THE INFLATION-GROWTH NEXUS ACROSS COUNTRIES UNDER SIMULTANEOUS EQUATIONS MODEL

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ABSTRACT

This paper investigates the causal relationship between inflation and economic growth using a broad cross-country data over the 1970-2005 period. The identification and estimation of the structural parameters of interest can be easily achieved by following the novel approach of Lewbel (2011). This implies that conventional empirical studies that analyze the causal relationships between inflation and growth separately suffer from endogeneity bias. After removal of the simultaneous bias, we find that inflation and growth are significant interrelated as predicted by recent theories. Most importantly, our results indicate that inflation is harmful to growth whereas the effect from growth to inflation is beneficial. Moreover, we split our cross national dataset into high income, low income and developing countries, and the results indicate that the negative impact of inflation on growth in low income countries is greater than in developing and high income countries. On the other hand, we exploit the difference in effect of growth on inflation in different income level countries. Higher economic growth no longer results in improvement of inflation in high and low income countries. On the contrary, rapider economic growth induces higher inflation in low income sample countries.

Keywords: *Economic Growth; Inflation; Simultaneous equations; Endogeneity bias*
JEL classification codes: O40; O15; E25

INTRODUCTION

Empirical methods for detecting inflation and output growth have been the subject of intensive research in econometrics. The issue may be of crucial importance in testing empirical relevance of competing monetary models, and in advancing our understanding of effect on economic activity from inflation. Although the inflation-growth linkage is part of the liberal consensus in modern economics, there are still some controversies. Theoretical models in the money and growth literature analyze the impact of inflation on growth focused on the effects of inflation on the stabilization and output. Not everyone shares the same degree of confidence in the consensus conclusions. For the most part, the possible role of inflation on the growth process was ignored. Johnson (1967) and Okun (1971) argue that although desirable, achieving and maintaining steady inflation proves problematic because of political factors or policy differences. Based on the specific assumptions of the previous empirical models, one can arrive at a positive, negative, or zero effect of inflation on growth. Using simultaneous regression analysis, this paper reexamines the empirical relationship between aggregate inflation and output growth, especially the issue whether a threshold inflation rates or threshold income level exists.

The linkages, if any, between inflation and economic growth received considerable attention over last forty years. They are described in the surveys by Barro (1991), De Gregorio (1992), Fischer (1993), Barro (1995, 1996), Barro and Sala-i-Martin (1995), Bruno and Easterly (1996, 1998), Ghosh and Phillips (1998) and presented as a rationale for the endogenous growth model in Gillman and Kejak (2005). They conclude that inflation and growth relationships have indicated significantly negative effects over time. Similarly, view of Singh and Kalirajan (2003), Gylfason and Herbertsson (2001), and Guerrero (2006) discover that inflation retards output growth. Wilson (2006) provided strong evidence for the predictions that increased inflation uncertainty raises inflation rates and lowers economic growth.

On the contrary, there are also arguments for the negative effect of inflation on growth. Especially in Latin America, historical and comparative studies did not provide clear empirical conclusions about the negative relationship between inflation and growth (Paul et al., 1997), which isarguing with the pioneering work of Tobin (1965). The latter assumed the demand for money, the substitute for capital, is motivated by the optimistic conjecture on the positive effect between inflation and output, which often referred to as the Tobin effect. Higher accumulated capitals would lead to higher economic output. A few of the earliest cross-country studies on inflation and growth, like Baer (1967) and Taylor (1979, 1983) reconfirm the positive relationship between inflation and growth. There are many efforts to identify the mechanical relationship between the level of inflation and economic growth, or to determine whether rapider inflation results in higher growth. In addition, several researchers suggest that there was no conclusive empirical evidence for either a positive or a negative association between inflation and output growth. Brock (1974) and Sidrauski (1967) established the unrelated relationship between these two variables, advocating that money is superneutral in an optimal control framework considering real money balances in the utility function. Arai et al. (2002) found no evidence supporting the view that inflation is in general harmful to GDP growth by using annual data covering 115 countries during the period 1960-1995.

