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THE RELATIONSHIP BETWEEN PUBLIC DEBT AND INFLATION IN DEVELOPING COUNTRIES: EMPIRICAL EVIDENCE BASED ON DIFFERENCE PANEL GMM

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Abstract

High inflation is considered to be an adverse factor to economic growth in developing countries. High economic growth at a stably low inflation is one of major objectives for most of governments worldwide. However, most of developing countries have to borrow debts to finance budget deficits and to promote economic growth. The paper empirically investigates the relationship between public debt and inflation for 60 developing countries in Asia, Latin America and Africa over the period 1990 – 2014 via the estimation method of difference panel GMM Arellano-Bond. The estimated results show that in the direction from public debt to inflation, public debt has a significantly positive effect on inflation while in the opposite direction, inflation has a significantly negative effect on public debt. Furthermore, the study also found the significant determinants of public debt and inflation in developing countries of Asia, Latin America and Africa. These results suggest some important policy implications for governments in developing countries.

Keywords: Public debt, inflation, different panel GMM, developing countries

1. INTRODUCTION

High economic growth at a stably low inflation is one of major objectives in most of economies worldwide. Stabilizing price level plays a critical role in determining growth of an economy; so, monetary authorities in many countries implement monetary policies to control and maintain inflation at a desirable level. Too high inflation has an adverse effect on the economy but there are empirical evidences to indicate that a moderate inflation also decreases economic growth (Temple, 2000). However, high inflation is not only stemmed from instruments of monetary policy (money supply, interest rate, exchange rate, inflation, …) but comes from instruments of fiscal policy (government revenue and expenditure, fiscal deficit, public debt, …) as well. Indeed, Fischer *et al.* (2002) show that fiscal deficit is one of determinants of high inflation. In order to promote economic growth, create more employments and maintain the socio-economic stability, most of governments in developing countries increasingly invest in education, health and infrastructure by government budget. As a result, budget deficit occurs because the budget revenue from tax cannot offset for government spending. Most of governments borrow domestic and external debts to deal with fiscal deficits instead of making seigniorage to avoid high inflation and socio-economic instability. However, some theoretical and empirical literature show evidence that above a certain threshold, the debt to GDP ratio has a negative impact on economic growth (Cordella *et al.*, 2005; Caner *et al.*, 2010). The economy can suffer adverse impacts from debt overhang: above a certain point, the level of debt can create a disincentive for investors who believe that their profits will be heavily taxed so that government has enough money to service its relatively large and growing stock of debt. This is

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an adverse implication for economic growth. Furthermore, some governments have not enough financial resource to service the debt, which leads to economic crisis and social instability (for instance Greek, Ireland, and Italia in European sovereign debt crisis 2010).

Bhattarai *et al.* (2014) developed a theoretical framework to show the effect of public debt on inflation, which includes three policy regimes.

The first is the "monetary dominant" regime with an active monetary and passive fiscal policy in which a high reaction of interest rates to inflation is connected closely with a high response of taxes to public debt. In this regime, inflation closely follows the path of the inflation target and in fact, stronger the reaction of monetary policy to inflation, more closely will actual inflation follow the inflation target and lower is inflation volatility. Public debt and fiscal policy stance do not matter for inflation dynamics.

The second is the so-called non-Ricardian or "fiscal dominant" regime with a passive monetary and active fiscal policy, where a low reaction of interest rates to inflation is linked closely with a low response of taxes to public debt. In this regime, sharply contrary to the first, inflation and the inflation target are divergent, means inflation varies in opposite direction from the inflation target. In fact, stronger the systematic reaction of monetary policy to inflation, greater will be the divergence between the inflation target and the actual inflation. In addition, a stronger reaction of monetary policy to inflation increases the response of inflation to non-policy shocks and raises inflation volatility. Moreover, now, fiscal policy – level of public debt and fiscal policy stance – has strong effects on inflation dynamics. In particular, a higher level of public debt makes inflation increase, while a more active fiscal policy makes the response of inflation to non-policy shocks weaker and a greater deviation of the actual inflation from the inflation target.

