	2.1398	15%
Developed Countries	{1,2,……,15}	{16,17,……,50}	Growth Expenditure Equation	Fixed Effects	5%	24%	30.46	1%	0.55516	35%
				Fixed and Time Effects	9%	24%	26.745	1%	0.55516	30%
			Growth Accounting Equation	Fixed Effects	5%	24%	5.0398	1%	2.4292	15%
				Fixed and Time Effects	5%	24%	8.4514	1%	1.211	20%

Notes: LR1is the approximate likelihood ratio statistic for testing the null hypothesis of no threshold against one threshold. **Sig. Level 1** shows the significance level which the null hypothesis of no threshold can be rejected. **LR2** is the approximate likelihood ratio statistic for testing the null hypothesis of one threshold against two thresholds. **Sig. Level 2** shows the significance level which the null hypothesis of one threshold can be rejected. Both **Sig.Level 1** and **Sig.Level 2** are based on the non-standard distribution by using bootstrapping simulation method proposed by Hansen (1999). (Pistar1*, Pistar2*) are the threshold estimates, at which ESS achieves minimum.

Table 7. Estimations with Threshold Effects: Growth Expenditure Equation

	Full Sample		Developing Countries		Developed Countries			
					Two Threshold		One Threshold	
Country Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Dummies	No	Yes	No	Yes	No	Yes	No	Yes
PI1	0.250*	0.048***	0.057**	0.136*	-0.267*	-0.082***	N.A.	N.A.
	(3.246)	(1.880)	(1.966)	(4.148)	(-3.909)	(-1.719)		
	[139]	[654]	[448]	[463]	[109]	[156]		
PI2	-0.024	-0.047*	-0.030**	0.023	-0.150*	-0.145*	-0.129*	-0.157*
	(-1.782)	(-2.864)	(-1.934)	(1.631)	(-5.804)	(-4.668)	(-5.518)	(-5.114)
	[530]	[63]	[96]	[92]	[92]	[45]	[201]	[201]
PI3	-0.001*	-0.001*	-0.001*	-0.001*	-0.010**	-0.006	-0.008***	-0.008
	(-6.668)	(-6.850)	(-5.706)	(-5.406)	(-2.089)	(-1.212)	(-1.930)	(-1.575)
	[50]	[102]	[67]	[56]	[7]	[7]	[7]	[7]
Investment	0.193*	0.186*	0.211*	0.221*	0.174*	0.173*	0.181*	0.177*
	(7.910)	(7.294)	(7.126)	(7.415)	(6.136)	(4.431)	(6.346)	(4.444)
log(Initial Income)	-3.312*	-3.564*	-4.371*	-4.488*	-1.318*	-2.568*	-1.329*	-2.614*
	(-5.776)	(-4.137)	(-5.146)	(-4.326)	(-4.471)	(-4.069)	(-4.543)	(-3.943)
Government Exp.	-0.104	-0.069	-0.151*	-0.106***	-0.089**	-0.136*	-0.085**	-0.141*
	(-1.738)	(-1.258)	(-2.310)	(-1.699)	(-2.260)	(-3.020)	(-2.173)	(-3.196)
Growth Rate of Terms of Trade(TOT)	0.004*	0.005*	0.004*	0.005*	0.165*	0.151*	0.164*	0.149*
	(2.647)	(4.251)	(3.099)	(4.699)	(6.007)	(4.935)	(5.959)	(4.801)
Pistar1*	4%	16%	15%	16%	5%	9%	N.A.	N.A.
Pistar2*	51%	24%	33%	45%	24%	24%	24%	24%
R Square Adjusted	0.3411	0.3797	0.3293	0.3794	0.6447	0.6754	0.6399	0.6706
No. of Countries	117	117	90	90	27	27	27	27
No. of Observations	819	819	611	611	208	208	208	208

Notes: The dependent variable is the five-year average growth rate of the real per capita GDP. Investment=Investment/GDP, Government Exp.=Government consumption expenditure as a share of GDP. The t-statistic for each coefficient, given in the parentheses, is computed from Heteroskedasticity-Consistent Standard Errors (HCSE). The asterisks "*", "**", "***" indicate statistical significance at 1, 5, 10 percent, respectively. The number in the bracket, which is below the t-statistic, denotes the number of observations for each inflation group. The regressions of OLS with time and country dummies drop one time dummy and one country dummy to avoid multicollinearity. The number of countries and observations are shown in the last two rows. (Pistar1*, Pistar2*) are the threshold estimates That is, ESS achieves minimum at the point (Pistar1*, Pistar2*).