Recent works gradually moved from robustness check. However, reverse causation might be a serious problem. This problem complicated attempts to resolve an econometric specific about the relationships between growth and inflation; we are considering two endogenous variables. In empirical multi-country studies, insufficient effort has been directed to identifying the pattern of causation. For example, Paul et al. (1997) conducted a multi-country empirical examination of the patterns between inflation and growth in a sample of 70 countries under Granger (1969, 1980) inference. Their data set included the industrialized economies and developing economies. The conclusions were that the relationship between inflation and growth was non-uniform across countries, and a vast majority of countries show either uniform or bilateral causality over the sample period 1960-1989. Similar arguments can be found in Feliz and Welch (1997), Andrés et al. (1996), Arai et al. (2004), which are supported by compelling empirical evidence from Apergis (2004). The observed relationships between inflation and growth appear convincingly to be causal and not an artifact of simultaneity or reverse causality. The potential problem is the difficulty to identify exogenous instruments for inflation, which could be plausibly excluded from the growth regression.

As mentioned above, Ghosh and Phillips (1998) later suggested that there's no reason for skepticism about the existence of a robust negative inflation-growth relationship. Their empirical procedure for checking the negative relationship between inflation and growth does not disappear once an effort is made to remove simultaneity bias by using instrument variables1. Gillman et al. (2004) also try to eliminate potential endogeneity bias; their model used other instrumental variables to re-estimate. They find a negative significant inflation-growth effect. In that study, the current and lagged values of the money supply are instruments for inflation. As always, the validity of potential instruments is an issue. For instruments to be valid, they must be exogenous to the error term and significantly correlated with the variable they purport to represent. Unfortunately, as mentioned in Bound et al. (1993), the weak instruments can lead to large inconsistencies in parameter estimates even if the instruments are only weakly correlated with the error in the structural equation. In other words, variables that affecting growth (inflation) but not affecting inflation (growth) is difficult to find.

In this paper, we investigate whether growth and inflation are simultaneously determined and if so, whether they are subject to the same conditioning information sets or not. After extending the model in Gillman et al. (2004), we applied the extension to interpret the estimation of the inflation-growth effect in a novel approach advocated by Lewbel. Lewbel (2011) demonstrates that identification can

[1]Typically, the instruments are initial values of the regressors and perhaps some contemporaneous indicators not included as regressors such as the exchange regime, legal central bank independence and central bank governor turnover.

be obtained by observing a vector of exogenous variables that are uncorrelated with the covariance of heteroskedastic errors, which is shown to be a common feature of models with endogenously. This finding creates a simple way to resolve the simultaneity and reverse causality issues by employing a heteroskedasticity based identification method. One particular advantage of this method is that we do not require instrumental variables, which are not always available in many cases, to obtain identification. In addition, the associated estimators often take the standard form of generalized method of moments (GMM).

This paper proceeds as follows. Section 2 lays out the simultaneous bias and introduces the regression framework. Section 3 describes data sources and basic statistics. Section 4 reports the main results of the simultaneous equation model. Section 5 provides a summary and a brief discussion of the new findings.

THE SIMULTANEOUS EQUATIONS MODEL

The Simultaneity Bias Problem

For illustrative purpose, we abstract from other control variables and focus mainly on the following simple simultaneous equations to describe the inter-relationship between economic growth (g) and inflation (π),2

$$g_i = \beta_1 \pi_i + \varepsilon_{1i} \tag{1}$$

$$\pi_i = \beta_2 g_i + \varepsilon_{2i} \tag{2}$$

where $i = 1,2,\ldots,n,\ \varepsilon_{1i} \sim (0,\sigma_1^2)$ and $\varepsilon_{2i} \sim (0,\sigma_2^2)$ are the (uncorrelated) structural shocks to the"growth"and"inflation"regressions, i.e., equations (1) and (2),respectively. Clearly, the simultaneous system consisting of Eq. (1) and Eq. (2) allows joint determination of economic growth and inflation. Existing studies mostly concentrate on the estimate of β_1, which measures the effect of inflationrates on economic growth. On the contrary, in addition to β_1, we are also interested in estimating β_2, which assesses the impact of changes in economic growth on inflation.

