# INFLATION AND ECONOMIC GROWTH: EVIDENCE FROM A GROWTH EQUATION

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***Summary:*** Many believe inflation has important adverse effects on long-run economic performance. Cross-country growth regressions would seem to offer a sensible means of empirically determining inflation's effects. However, there is little existing empirical evidence on the relationship between inflation and growth. The 1950s and 1960s growth theory literature on inflation and growth emphasized the positive impact of inflation on capital accumulation which implies a positive impact on the rate of economic growth, the Tobin-Mundell effect. Similarly, all the costs of inflation detailed in Fischer and Modigliani (1978) would imply a negative association between the inflation and economic growth through the new growth theory mechanisms. It is also argued that the relationship between inflation and growth is nonlinear.

This empirical exercise uses a small sample of OECD countries and Asian countries separately for which capital stock and labor force data are available to investigate, in a pooled time series and cross-section fashion, the relationship between inflation and growth. Having appropriately controlled for capital and labor inputs, strong evidence is found that inflation and its first difference has a large and statistically significant negative impact on growth of OCED countries but it does not significantly affect the growth in developing countries. Statistically insignificant positive correlation is found between the first difference of inflation and growth for developing countries of Asia. The basic finding of this empirical exercise is that the cross-country relationship between inflation and long-term growth suffers some fundamental difficulties: modification in country sample and time period. It seems that little can be learned from comparing time-series cross country regressions growth on inflation between different regions with different time periods. More might be learned on inflation and economic growth using the large sample with same time period.

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## 1.1 INTRODUCTION

Inflation and unemployment are two of the main subjects of macroeconomics. In particular, inflation is one of the principal concerns of policy-makers and the public, and it has been the subject of large amounts of research. Many believe that inflation has important adverse effects on long-run economic performance. Fisher and Modigliani (1978) note “the typical belief - of the economist and the layman - that inflation poses a serious economic problem, relative to unemployment”. More recently, Stanners (1993) has drawn attention to the widespread belief amongst the policy-makers “that zero or low inflation is an essential or at least very important condition for high and sustained growth”. Levine and Zervos (1993) not that “Given the uncharacteristically unified view amongst economists and policy analysts that countries with high inflation rates should adopt polices to lower inflation in order to promote economic prosperity, the inability to find simple cross-country regressions supporting this contention is both surprising and troubling”. They do concede that their use of the average rate of inflation over a lengthy time period might result in a few extreme observations distorting this average. The use of annual data would overcome this distortion and retain the maximum amount of information.

Cross-country growth regressions would seem to offer a sensible means of empirically determining inflation’s effects. A number of authors have argued that time-series analysis across countries also offers a sensible means of empirically determining inflation’s effects. Grimes (1991) and Burdekin, et al (1994), for example, estimate time series regressions of growth on inflation across countries and find inflation to be inversely related to growth. Such analysis would appear less sensible, however, in light of the Levine and Renelt (1992) finding that estimates of the inflation - economic growth relation vary sharply with the regression specification. Likewise, Karras (1993) argues that such reduced-form time-series estimates are contaminated by endogeneity. It is true, however, that there is surprisingly little evidence available that would sustain a belief in an inflation - growth linkage. Nonetheless, analyses completed subsequent to Levine and Renelt (1992)- for example, Fisher (1993), De Gregorio (1993), and Grimes (1991) - continue to use growth regressions to infer inflation’s effects, and typically conclude growth and inflation to be inversely related.

The purpose of this empirical exercise is to exploit a very simple inflation - growth theoretical framework to address the question of how inflation affects economic growth. The argument that Levine and Renelt (1992) that there “does not exist a consensus theoretical framework to guide empirical work on growth” is almost certainly true but it does not justify the entirely atheoretical nature of the many of the growth studies, including the cited works on inflation, but also such papers as those by Kormendi and Meguire (1985) and Grier and Tullock (1989).