Table 8. Estimations with Threshold Effects: Growth Accounting Equation

	Full Sample (90)		Developing Countries (63)		Developed Countries (27)			
					Two Threshold		One Threshold	
Country Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Dummies	No	Yes	No	Yes	No	Yes	No	Yes
PI1	-0.001	0.011	0.020	0.025	-0.204*	-0.242*	N.A.	N.A.
	(-0.069)	(0.476)	(0.944)	(0.754)	(-3.221)	(-4.176)		
	[380]	[380]	[211]	[211]	[95]	[95]		
PI2	-0.043**	-0.034*	-0.041**	-0.032**	-0.078*	-0.090*	-0.052*	-0.056*
	(-2.538)	(-2.851)	(-2.111)	(-2.185)	(-3.645)	(-4.218)	(-2.608)	(-2.848)
	[87]	[87]	[69]	[69]	[89]	[89]	[184]	[184]
PI3	-0.001*	-0.001*	-0.001*	-0.0005**	-0.005	-0.001	-0.003	0.002
	(-3.361)	(-2.782)	(-3.471)	(-2.426)	(-1.847)	(-0.385)	(-1.547)	(1.091)
	[44]	[44]	[40]	[40]	[7]	[7]	[7]	[7]
TFP	0.878*	0.835*	0.867*	0.832*	0.883*	0.727*	0.893*	0.830*
	(9.776)	(8.197)	(9.105)	(7.633)	(10.100)	(9.517)	(9.950)	(11.800)
INV	0.198*	0.199*	0.231*	0.241*	0.136*	0.088*	0.138*	0.050
	(6.244)	(5.746)	(5.985)	(5.557)	(3.661)	(2.716)	(3.535)	(1.569)
g(L)	0.426*	0.389*	0.117	0.162	N.A.	N.A.	N.A.	0.619*
	(5.359)	(4.466)	(0.827)	(1.068)				(8.454)
Pistar1*	14%	14%	14%	14%	5%	5%	N.A.	N.A.
Pistar2*	38%	38%	38%	38%	24%	24%	24%	24%
R Square Adjusted	0.7205	0.7248	0.6891	0.6901	0.7177	0.7961	0.713	0.8608
No. of Countries	90	90	63	63	27	27	27	27
No. of Observations	511	511	320	320	191	191	191	191

Notes: The dependent variable is the five-year average growth rate of the real per capita GDP. Investment=Investment/GDP, TFP growth=the growth rate of total factor productivity, g(L)=the growth rate of employment. The t-statistic for each coefficient, given in the parentheses, is computed from Heteroskedasticity-Consistent Standard Errors (HCSE). The asterisks "*", "**", "***" indicate statistical significance at 1, 5, 10 percent, respectively. The number in the bracket, which is below the t-statistic, denotes the number of observations for each inflation group. The regressions of OLS with time and country dummies drop one time dummy and one country dummy to avoid multicollinearity. The number of countries and observations are shown in the last two rows. (Pistar1*, Pistar2*) are the threshold estimates That is, ESS achieves minimum at the point (Pistar1*, Pistar2*).

Table 9. Linear Estimation of Investment-Inflation Relationship

			Full Set	Developing Countries	Developed Countries
OLS		Inflation	-0.001* (-2.758)	-0.001* (-2.748)	0.0002 (0.016)
		Lag(INV)	0.751* (27.370)	0.755* (23.910)	0.7269* (10.530)
		Adjusted R-Sq	0.5978	0.5899	0.551
Fixed Effects	Time Dummies	Inflation	-0.001** (-2.233)	-0.001** (-2.112)	-0.006 (-0.801)
		Lag(INV)	0.759* (27.270)	0.768* (23.580)	0.717* (10.070)
		Adjusted R-Sq	0.6134	0.6085	0.596
	Country Dummies	Inflation	-0.001* (-3.472)	-0.001* (-3.509)	0.014 (0.870)
		Lag(INV)	0.451* (10.870)	0.456* (9.732)	0.415* (5.457)
		Adjusted R-Sq	0.648	0.639	0.616
	Time Dummies & Country Dummies	Inflation	-0.001** (-2.393)	-0.001** (-2.268)	-0.004 (-0.487)
		Lag(INV)	0.456* (10.690)	0.467* (9.640)	0.333* (4.289)
		Adjusted R-Sq	0.6638	0.6555	0.691
Number of Countries			120	92	28
Number of Observations			800	598	202

Notes: The dependent variable is the Investment/GDP ratio. The explanatory variable is Inflation and the first lag of the Investment/GDP ratio. The table shows the estimated coefficients of inflation and the lag of investment by using different estimation method. The t-statistic for each coefficient, given in the parentheses, is computed from Heteroskedasticity-Consistent Standard Errors (HCSE). The asterisks "*", "**", "***" indicate statistical significance at 1, 5, 10 percent, respectively. The regressions of OLS with time and country dummies drop one time dummy and one country dummy to avoid multicollinearity. The number of countries and observations are shown in the last two rows.