It is well known that if both β_1 and β_2 is different from zero, equations (1) and (2) cannot be consistently estimated by standard econometric methodologies without further information or restriction. To see this, suppose that we estimate equation (1) by ordinary least squares (OLS) without taking into account the problem resulted from simultaneous equations. Specifically, the OLS estimator is given by

$$\hat{\beta}_1 = (\pi'\pi)^{-1}\pi' g$$

Where $\pi = (\pi_1, \pi_2, \ldots, \pi_n)'$ and $g = (g_1, g_2, \ldots, g_n)'$. The estimated coefficient $\hat{\beta}_1$ will be biased since the shock term ε_{1i} is correlated with the (endogenous) regressor π_1 as $Cov(\varepsilon_{1i}, \pi_i) = \dfrac{\beta_2 \sigma_1^2}{1-\beta_1\beta_2} \neq 0$. To see this, we can take expectation of the estimator $E(\hat{\beta}_1) = \beta_1 + (1-\beta_1\beta_2)\dfrac{\beta_2\sigma_1^2}{\beta_2^2\sigma_1^2 + \sigma_2^2}$. And soon we can find that the estimate is biased away from its true value β_1 due to simultaneity bias (i.e., if $\beta_2 \neq 0$ and $\sigma_1^2 > 0$). Similarly, the estimator $\hat{\beta}_2$ is also

[2] Without loss of generality, we omit constant terms for simplicity

biased. In this paper, we will follow Lewbel (2011) to search for a novel methodology to obtain identification and estimation of the structural parameters in the simultaneous equations system.

Modeling Strategy

To examine the interactions between inflation and growth jointly, we consider the following simultaneous equation model:

$$g_{it} = \alpha_1 \pi_{it} + x'_{it}\beta_1 + \varepsilon_{1it} \tag{3}$$

$$\pi_{it} = \alpha_2 g_{it} + x'_{it}\beta_2 + \varepsilon_{2it} \tag{4}$$

Where g_{it} and π_{it} denote real per capita GDP growth and the inflation coefficient for country i inyear t, respectively. Clearly, the system of equations allows inflation to affect growth and, in turn, growth to influence inflation. In addition, we also allow growth and inflation to depend on a vector of other control variables x_{it}. The parameters of particular interest are the coefficients of the endogenous variables, i.e., α_1 and α_2 as they measure the causal effect of inflation on growth and the causal impact of growth on inflation, respectively.

Identification and Estimation

Given equations (3) and (4), the common next step is to identify and estimate the structural parameters $\alpha_1, \alpha_2, \beta_1$ and β_2. Conventionally, identification of the structural parameters can be obtained by exclusion restrictions, such as assuming some elements of β_1 or β_2 are zero, or equivalently assuming the availability of instrumental variables. However, since variables that affect growth (inflation) but not affect inflation (growth) are difficult to find,if not impossible, we follow Lewbel (2011) to rely on heteroskedasticity in the errors to achieve identification of the structural parameters.[3]

In particular, Lewbel (2011) shows that the structural parameters in equations (3) and (4) can be identified if

$$E(x_{it}\varepsilon_{1it}) = 0 \tag{5}$$

$$E(x_{it}\varepsilon_{2it}) = 0 \tag{6}$$

$$Cov(z_{it}, \varepsilon_{1it}\varepsilon_{2it}) = 0 \tag{7}$$

and $Cov(z_{it}, \varepsilon_{jit}^2) \neq 0$ for both $j = 1$ and $j = 2$ where the observed z_{it} may be, though not needed to be a subset of x_{it}.Let π_{it} be the vector of elements of g_{it}, π_{it}, x_{it} and z_{it}. In addition, let θ represent the set of parameters $\{\alpha_1, \alpha_2, \beta_1, \beta_2, \mu\}$ where $\mu = E(z_{it})$. Now, define

$$Q_1(\theta, \pi_{it}) = x_{it}(g_{it} - \alpha_1\pi_{it} - x'_{it}\beta_1) \tag{8}$$

$$Q_2(\theta, \pi_{it}) = x_{it}(\pi_{it} - \alpha_2 g_{it} - x'_{it}\beta_2) \tag{9}$$

$$Q_3(\theta, \pi_{it}) = z_{it} - \mu \tag{10}$$

[3] Another interesting approach relies on heteroskedasticity in errors to obtain identification of endogenous regressors can be found in Rigobon (2003). Recent applications of Rigobon's identification method can be found in Rigobon and Sack (2003, 2004, 2005), Lee, Ricci and Rigobon (2004) and Kearns and Rigobon (2005).