The simplest possible theoretical framework for the study of growth uses a single aggregate production function as in, for example, Balassa (1985), and Ram and Ramsey (1985). From such a basis, the well-known neoclassical sources-f-growth equation is easily derived. It would seem, therefore, that any study of growth which fails to control for the growth of the capital stock and the growth of the labor force must necessarily be flawed.

In this next Section 1.2 of Part I, it is argued that that recent work on inflation and growth is so flawed and the framework used here is justified. In Section 1.3 the data and methods used are discussed. Particular attention is paid to the use of appropriate proxies for capital and labor. Section 1.4 summarized the econometric formulation.

In the Replication Part (i.e. Part II), Section 2.1 presents the results of the estimations and comparisons from replication of the paper by Alexander (1997) and suggest that inflation and change in inflation both have a significantly negative effect on economic growth. Also discrepancies are discussed. Section 2.2 presents the conclusion.

In the Extension Part (i.e. Part III), Section 3.1 the rational of extension of the model to the emerging economies of the world i.e., South-East Asia is discussed. In Section 3.2 data and methods used are discussed. Section 3.3 presents the results and findings by extending the same model mentioned in Part I.

## 1.2 THEORY AND THE MODEL

The building of the model to show the inflation - growth linkage is easier in theory than in practice. It is possible, for example, to construct a model in which the "negative effect of inflation on growth is due to the negative effect of inflation on the profitability of investment" (De Gregorio, 1993). It is quite another matter to construct such a model in a way which allows direct testing of the stated implication. It appears that De Gregorio (1993) acknowledges that specification and interpretation of the regressions presented are not strictly derived from the theoretical analysis. If this is the case, then Gregorio's work is in the tradition of Barro's (1991) paper on growth. Barro appeals to the new growth theory, but, in his empirical analysis, simply adds proxies for various school enrollment rates to initial GDP, share of investment, share of government consumption, and even number of assassinations and other non-economic variables, chosen in an *ad hoc* manner. While some of the regressors used by Barro may be seen as potential sources of omitted variables bias in the present empirical exercise, given the sample of countries used, any measure of political instability is likely to display little variation. Also, human capital measures are difficult to incorporate in anything other than pure cross-sectional work because of data availability. Grimes (1991) also typifies the *ad hoc* manner. Re regresses the growth rate of GDP on inflation and change in inflation, choosing to control for other factors by means of adding the change in the terms of trade and a linear time trend as regressors. He does, however, notes the sources in the economic literature of both an implied negative and an implied positive link between inflation and growth. Evidently, the question must be resolved empirically, but previously proposed theories are briefly outlined below.

The point that appears to be missed in recent testing of the inflation-growth linkage is that there exists a respectable body of literature, namely, "growth accounting", which exploits a simple technique, namely a production function, with the purpose of a "complete analysis of aggregate economic growth - growth of real products and its sources - growth in real factor input and growth in total productivity. Many of the growth accounting literature is devoted to discussions of how various functional forms affect the results arrived at, as well as to how omitted variables affect the size of the "residual". For the purpose of this empirical exercise what we take from this literature is that any model which purports to explain economic growth must adequately account for growth in real capital input and growth in real labor input.

Consider the production function

$$Y = Y(K, L) \tag{1}$$

where Y is output, K is capital and L is labor. The proportional growth rate of real output is given by :

$$Y'/Y = MPK\,(K'/Y) + MPL\,(L'/Y) \tag{2}$$

where MPK and MPL are the marginal products of capital and labor respectively, and oblique to denote the differentiation with respect to time. Naturally, if one were to regress real output growth on only (K'/Y) and (L'/Y) there would probably a large residual, some of which might be due to omitted variables and not all of which might be regarded as technological progress. Nevertheless, it is the modified version of this equation that is proposed here as a means of determining whether inflation affects growth. Restated in a form suitable for estimation, the above growth equation yields :

$$Y'/Y = a_0 + a_1 (K'/Y) + a_2 (L'/Y) + a_3 d + \varepsilon \tag{3}$$

where $a_0$ is a constant term which will capture the trend growth rate and d is the dummy variable which set to zero before the well-known structural break in growth performances in about 1973. $\varepsilon$ is an error term.