Table 10. Linear Estimation of TFP-Inflation Relationship

			Full Set	Developing Countries	Developed Countries
OLS		Inflation	-0.001* (-8.719)	-0.001* (-8.646)	-0.007** (-2.204)
		Lag(TFP)	0.198* (3.036)	0.171** (2.414)	0.123 (1.534)
		Adjusted R-Sq	0.060	0.044	0.014
Fixed Effects	Time Dummies	Inflation	-0.001* (-8.33)	-0.001* (-6.16)	-0.006** (-2.164)
		Lag(TFP)	0.200* (2.946)	0.180** (2.432)	0.115 (1.408)
		Adjusted R-Sq	0.126	0.129	0.062
	Country Dummies	Inflation	-0.001* (-3.259)	-0.001* (-3.234)	-0.016* (-3.475)
		Lag(TFP)	-0.049 (-0.569)	-0.045 (-0.492)	-0.117 (-1.426)
		Adjusted R-Sq	0.1929	0.1431	0.1141
	Time Dummies & Country Dummies	Inflation	-0.001* (-3.332)	-0.001* (-3.141)	-0.014* (-3.948)
		Lag(TFP)	-0.067 (-0.771)	-0.056 (-0.606)	-0.199** (-2.405)
		Adjusted R-Sq	0.2744	0.2459	0.231
Number of Countries			93	66	27
Number of Observations			506	323	183

Notes: The dependent variable is the growth rate of TFP. The explanatory variable is Inflation and the first lag of TFP. The table shows the estimated coefficients of inflation and the lag of TFP by using different estimation method. The t-statistic for each coefficient, given in the parentheses, is computed from Heteroskedasticity-Consistent Standard Errors (HCSE). The asterisks "*", "**", "***" indicate statistical significance at 1, 5, 10 percent, respectively. The regressions of OLS with time and country dummies drop one time dummy and one country dummy to avoid multicollinearity. The number of countries and observations are shown in the last two rows.

Table 11. Estimation of Investment- Inflation Relationship with Thresholds

	Full Sample		Developing Countries		Developed Countries	
Country Dummies	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Time Dummies	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**
Pi1	0.204* (5.856) [643]	0.170* (3.896) [575]	0.177* (4.178) [455]	0.167* (2.686) [350]	0.412* (7.269) [178]	0.347* (4.167) [178]
Pi2	0.056* (3.328) [113]	0.043** (2.576) [186]	0.048* (2.652) [101]	0.034*** (1.849) [211]	0.191* (3.805) [20]	0.141** (2.491) [20]
Pi3	-0.0005 (-1.883) [44]	-0.0004 (-1.406) [39]	-0.001** (-2.092) [42]	-0.001 (-1.654) [37]	0.013*** (1.742) [4]	0.013 (1.545) [4]
Lag(TFP)	0.433* (10.360)	0.447* (10.700)	0.445* (9.449)	0.463* (9.730)	0.356* (5.235)	0.362* (4.893)
Pistar1*	17%	13%	17%	11%	13%	13%
Pistar2*	62%	65%	62%	65%	42%	42%
R-sq Adjusted	0.661	0.6694	0.6474	0.6588	0.6929	0.7135
Test by using Bootstrapping Distributions:						
No threshold against One	1%	1%	1%	1%	1%	1%
One threshold against Two	1%	1%	2%	10%	1%	1%
Number of Countries	120	120	92	92	28	28
Number of Observations	800	800	598	598	202	202

Notes: The dependent variable is the Investment/GDP ratio. The explanatory variable is Inflation and the first lag of the Investment/GDP ratio. The table shows the estimated coefficients of inflation by using different estimation method. The t-statistic for each coefficient, given in the parentheses, is computed from Heteroskedasticity-Consistent Standard Errors (HCSE). The asterisks "*", "**", "***" indicate statistical significance at 1, 5, 10 percent, respectively. The number in the bracket, which is below the t-statistic, denotes the number of observations for each inflation group. The regressions of OLS with time and country dummies drop one time dummy and one country dummy to avoid multicollinearity. The number of countries and total observations are shown in the last two rows. (Pistar1*, Pistar2*) are the threshold estimates That is, ESSs achieve minimum at the point (Pistar1*, Pistar2).