$$Q_4(\theta,\pi_{it}) = (z_{it} - \mu)(g_{it} - \alpha_1\pi_{it} - x'_{it}\beta_1)(\pi_{it} - \gamma_2 g_{it} - x'_{it}\beta_2) \qquad (11)$$

and stack the above four vectors into one long vector $Q(\theta,\pi_{it})$. It is straightforward that

$$E[Q(\theta,\pi_{it})] = 0 \qquad (12)$$

However, because the population moments $E[Q(\theta,\pi_{it})]$ are unobservable, we are unable to solve for θ in the equation directly. Instead, it is natural to proceed by defining the corresponding sample moments

$$Q_n(\theta) = \frac{1}{n}\sum_{n=1}^{n} Q(\theta,\pi_{it}) \qquad (13)$$

and estimate θ by GMM of Hansen (1982).

GMM estimation mimics the population moment conditions by minimizing a quadratic form of the sample counterpart (11). The GMM estimator is:

$$\hat{\theta} = \underset{\theta}{\arg\min}\; Q_n(\theta)' \Omega_n^{-1} Q_n(\theta) \qquad (14)$$

where Ω_n is a positive definite weighting matrix. Hansen (1982) shows that, under some mild conditions, the resulting GMM estimator can be obtained by setting the weighting matrix $\Omega_n(\theta) = V_n^{-1}$, where $V_n^{-1} = n \times Var[Q_n(\theta)]$. Please see Hansen (1982) for more details.

DATA SOURCES

The cross-country dataset used in this paper is taken from the "International Financial Statistics (2006), IMF" consisting of 140 observations observed from 1970 to 2005. The list of countries can be found in the Appendix 1. The endogenous variables, *growth* and *inflation*, are the growth rate of per capita real GDP and the CPI index. Control variables are included to ensure that our coefficient estimates for the two endogenous regressors are not capturing the effects offactors that affect both growth and inflation. We followedthe monetary model of endogenous growth model, provided by Gillman et al. (2004), to construct conditioning information sets. The control variables are as follows: the natural logarithm of the share of government expenditure in GDP (*gov*), the share of gross capital formation in GDP (*inv*) , the share of money and quasi money in GDP (*m2*), which is a measure of financial development, the share of trade in GDP (*openness*), the ratio of US output to country i output (*pcgdp_us*) and the percent change in population (*pop*). These are variables that have been found by previous studies to have an impact on growth and inflation. Table 1 presents summary statistics and correlation matrix of these variables.

Furthermore, we split our cross-national dataset into high income, low income and developing countriesto provide robustness check from growth (inflation) on inflation (growth). For analytical purposes, the World Bank's main criterion for classifying economies is gross national income per capita (GNI). According to its GNI per capita, every individual economy is classified as low income, high income and middle income. Classification by income does not necessarily reflect development status. In addition, lowincome and middle income economies are sometimes referred to as developing economies. Following World Bank's criterion, we re-estimate the simultaneous equations using high income, low income and developing countries of our data sets, along with the controlling variables.

EMPIRICAL RESULTS

First of all, we start our analysis by estimating single-equation OLS regressions as carried out in equations (1) and (2). In original papers, each equation is of course estimated independently. Clearly, two coefficient estimates of the endogenous regressors are statistically different from zero. (Columns (1) and (2) in Table 2) As mentioned in section 3.1, we view these results as a possibly biased. By testing cross-equation restrictions, we can estimate them simultaneously.