Of course, this equation may omit variables which are crucial to explaining growth. If the regressors in Equation 3 are all expressed in real terms, as they should be to explain growth in real output, then adding a term for inflation, with the intention of testing whether its coefficient is zero, could be justified. If the coefficient in question were to turn out to be non-zero, then we ought to call for further theoretical analysis to explain the linkage. Various authors have suggested both positive and negative impacts on growth from inflation. In the Phillips curve, tradition it was long assumed that there was a negative (positive) correlation between inflation and unemployment (output). According to Tobin - Mundell hypothesis an increase in inflation out to cause a substitution away from money to investment in fixed capital, with a consequent positive impact on the rate of economic growth. By contrast, Feldstein (1982) has outlined a mechanism by which, through interaction with a nominal tax system, inflation increases the cost of capital., thereby reducing investment and economic growth. It is also often suggested that high rates of inflation go with highly variable rates of inflation and that the consequent uncertainty exacerbates the signal extraction problem. Given these conflicting theories, we intend o estimate:

$$Y'/Y = a_0 + a_1 (K'/Y) + a_2 (L'/Y) + a_3 d + a_4 \pi + \varepsilon \tag{4}$$

and

$$Y'/Y = a_0 + a_1 (K'/Y) + a_2 (L'/Y) + a_3 d + a_4 \pi + a_5 \Delta\pi + \varepsilon \qquad (5)$$

where $\pi$ is the inflation and $\Delta$ is the difference operator.
If none of the above theories outlined above with respect to inflation is true, then we would expect that the coefficients on the inflation variables would be zero. Unfortunately, $a_4$ could well be zero in the presence of both negative and positive effects on growth of the type described above. For example, the Tobin - Mundell effect might cancel out the effect Feldstein describes. Thus a significant coefficient would constitute strong evidence of the dominance of the effect over the other.

Even if the evidence supported the existence of inflation effects on growth, there would be those who would argue that the estimates of $a_4$ and $a_5$ might be biased by omission of other relevant variables. Using the sectoral production function as pioneered by Robinson (1971) and Feder (1983, 1986), it can be shown that any of Equations 3, 4 and 5 can be augmented by "unconventional" variables, such as "government" or "exports". They, then appear as :

$$Y'/Y = a_0 + a_1 (K'/Y) + a_2 (L'/Y) + a_3 d + b_1 (G'/Y) + b_2 (X'/Y) + \varepsilon \qquad (6)$$

$$Y'/Y = a_0 + a_1 (K'/Y) + a_2 (L'/Y) + a_3 d + a_4 \pi + b_1 (G'/Y) + b_2 (X'/Y) + \varepsilon \qquad (7)$$

$$Y'/Y = a_0 + a_1 (K'/Y) + a_2 (L'/Y) + a_3 d + a_4 \pi + a_5 \Delta\pi + b_1 (G'/Y) + b_2 (X'/Y) + \varepsilon \qquad (8)$$

If the estimates of $a_1$ are robust to the introduction of these extra variables (and the extra variables are significant) further weight can be given to the conclusions from estimating Equations 3, 4 and 5.

## 1.3 DATA

The raw data for OECD countries employed in the regressions reported in the next section were provided by Prof. Alexander, W. R. J, author of the original paper via internet which were extracted from the tapes provided by International Monetary Fund (IMF, 1990). For each country used in the sample, nominal and real GDP (Y) were extracted. The implicit GDP deflator was calculated from these and used to deflate variables before calculation of growth rates. Government consumption (G) and exports (X) were extracted from the same source. The GDP deflator was used to construct the measure of inflation ($\pi$).