Table 12. Estimation of TFP growth- Inflation Relationship with Thresholds

	Full Sample		Developing Countries				Developed Countries	
			One Threshold		Two Thresholds			
Country Dummies	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**
Time Dummies	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Pi1	0.015 (0.418) [391]	0.014 (0.394) [391]	0.065 (1.676) [224]	0.087** (2.269) [224]	0.033 (0.769) [224]	0.056 (1.318) [224]	-0.238* (-2.952) [89]	-0.260* (-3.580) [89]
Pi2	-0.050** (-2.039) [50]	-0.049** (-2.209) [50]	-0.001* (-5.119) [99]	-0.001* (-3.123) [99]	-0.055*** (-1.828) [39]	-0.049*** (-1.770) [39]	-0.097* (-3.875) [85]	-0.127* (-4.490) [85]
Pi3	-0.001* (-8.435) [65]	-0.001* (-3.806) [65]	N.A.	N.A.	-0.001* (-5.856) [60]	-0.001* (-3.635) [60]	-0.010* (-3.288) [9]	-0.015* (-3.717) [9]
Lag(TFP)	0.200* (2.920)	-0.061 (-0.701)	0.175** (2.371)	-0.056 (-0.609)	0.180** (2.419)	-0.048 (-0.529)	0.115 (1.507)	-0.187** (-2.544)
Pistar1*	16%	16%	16%	16%	16%	16%	5%	5%
Pistar2*	25%	25%	N.A.	N.A.	25%	25%	21%	21%
R-sq Adjusted	0.1347	0.2819	0.1347	0.2559	0.1401	0.259	0.1199	0.3114
Test by using Bootstrapping Distributions:								
No threshold against One	1%	1%	5%	1%	1%	1%	1%	1%
One threshold against Two	7%	15%			8%	16%	3%	5%
Number of Countries	93	93	66	66	66	66	27	27
Number of Observations	506	506	323	323	323	323	183	183

Notes: The dependent variable is the growth rate of TFP. The explanatory variable is Inflation and the first lag of the TFP growth rate. The table shows the estimated coefficients of inflation by using different estimation method. The t-statistic for each coefficient, given in the parentheses, is computed from Heteroskedasticity-Consistent Standard Errors (HCSE). The asterisks "*", "**", "***" indicate statistical significance at 1, 5, 10 percent, respectively. The number in the bracket, which is below the t-statistic, denotes the number of observations for each inflation group. The regressions of OLS with time and country dummies drop one time dummy and one country dummy to avoid multicollinearity. The number of countries and observations are shown in the last two rows. (Pistar1*, Pistar2*) are the threshold estimates That is, ESSs achieve minimum at the point (Pistar1*, Pistar2).

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APPENDIX: Complete List of Countries (N=117)

NCROSS	COUNTRY	CONTINENT	DATA AVAILABLE PERIOD
	Developing Countries (N=90)		
1	Algeria*	Africa	1969-2004
2	Antigua and Barbuda	Latin America	1977-2002
3	Argentina*	Latin America	1961-2004
4	Bangladesh*	Asia	1980-2004
5	Belize	Latin America	1980-2002
6	Benin	Africa	1982-2004
7	Bolivia*	Latin America	1970-2004
8	Botswana	Africa	1965-2004
9	Brazil*	Latin America	1970-2004
10	Bulgaria	Europe	1980-2004
11	Burkina Faso	Africa	1979-2004
12	Burundi	Africa	1961-2002
13	Cameroon*	Africa	1975-2004
14	Central African Republic	Africa	1977-2004
15	Chad	Africa	1982-2004
16	Chile*	Latin America	1961-2004
17	China*	Asia	1965-2004
18	Colombia*	Latin America	1961-2004
19	Comoros	Asia	1980-2004
20	Congo, Rep.	Africa	1974-2004
21	Costa Rica*	Latin America	1961-2004
22	C“te d'Ivoire*	Latin America	1965-2004
23	Cyprus*	Europe	1975-1999
24	Dominica*	Latin America	1977-2003
25	Dominican Republic	Latin America	1961-2004
26	Ecuador*	Latin America	1965-2004
27	Egypt, Arab Republic of*	Africa	1961-2004
28	El Salvador*	Latin America	1961-2004
29	Ethiopia*	Africa	1981-2004
30	Gabon	Africa	1970-2004
31	Gambia, The	Africa	1981-2004
32	Ghana*	Africa	1967-2004
33	Grenada	Latin America	1978-2003
34	Guatemala*	Latin America	1961-2003
35	Guinea-Bissau	Africa	1975-2004
36	Guyana	Latin America	1961-2002
37	Haiti*	Latin America	1983-2004
38	Honduras*	Latin America	1961-2003
39	Hungary	Europe	1961-2004
40	India*	Asia	1961-2003
41	Indonesia*	Asia	1979-2004