We present main results in columns (3) and (4) of Table 2. After elimination of the endogeneity bias, all coefficient estimates for the endogenous regressors are statistically significant. We find that the impact of inflation on growth is negative at conventional levels. Our standard growth results taken from this sample do confirm the main hypothesis of monetary model of endogenous growth. The estimates imply that onepoint increase in inflation coefficient leads to 0.5050 percentage point decrease in per capita real GDP growth, depending on the conditioning information set. Regarding the effect of growth on inflation, we find a negative and statistically significant effect. That is, higher economic growth benefits improvement of inflation in our sample countries. The results in Columns 4 indicate that one percentage point increase in per capita real GDP growth leads to 0.4427 point decrease in inflation coefficient.

The results reported in Table 3 use data observations excludingall the high or low income level sample countries. In this context, it will be interesting to know the inflation-growth nexus in developing countries too. Once again, we test cross-equation restrictions simultaneously and present three sets of results: low income group, high income group and developing countries estimates. Overall, the coefficients from Table 3 strongly support that there is a significantly negative and causal inter-relationship between inflation and economic growth. For low income sample countries, the estimate of β_1 is -0.6044 in our standard growth equation. This estimated parameter is negative, statistically significant (at 1% level) and economically large. In addition, for the other two sample groups, high income group and developing countries, a simultaneous system is also estimated. These resultsalso indicate a negative inter-relationship between inflation to growth. (Columns (3) and (5) in Table 3) Moreover, the harmful impact of inflation on growth in low income countries is larger than the impact in high-income countries. (See in Fisher, 1993; Barro, 1995; Barro and Sala-i-Martin, 1995; Bruno,1995; Judson and Orphanides, 1996; Sarel, 1996)In sum, the finding confirms one of the main theoretical implications, the negative effect of inflation rate on economic growth, as predicted in Phillips (1958) and Fisher (1993) and Ghosh and Phillips (1998). More recent studies provide several arguments are advanced to support this viewpoint. For instance, increasing inflation rates has the potential to raise the cost of investment project, in turn affects growth. High inflation rate results in inefficient allocation in resourcesthus it has negative output effects.

Another interesting and important issue that we would like to address in this study is how the economic growth causally affects the level of inflation rates. Other researchers have advanced the argument that economic growth may cause the level of inflation rates to rise through the effects of expansion of some sectors of the economy. (see Lewis, 1964; Vogel, 1974) In our inflation regression, for lowincomesample countries, the inflation effect of growth measured by the parameter β_2 is estimated to be 0.3804. (Columns 2 in Table 3) This coefficient is positive and significant at the conventional 5% level. Consequently, it indicates that rapider economic growth induces higher inflation. This finding also confirmsanother important theoretical prediction by Ungar and Zilberfarb (1993) as the impact of economic performance on inflation is significantly positive.

In order to verify the hypothesis of no output-inflation trade-off, which was discussed earlier,we re-estimate the simultaneous system consisting of equation (3) and (4) using highincome countries in our sample, along with the controlling variables. As can be seen, in the context of the inflation equation, the coefficient loses its statistical significance. This result confirms Lucas (1973) which use data of 18 countries (fifthteen of them belong to the high income or developed countries), also provided support for the no output-inflation relationshiphypothesis. However, the hypothesis is rejected when using developing sample countries in our simultaneous estimate. The coefficient of growth in Columns (6) of Table 3 is still negative and statistically significant. This finding is also consistent with the recent study in Odedokun (1991). Thus, after we remove the endogeneity bias in investigating sub-sample that include low and high income countries, we can provide a reason for the non-uniform relations between inflation and growth.

We also examine the independent effects of the control variables on growth and inflation after the contemporaneous effect of the endogenous regressor has been accounted for. What are the driving forces of economic growth? According to the estimates in Columns 3 of Table 2, higher investment shares are associated with higher growth. Moreover, a larger government is associated with slower growth. The determinants of inflation can be found in Columns 4 of Table 2. The coefficient estimate for investment is positive and statistically significant in the inflation equation, indicating that higher investment is associated with more inflation. The estimates of “openness” and “pop” are negative and statistically significant in the inflation equation, indicating that trade surplus and human capital play a role in reducing inflation rates. We also find that the effect of “the ratio of US output to country *i* (*pcgdp_us*)” on inflation is negative and statistically significant. However, we do not find evidence that relative income induces growth.