Many researchers use investment-output ratio (I/Y) as a proxy for the growth of capital stock, which does not consider the deduction of the scrapped capital equipment, simply because of lack of suitable data. Instead of using I/Y as a regressor, it would be preferable to use K'/Y, where K is some measure of the capital stock. The data on the net capital stock were extracted from OECD's Flow and Stocks of Fixed Capital (OECD, 1991a), which includes data for only twelve countries. In this empirical exercise, only eleven countries of these data were used since data for Sweden after 1983 were not available. With respect to labor, labor force data from OECD

(1991b) for all member countries were used. These data were used to construct and employment variable (L). The raw data set of OECD countries are documented in Annex I.A.

## 1.4 ECONOMETRIC FORMULATION

There are too few countries in the sample to allow cross-sectional work, especially considering the loss of observations if decade or five - yearly averaging were to be employed. Averaging simply results in the loss of too much information. What is proposed here is to estimate the models in pooled, or combined time series and cross-sectional form, using annual data. Of course, the behavior of the disturbances over the countries of the sample is probably different from the behavior of the disturbances for a given country over time.

The model used (Kmenta, 1971) in this empirical exercise combines assumptions frequently made about cross-sectional observations with those made when dealing with time series data. The essence of the method is to subject the data to two transformations, one to remove possible (first-order) autoregression and the other to remove heteroscedasticity. If $\varepsilon_{it}$ is a general error term with I indexing the countries of the sample and t the years, then the assumptions make about errors are that $E(\varepsilon_{it}^2) = \sigma_i^2$ (heteroscedasticity) and $\varepsilon_{it} = \rho_i \varepsilon_{i,t-1} + u_{it}$ (autoregression). In addition, the possibility of cross-sectional dependence is allowed for by assuming that $E(\varepsilon_{it} \varepsilon_{jt}) = \sigma_{ij}$ (mutual correlation). Given the imposition of this error structure on the model the only remaining econometric issue that might arise is multicollinearity, which is investigated empirically when the model is estimated.

Given the data and the econometric formulation described above, Equations 3 to 8 were estimated in combined time series and cross-sectional form over the period of 1966 to 1988 for the following eleven countries : United States, United Kingdom, Belgium, France, Germany, Norway, Canada, Japan, Finland, Greece and Australia. SHAZAM version 7 computer package was used to estimate the equations. The output of the regressions results are summarized in Annex I.B.

## 2.1 RESULTS

Tables 1 and 2 document the growth - inflation regression results of this empirical exercise and from the paper by Alexander (1997) for comparison. The empirical exercise is limited to whole sample and not sub-sample as outlined in Alexander (1997) paper. It is interesting to note the discrepancies about the results between them, although both the results showed strong negative relation between the growth and inflation.

Table 1: Estimated Coefficients of Equations 3, 4 and 5

| **Variable** | **Paper by Alexander** | | | **Empirical Exercise** | | |
|---|---|---|---|---|---|---|
| | **Equation 3** | **Equation 4** | **Equation 5** | **Equation 3** | **Equation 4** | **Equation 5** |
| Constant | 0.040218<br>(13.673) | 0.050806<br>(14.919) | 0.049260<br>(14.815) | 0.004118<br>(9.806) | 0.049342<br>(14.54) | 0.04926<br>(14.54) |
| Dummy | -0.024381<br>(-8.3338) | -0.018461<br>(-6.2324) | -0.021527<br>(-7.1239) | -0.02357<br>(-8.927) | -0.01802<br>(-6.902) | -0.02771<br>(-7.057) |
| K'/Y | 0.10016<br>(7.5665) | 0.093542<br>(7.8712) | 0.090112<br>(7.6636) | 0.1001<br>(7.7912) | 0.07732<br>(7.959) | 0.07600<br>(7.671) |
| L'/Y | 7571.9<br>(2.2948) | 6127.5<br>(2.1281) | 7421.6<br>(2.5819) | 7561.03<br>(2.507) | 6478.5<br>(2.169) | 6571.8<br>(2.206) |
| $\pi$ | | -0.16435<br>(-5.9417) | -0.11416<br>(-3.9182) | | -0.47254<br>(-12.42) | -0.11614<br>(-10.88) |
| $\Delta\pi$ | | | -0.11416<br>(-3.0085) | | | -0.11244<br>(-3.0056) |
| Buse $R^2$ | 0.4801 | 0.5198 | 0.5467 | 0.4892 | 0.4547 | 0.5484 |

Note: The figure in the parentheses are *t*-statistics.