42	Iran, Islamic Republic of	Middle East	1974-2004
43	Jordan*	Middle East	1976-2004
44	Kenya*	Africa	1964-2004
45	Kuwait*	Asia	1963-2003*
46	Lesotho	Africa	1967-2004
47	Libya*	Africa	1963-2002
48	Madagascar*	Africa	1970-2004
49	Malawi*	Africa	1973-2004
50	Malaysia*	Asia	1961-2004
51	Mali*	Africa	1968-2004
52	Malta*	Europe	1961-2004
53	Mauritania	Africa	1985-2002
54	Mauritius*	Africa	1981-2004
55	Mexico*	Latin America	1961-2004
56	Morocco*	Africa	1961-2004
57	Mozambique*	Africa	1980-2004
58	Namibia	Africa	1981-2004
59	Nicaragua*	Latin America	1961-2004
60	Niger	Africa	1980-2004
61	Nigeria*	Africa	1973-2004
62	Pakistan*	Asia	1961-2004
63	Panama*	Latin America	1980-2004
64	Papua New Guinea	Oceania	1961-2004
65	Paraguay*	Latin America	1961-2004
66	Peru*	Latin America	1961-2004
67	Philippines*	Asia	1961-2004
68	Rwanda*	Africa	1965-2004
69	Senegal	Africa	1965-2004
70	Sierra Leone*	Africa	1980-2004
71	South Africa*	Africa	1961-2004
72	Sri Lanka*	Asia	1970-2004
73	St. Kitts and Nevis	Latin America	1990-2003
74	St. Lucia	Latin America	1981-2003
75	St. Vincent and the Grenadines	Latin America	1977-2004
76	Sudan*	Africa	1976-2004
77	Swaziland	Africa	1971-2004
78	Syrian Arab Republic	Asia	1965-2004
79	Tanzania	Africa	1990-2004
80	Thailand*	Asia	1961-2004
81	Togo	Africa	1980-2004
82	Trinidad and Tobago*	Latin America	1961-2004
83	Tunisia*	Africa	1962-2004
84	Turkey*	Europe	1969-2004
85	Uganda*	Africa	1983-2004
86	Uruguay*	Latin America	1961-2004
87	Venezuela*	Latin America	1961-2004
88	Zaire (Democratic Republic of the Congo)*	Africa	1961-2004
89	Zambia*	Africa	1970-2004
90	Zimbabwe*	Africa	1961-2002

	Developed Countries (N=27)		
1	Australia*	Oceania	1961-2004
2	Austria*	Europe	1971-2003
3	Belgium*	Europe	1970-2003
4	Canada*	North America	1966-2002
5	Denmark*	Europe	1966-2003
6	Finland*	Europe	1961-2003
7	France*	Europe	1970-2002
8	Germany*	Europe	1971-2003
9	Greece*	Europe	1961-2003
10	Hong Kong	Asia	1965-2004
11	Iceland*	Europe	1961-2003
12	Ireland*	Europe	1971-2002
13	Israel*	Middle East	1961-2004
14	Italy*	Europe	1965-2003
15	Japan*	Asia	1961-2003
16	Korea, Republic of*	Asia	1961-2003
17	Luxembourg*	Europe	1965-2003
18	Netherlands*	Europe	1971-2002
19	New Zealand*	Oceania	1971-2002
20	Norway*	Europe	1961-2003
21	Portugal*	Europe	1971-2002
22	Spain*	Europe	1971-2003
23	Sweden*	Europe	1965-2003
24	Switzerland*	Europe	1965-2002
25	TAIWAN PROV.OF CHINA*	Asia	1970-1998
26	United Kingdom*	Europe	1961-2003
27	United States*	North America	1961-2002

Notes:

1. This complete country list table is based on the dataset for the growth expenditure equation. Country name marked with star denotes this country is also included in the dataset for the growth accounting equation. Three countries, Myanmar, Jamaica, and Singapore are not included in the above country table, but are included in the dataset of the growth accounting equation.
2. Kuwait has missing values for all variables from 1990 to 1995.