CONCLUSIONS

Is growth negatively affected by inflation? Is inflation influenced by economic growth? The answers to these questions are of interest to policy makers who care about both growth and whatbenefits from growth. Enormous theoretical efforts have been devoted to solve these questions over the past few decades.Some focus on the potential effects of inflation on growth, while others emphasize the potential impact of growth on inflation. More recent theoretical papers point out that policies and structural changes that affect one of the two outcomes are likely to impact the other as well, implying that growth and inflation are jointly determined. Thus, conventional empirical studies on the causal links between inflation and growth are plagued by endogeneity and reverse causality.

Our research sets out to resolve the endogeneityand reverse causality issues applying the method inLewbel (2011). In contrast to previous studies, the main advantage of Lewbel’s method is that no instrumental variables are needed to identify the structural parameters. We consider a linear simultaneous equation model in this procedure, thus the indentification of structural parameters only requires that the errors to be heteroskedastic and a subset of the exogenous control variables to be uncorrelated with the error covariance. Using a broad cross-country data set taken from IFS, we find that inflation does cause economic growth and vice versa. The results show that inflation and growth are strongly negatively inter-related inall sample countries. This finding is supportive of the empirical implications of Ghosh and Phillips (1998), Valdovinos (2003), Apergis (2004) and Gillman et al. (2004).

After removal of the endogeneity bias, we also find a positive impact on inflation from economic growth in lowincome sample countries. This result is consistent with the demand theory argument in Stockman (1981). His argument provided that anticipated inflation reduces the demand for real balances, implying that the demand for capital and output growth decreases. Certain studies support a negative association between them. (Zhang, 2000; Dorrance, 1964; Lewis, 1964) The main results that emerge from our exercise are that the relationshipbetween inflation and growth is non-uniform in cross-country. This implies that conventional analysis, which looks at each outcome independently, fails in two aspects. First, it ignores the evidence that policies designed to improve one outcome will probably also influence the other; second, it fails to see that their independent model is unidentified; it can’t even be certain about what it is estimating. Therefore, future research should try to expand the siultaneous equations model to allow for more endogenous variables.

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Table1: Summary statistics and correlation matrix

Panel A: Summary statistics

	growth	inflation†	gov†	inv†	m2†	openness†	pcgdp_us	pop
Mean	1.4217	2.7365	2.7144	3.1033	3.3771	4.2150	0.1428	1.8145
Median	1.3271	2.3795	2.7508	3.1349	3.3571	4.2389	0.0521	2.0625
Max.	7.3558	6.9829	3.5860	3.7286	5.2611	5.4157	1.1459	4.0530
Min.	-3.8284	-0.9883	1.5804	2.2728	-2.9805	2.8406	0.0037	-0.2383
Std.	1.9156	1.4077	0.3705	0.2586	0.8017	0.5311	0.2362	1.0263
Obs.	140							

Panel B: Sample correlation of variables

growth	1.0000							
inflation†	-0.3784	1.0000						
gov†	-0.0868	-0.0426	1.0000					
inv†	0.4900	-0.1269	0.3771	1.0000				
m2†	0.3542	-0.3678	0.1082	0.3655	1.0000			
openness†	0.1192	-0.1828	0.5328	0.4740	0.2005	1.0000		
pcgdp_us	0.1020	-0.2372	0.1813	0.1451	0.3641	0.0158	1.0000	
pop	-0.1690	-0.1628	-0.0782	-0.3544	-0.0900	-0.2053	-0.2636	1.0000

Note: 1. The dataset is taken from the "International Financial Statistics (2006), IMF"and is a cross sectional dataset consisting of 140 countries observed from 1970 to 2005. The list of countries can be found in the Appendix2. 2. †Take the logarithm of variables.