Table 2: Estimated Coefficients of Equations 6, 7 and 8

| **Variable** | **Paper by Alexander** | | | **Empirical Exercise** | | |
|---|---|---|---|---|---|---|
| | **Equation 6** | **Equation 7** | **Equation 8** | **Equation 6** | **Equation 7** | **Equation 8** |
| Constant | 0.031322<br>(8.6728) | 0.043339<br>(12.169) | 0.043059<br>(12.185) | 0.051949<br>(11.01) | 0.04004<br>(9.702) | 0.04361<br>(9.776) |
| Dummy | -0.01984<br>(-6.1911) | -0.013538<br>(-4.9667) | -0.016588<br>(-5.6374) | -0.01599<br>(-6.040) | -0.01274<br>(-4.890) | -0.01569<br>(-5.949) |
| K'/Y | 0.084469<br>(5.9604) | 0.065814<br>(5.3921) | 0.067022<br>(5.5419) | 0.08408<br>(5.016) | 0.07367<br>(7.219) | 0.073968<br>(7.328) |
| L'/Y | 9213.4<br>(2.9091) | 7635.9<br>(2.9217) | 8719.78<br>(3.3052) | 9139.6<br>(3.060) | 9525.3<br>(3.252) | 9471.7<br>(3.224) |
| $\pi$ | | -0.18900<br>(-7.2714) | -0.14510<br>(-4.7786) | | -0.18108<br>(-3.172) | -0.14098<br>(-4.451) |
| $\Delta\pi$ | | | -0.096935<br>(-2.5916) | | | -0.0927<br>(-2.348) |
| G'/Y | 0.47431<br>(2.1316) | 0.66958<br>(3.3664) | 0.47536<br>(2.2500) | 0.41312<br>(2.454) | 0.42655<br>(2.108) | 0.49060<br>(2.724) |
| X'/Y | 0.23245<br>(4.2718) | 0.26998<br>(4.9713) | 0.27054<br>(5.1317) | 0.23581<br>(4.029) | 0.23492<br>(4.744) | 0.26203<br>(4.770) |
| Buse $R^2$ | 0.4777 | 0.5933 | 0.6127 | 0.4695 | 0.5130) | 0.5156 |

Note: The figure in the parentheses are *t*-statistics.

Through the series of exchange of e-mails with the author of the paper (see Annex II.A), it was confirmed that the author used in his analysis, the L'/Y variable, without converting real output (i.e., Y) into the common units (for example in US $). The author then suggested to use the L'/Y variable by converting the real output into some common units. In this empirical exercise, additional official exchange rate was extracted from IMF (1997) and the real output of all countries were converted into dollar units for calculating L'/Y variable. In addition, the author admitted that the Austria reported in the paper is in fact Australia. It was a "very good experience and exercise for replicating the results of some of the published papers". The paper by Alexander (1997) is attached in Annex II.B.

Some of the common data problems encountered with time-series data, such as multi-collinearity and first order auto-correlation were checked and corrected. In fact, multi-collinearity did not posed a problem. Multi-collinearity leads only to inefficiency, not bias in the estimators. Here, al the coefficients are significant. However, serial auto-correlation were found and corrected.