Table2: Linear regression and main results of the simultaneous

	Dependent Variable			
	OLS		Simultaneous	
	growth	inflation	growth	inflation
inflation	-0.4484***		-0.5050***	
	(0.0000)		(0.0027)	
growth		-0.2843***		-0.4427**
		(0.0000)		(0.0455)
constant	-5.0485***	4.8456***	-4.5312**	3.5227*
	(0.0089)	(0.0015)	(0.0433)	(0.0719)
gov	-1.3391***	0.1390	-1.3163***	-0.2637
	(0.0020)	(0.6917)	(0.0023)	(0.5846)
inv	3.9500***	0.9049	3.9109***	1.6894**
	(0.0000)	(0.1075)	(0.0000)	(0.0465)
m2	0.2391	-0.3255**	0.1831	-0.2681
	(0.2042)	(0.0290)	(0.2604)	(0.2211)
openness	-0.3295	-0.6762***	-0.3581	-0.6797***
	(0.2913)	(0.0059)	(0.2833)	(0.0067)
pcgdp_us	-0.5082	-1.4029***	-0.5276	-1.4476***
	(0.4189)	(0.0045)	(0.4681)	(0.0003)
pop	-0.1497	-0.4081***	-0.1469	-0.4066***
	(0.2987)	(0.0003)	(0.3705)	(0.0000)
Obs.	140		140	

Note: 1. Numbers in parentheses are *p-value*. 2.***, ** and * indicate significant at 1%, 5% and 10% level, respectively.

Table 3: Main Results of the simultaneous in different income level countries

	Dependent Variable					
	low income		high income		Developing#	
	growth	inflation	growth	inflation	growth	inflation
inflation	-0.6044***		-0.4778**		-0.5367***	
	(0.0046)		(0.0467)		(0.0009)	
growth		0.3804**		0.0486		-0.4565**
		(0.0282)		(0.8266)		(0.0300)
constant	-4.4042	11.2626***	-6.9692	15.2018***	-3.8189*	3.9019**
	(0.1761)	(0.0000)	(0.1699)	(0.0000)	(0.0959)	(0.0478)
gov	-2.3189**	2.3394***	-0.2723	-0.4257	-1.4867***	-0.1430
	(0.0224)	(0.0012)	(0.7402)	(0.3323)	(0.0020)	(0.7697)
inv	5.0168***	-2.2175*	4.1550***	-1.5324	4.0479***	1.8354**
	(0.0000)	(0.0594)	(0.0027)	(0.2374)	(0.0000)	(0.0262)
m2	0.4088	-2.0626***	0.4757	-0.7336**	0.1284	-0.2696
	(0.5847)	(0.0014)	(0.5181)	(0.0527)	(0.4172)	(0.2068)
openness	-0.8760	-0.6977	-0.6629	-0.6941**	-0.5337	-0.9905***
	(0.1461)	(0.1717)	(0.1689)	(0.0399)	(0.1945)	(0.0005)
pcgdp_us	-29.1301	130.0079***	-2.1484*	-1.3781**	1.4813	0.0913
	(0.3621)	(0.0000)	(0.0592)	(0.0169)	(0.3499)	(0.9273)
pop	0.2984	-0.3912	-0.2393	-0.3935**	-0.0784	-0.3844***
	(0.5702)	(0.2136)	(0.4062)	(0.0123)	(0.6428)	(0.0004)
Obs.	51		44		124	

Note: 1. Numbers in parentheses are *p-value*. 2.***, ** and * indicate significant at 1%, 5% and 10% level, respectively. 3. # includes low income, upper-middle income and middle income countries in our data set.