Based on the modified version of the model, six Equations from 3 to 8 were estimated. In estimates of equation (3) in Table 1, the constant term is positive and significantly different from zero at any conventional significance level. It is also of plausible magnitude of about 4.0 %, and can be regarded as representing the average trend annual growth rate over the sample of countries. The dummy variable is negative and significantly different from zero and of plausible magnitude in economic terms. Its value of -2.3 % represents an estimate of the set-back to growth rates post 1973. The coefficients of both input variables are, as would be expected, positive and significantly different from zero. In traditional growth accounting the term L/Y is subsumed in the coefficient of (L'/L) by making some assumption such as that the marginal and average products of labor are linearly related to the real wage (Bruno, 1968). Making no such assumption, the variable used here to represent labor is the growth rate of labor divided by output per worker. The differing magnitudes of the coefficients of the capital and labor variables can be understood by comparing their average values which differ by by five orders of magnitude. Buse $R^2$ (Buse, 1973) is a measure of goodness of fit which is monotonically related to the more usually quoted *F* statistics. The fit of Equation 1 is reasonably good by the standards of combined time series and cross-section studies.

From the estimates of Equations 4 and 5, we see that the estimates of the constant and the coefficients of the dummy, K'/Y and L'/Y are all quite robust to allowing either inflation or its first difference to enter the regression. In Equation 2, $\pi$ enters with a negative and significant coefficient. In Equation 5, both $\pi$ and difference of $\pi$ enter with significantly negative coefficients, with the coefficient of inflation of somewhat smaller magnitude and lesser significance once difference of $\pi$ is taken into account. The fit is best when both $\pi$ and difference of $\pi$ incorporated. The reported Buse $R^2$ incorporates an adjustment for the number of regressors.

It might be argued that all the estimates are biased due to omitted variables. There is no shortage of candidate repressors if we judge by the growth literature. For example, Landau (1986) includes up to 25 regressors, many of them dubiously measured socio-political variables, in a single equation. However, staying within the realms of economics (excluding dubiously measured socio-political variables) and, even more narrowly within the confines of a production function approach, let us check the effect of allowing G'/Y and X'/Y to enter the equation, where G is government consumption and X is exports. For justification on the use of G see Ram (1986) and for X see Feder (1983). These results are given in Table 2. We see that the conclusions drawn from Table 1 are robust to the addition of these variables. The magnitude and significance of the constant and the coefficients of the dummy and the input variables follow the same general pattern. Inflation and difference of inflation remain significantly negative. Interestingly, both of the additional unconventional variables are positive and significantly different from zero. Their addition improves the fit of any of the models containing an inflation variable by a considerable margin. There is still no cause for concern over multi-collinearity.

The weight of evidence is that, having appropriately controlled for capital and labor inputs, $\pi$ and difference of $\pi$ are significantly negatively related to economic growth, at least within this sample of developed nations for the time period under consideration.

## 2.2 CONCLUSION

There is little existing empirical evidence on the relationship between inflation and growth, and much of what evidence there is fails to control appropriately for growth in real inputs. This empirical exercise uses a small sample of eleven OECD countries for which capital stock and labor force data are available to investigate, in a pooled time series and cross-section fashion, the relationship between inflation and growth. Strong evidence is found contrary to the hypothesis that there should be no association between inflation and growth. Strong evidence is found contrary to the hypothesis that there should be no association between inflation and real growth. In fact, given the conflicting theoretical approaches to inflation’s effects on growth briefly discussed above, the finding of negative coefficient on $\pi$ in Equation 5 suggests that any positive effect of inflation on growth is more than outweighed by the negative effects. The coefficient of $\pi$ in Equation 3, -0.11614, is strikingly similar to Grimes’s (1991) finding of -0.11 for larger sample of OECD countries, even although Grimes uses terms of trade to control for supply-side factors. Thus, even if inflation had been at a constant rate for some time (difference of $\pi = 0$), and therefore surely fully anticipated, the result implies lost growth from a high level of inflation that this finding implies must be added further loss from an increase in inflation, since difference of $\pi$ has a coefficient of -0.11244. Taking these combined effects, a reduction in inflation from, say 6% to 2%, would imply an improved growth performance close to 1% per annum. Even if only the effect from the reduced level persisted, and there is reason to believe that the effect of the change variable will continue to act for one more period anyway, here is no need to stress the long-run benefits of such and increment to growth.

## 3.1 OECD TO ASIAN ECONOMIES

Until the recent mid 1997 financial crisis in Asia, the fast growing countries of South - East Asian countries have generally maintained single or low double digit inflation, have for the most part avoided balance of payments crises, and when they have had them - as for instance in Korea in 1980 - moved swiftly to deal with them. In essence, the inflation rate serves as an indicator of the overall ability of the government to manage the economy. Since there are no good arguments for very high rates of inflation, a government that is producing high inflation is a government that has lost control. Although, most of the Asian countries have for a long time succeed in maintaining low and stable inflation through policies that are not ultimately sustainable. I believe, the recent fiscal and balance of payments crises in this region could necessitate sharp changes in macroeconomic policies. For example, Thailand, Indonesia and Philippines have already started changing their polices and South Korea is in the process of getting help from IMF.

It can be argued that developing countries (for example, most of the Asian economies excluding Japan) are sufficiently and systematically different from industrialized OECD countries. Fischer (1993) argued that "while inflation is negatively associated with growth and with its production function determinants, it is not clear - especially in the panel regressions of developing countries - which way the causation runs. If supply shocks predominate, then possibly adverse supply shocks cause both inflation and slower growth, and the regressions may merely reflecting that association". For most of the developing countries, changes in the terms of government spending and exports are a major supply shocks, and these will be taken into account in the regressions. It is useful also to note that some developing countries in Lain America that have experienced rapid growth at high inflation rates. During the period 1961-88, at least 14 countries in the World Bank database experienced an annual inflation rate greater than 50 percent in at least one year. Growth rate in these countries exceeded 5 percent during a year or more of the 50 percent or more inflation.

While inflation is generally inversely related to growth in most of the developed OECD economies, the purpose of this extension empirical exercise is to see whether it is true also in the case developing countries in Asia.

## 3.2 DATA AND METHODS

This analysis is based on annual data over the period of 1979 to 1995. The data employed in the regressions were derived from the raw data extracted from the Asian Development Bank's (ADB) data homepage (http://www.asiandevbank.org).The eight countries selected based on the availability of data are : Hongkong (China), Indonesia, Malaysia, Philippines Singapore, South Korea, Taiwan and Thailand. Same procedure as explained in Section 1.3 of Part I were used to derive the data necessary for regressions. However, for the measure for capital (i.e. K), gross fixed capital was used. Annex II.A documents the raw data that were extracted from ADB for all eight countries. The models are estimated in pooled, or combined time series and cross-sectional form using the annual data. The dummy variable is excluded since the data set does not include the oil shock of 1973. Details of the equations used and the assumptions made about cross-sectional observations when dealing with time series data are explained in Section 1.3 of Part I.

## 3.3 RESULTS

Tables 3 and 4 document the growth - inflation regression results of this empirical exercise for both Asia and OCED countries for comparison. It is interesting to note the discrepancies about the results between them, although both the results showed strong negative relation between the growth and inflation. While difference in π has positive relation with growth and government consumption was statistically insignificant.

Table 1: Estimated Coefficients of Equations 3, 4 and 5

| **Variable** | **Asia** | | | **OECD** | | |
|---|---|---|---|---|---|---|
| | **Equation 3** | **Equation 4** | **Equation 5** | **Equation 3** | **Equation 4** | **Equation 5** |
| Constant | 0.044031<br>(14.41) | 0.05155<br>(13.09) | 0.054699<br>(13.61) | 0.004118<br>(9.806) | 0.049342<br>(14.54) | 0.04926<br>(14.54) |
| Dummy | | | | -0.02357<br>(-8.927) | -0.01802<br>(-6.902) | -0.02771<br>(-7.057) |
| K'/Y | 0.1041<br>(13.68) | 0.10724<br>(13.88) | 0.10534<br>(13.95) | 0.1001<br>(7.7912) | 0.07732<br>(7.959) | 0.07600<br>(7.671) |
| L'/Y | 3116.2<br>(3.575) | 2831.1<br>(4.073) | 2872.34<br>(4.033) | 7561.03<br>(2.507) | 6478.5<br>(2.169) | 6571.8<br>(2.206) |
| $\pi$ | | -0.22897<br>(-7.123) | -0.26075<br>(-7.532) | | -0.47254<br>(-12.42) | -0.11614<br>(-10.88) |
| $\Delta\pi$ | | | 0.090079<br>(1.657) | | | -0.11244<br>(-3.0056) |
| Buse $R^2$ | 0.6023 | 0.6882 | 0.7022 | 0.4892 | 0.4547 | 0.5484 |

Note: The figure in the parentheses are *t*-statistics.