Appendix 1: List of the 140 countries in the sample

Africa			***Asian Pacific***	***Europe***
Algeria[‡]	Guinea-Bissau[*‡]	Oman[†‡]	Australia[†]	Albania[‡]
Angola[*‡]	Iran[‡]	Rwanda[*‡]	Bangladesh[*‡]	Armenia[*‡]
Bahrain[†‡]	Israel[†]	Saudi Arabia[†‡]	Bhutan[*‡]	Azerbaijan[*‡]
Benin[*‡]	Jordan[†‡]	Senegal[*‡]	Cambodia[*‡]	Belarus[‡]
Botswana[†‡]	Kenya[*‡]	Seychelles[†‡]	China[*‡]	Bulgaria[‡]
Burkina Faso[*‡]	Korea[†‡]	Sierra Leone[*‡]	Fiji[‡]	Croatia[†‡]
Burundi[*‡]	Lesotho[*‡]	South Africa[‡]	Hong Kong, China[†]	Cyprus[†]
Cameroon[*‡]	Madagascar[*‡]	Sudan[*‡]	India[*‡]	Czech Rep.[†‡]
Cape Verde[‡]	Malawi[*‡]	Swaziland[‡]	Indonesia[*‡]	Denmark[†]
Central African Rep.[*‡]	Mali[*‡]	SyrianArabRepublic[‡]	Japan[†]	Estonia[†‡]
Chad[*‡]	Malta[†‡]	Tanzania[*‡]	Korea[†‡]	Georgia[‡]
Congo, Dem. Rep.[*‡]	Mauritania[*‡]	Togo[*‡]	Lao PDR[*‡]	Hungary[†‡]
Cote d'Ivoire[*‡]	Mauritius[†‡]	Tunisia[‡]	Malaysia[†‡]	Iceland[†]
Egypt, Arab Rep.[‡]	Morocco[‡]	Uganda[*‡]	Maldives[‡]	Kazakhstan[‡]
Ethiopia[*‡]	Mozambique[*‡]	Yemen, Rep.[*‡]	Mongolia[*‡]	Kyrgyz Rep.[*‡]
Gabon[†‡]	Namibia[‡]	Zambia[*‡]	Nepal[*‡]	Latvia[‡]
Gambia, The[*‡]	Niger[*‡]	Zimbabwe[*‡]	New Zealand[†]	Lithuania[‡]
Ghana[*‡]	Nigeria[*‡]		Pakistan[*‡]	Macedonia[‡]
			Papua New Guinea[‡]	Moldova[*‡]
North America, South America, Central America and Caribbean:			Philippines[‡]	Norway[†]
Argentina[†‡]	Dominican Rep.[‡]	Panama[†‡]	Solomon Islands[*‡]	Poland[†‡]
Bahamas[†]	Ecuador[‡]	Paraguay[‡]	Sri Lanka[‡]	Romania[‡]
Barbados[†‡]	El Salvador[‡]	Peru[‡]	Thailand[‡]	Russian Federation[‡]
Belize[‡]	Grenada[†‡]	St. Kitts and Nevis[†‡]	Tonga[‡]	Slovak Republic[†‡]
Bolivia[‡]	Guatemala[‡]	St. Lucia[‡]	Vanuatu[‡]	Slovenia[†]
Brazil[†‡]	Guyana[‡]	St. Vincent and the Grenadines[‡]	Vietnam[*‡]	Switzerland[†]
Canada[†]	Haiti[*‡]	Suriname[‡]		Turkey[†‡]
Chile[†‡]	Honduras[*‡]	Trinidad and Tobago[†‡]		Ukraine[‡]
Colombia[‡]	Jamaica[‡]	United States[†]		
Costa Rica[‡]	Mexico[†‡]	Uruguay[†‡]		
Dominica[‡]	Nicaragua[*‡]	Venezuela[†‡]		

Note: Three panels of countries are examined. [*] and [†] indicate country's income level at low and high, respectively. [‡] indicates the third panel consisting of 124 developing countries. (forty-five of them belonging to middle and twenty-eight of them belonging to upper-middle)

Appendix 2: Results of linear regression in different income level countries

	Dependent Variable					
	low income		high income		Developing#	
	growth	inflation	growth	inflation	growth	inflation
inflation	-0.2028		-0.0739		-0.4705***	
	(0.2745)		(0.7828)		(0.0000)	
growth		-0.1366		-0.0289		-0.3278***
		(0.2745)		(0.7828)		(0.0000)
Obs.	51		44		124	

Note: 1. Numbers in parentheses are *p-value*. 2.***, ** and * indicate significant at 1%, 5% and 10% level, respectively. 3. # includes upper-middle and middle countries in our data set.