Table 2: Estimated Coefficients of Equations 6, 7 and 8

| **Variable** | **Asia** | | | **OECD** | | |
|---|---|---|---|---|---|---|
| | **Equation 6** | **Equation 7** | **Equation 8** | **Equation 6** | **Equation 7** | **Equation 8** |
| Constant | 0.048463<br>(11.62) | 0.046512<br>(12.50) | 0.048685<br>(12.77) | 0.051949<br>(11.01) | 0.04004<br>(9.702) | 0.04361<br>(9.776) |
| Dummy | | | | -0.01599<br>(-6.040) | -0.01274<br>(-4.890) | -0.01569<br>(-5.949) |
| K'/Y | 0.12454<br>(12.26) | 0.18056<br>(13.48) | 0.198095<br>(5.5419) | 0.08408<br>(5.016) | 0.07367<br>(7.219) | 0.073968<br>(7.328) |
| L'/Y | 3404.38<br>(4.131) | 2877.91<br>(5.005) | 2912.6<br>(5.017) | 9139.6<br>(3.060) | 9525.3<br>(3.252) | 9471.7<br>(3.224) |
| $\pi$ | | -0.25348<br>(-8.428) | -0.27353<br>(-8.443) | | -0.18108<br>(-3.172) | -0.14098<br>(-4.451) |
| $\Delta\pi$ | | | 0.064921<br>(1.949) | | | -0.0927<br>(-2.348) |
| G'/Y | 0.08156<br>(1.113) | 0.059912<br>(0.8777) | 0.061953<br>(0.8991) | 0.41312<br>(2.454) | 0.42655<br>(2.108) | 0.49060<br>(2.724) |
| X'/Y | 0.1038<br>(3.538) | 0.15876<br>(5.598) | 0.15137<br>(5.375) | 0.23581<br>(4.029) | 0.23492<br>(4.744) | 0.26203<br>(4.770) |
| Buse $R^2$ | 0.6379 | 0.7259 | 0.7321 | 0.4695 | 0.5130) | 0.5156 |

Note: The figure in the parentheses are *t*-statistics.

The constant term (representing average trend annual growth rate over the sample of countries) is positive and significantly different from zero. It is also plausible magnitude of about 5% on average which is higher than the OCED countries indicating that Asian countries are growing much faster than the already developed countries. The coefficient of input variables are, as would be expected, positive and significantly different from zero. The fit of the equations (Buse $R^2$) is reasonably good and by the standards of combined time series and cross-section studies. Annex III.B summarizes the regression output.

Looking at the estimates of coefficients $\pi$ and difference of $\pi$, results are quite different than that of the OCED countries. Although, estimates of the constant and the coefficients of the K'/Y and L'/Y (Equations 3 to 8) are quite robust to allowing inflation to enter the regression, the first difference of $\pi$ enters with a positive and insignificant coefficient (Equations 5 and 8), with the coefficient of $\pi$ of somewhat higher magnitude as compared with the OCED countries. Clark (1997) and Fischer (1993) in their studies argued that the estimates of relationship suffer robustness problems and highly sensitive to modifications to the country sample, from developing countries to developed countries. Results are also sensitive to modifications in the time period of analysis.

When the effect of allowing G'/Y and X'/Y to enter the equation, we see from the Tables 3 and 4 that G'/Y is statistically insignificant. However, the magnitude and the significance of constant and coefficients of the input variables and $\pi$ follow the same general pattern. The discrepancies can be attribute to the same reason as outlined in the previous paragraph.

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