The final regime is a passive monetary and passive fiscal policy where a low reaction of interest rates to inflation is associated closely with a high response of taxes to public debt, and which leads to equilibrium indeterminacy. Then, both monetary and fiscal policy stances have effects on inflation dynamics, although the level of public debt doesn't matter to inflation.

In principle, higher inflation could help reduce public debt (Akitoby *et al.*, 2014). According to Abbas *et al.* (2014), if income brackets are not indexed under a progressive income tax, then inflation can influence the primary balance. Governments can also capture real resources by base money creation, but the scope for raising seignior age is limited by the small size of base money. The largest effect of inflation on debt would be from eroding the real value of debt. Based on assumptions such as a constant debt maturity structure, no impact of inflation on economic growth, and a one-for-one adjustment of nominal interest rates on newly issued debt to inflation (full Fisher effect), Abbas *et al.* (2014) made simulations on the impact of inflation on debt for Group of Seven countries. The results suggest that a hypothetical increase in inflation from World Economic Outlook baseline levels to 6 percent for five years would reduce the average net debt by less than 10 percentage points by the end of the period in most countries. Therefore, inflation is one of effective tools for reducing public debt. Reinhart *et al.* (2015) argued in principle inflation is always an option for substantially reducing debt as long as debt is denominated in domestic currency.

A report about the situation of economic growth, public debt and inflation in developing countries in Asia, Latin America and Africa was described in World Economic Situation and Prospects 2015 (UN, 2015). According to UN (2015), the rate of economic growth in developing countries and economies in transition have become more divergent during 2014 due to a sharp deceleration in a number of large emerging economies, particularly in Latin America and the Commonwealth of Independent States. Thus, growth in developing countries as a group is expected at 4.8 and 5.1 per cent in 2015 and 2016, respectively. However, the least developed countries are expected to continue exceeding the global average growth, at 5.7 per cent in 2015 and 5.9 per cent in 2016. Meanwhile, economies in transition are expected to grow at 1.1 per cent and 2.1 per cent in 2015 and 2016, respectively.

In 2014, the fiscal developments in these developing countries also varied. The report of UN (2015) showed budget deficits and public debt levels in these countries are generally lower than in developed economies. As commodity prices still remained weak, government revenues in many commodity exporters continued to underperform. Against the backdrop of the high indebtedness of local governments, public spending by the central government seems to increase in the future. Developing countries should be more cautious in sovereign borrowing despite comparatively low public debt levels. The borrowing cost to refinance external debt may be high if there is a sharp change of investor appetite for emerging markets, a weakening of the exchange rate, or higher levels of benchmark interest rates. However, the increasing inequality will make governments in many emerging economies increase fiscal spending to narrow income gaps and promote social mobility.

According to UN (2015), the average inflation in developing economies will fall slowly over the outlook period. Due to increasingly prudent monetary policies as well as moderating import prices, inflation in Africa will decline to 6.8 per cent in 2016. While inflation for East Asia will maintain the recent levels of 2–3 per cent, a pronounced decrease in South Asia is forecast from 14.7 per cent in 2013 to 7.2 per cent in 2016, owing to falling inflation in almost all countries. In Western Asia, inflationary pressures have been well contained. In Latin America and the Caribbean, in spite of an increase in aggregate regional inflation in 2014, it is expected to recede moderately to 8.8 per cent in 2015. Therefore, the research question is whether there exists a significant relationship between public debt and inflation in these developing countries and what determinants of public debt and inflation are.

The main goal of this paper is to employ the estimation method of difference panel GMM Arellano-Bond to empirically investigate the relationship between public debt and inflation with control variables of real GDP per capita, private investment, labor force, government revenue, infrastructure and trade openness for 60 developing countries in Asia, Latin America and Africa over the period 1990 – 2014.

The remainder of this paper will be proceeded as follows: Section 2 outlines a review of literature about the relationship between public debt and inflation; Section 3 describes the methodology and data; Section 4 presents the results and discussion, and final section is the conclusion and policy implications.

2. LITERATURE REVIEW

Stabilization of price level is one of main goals of most governments in macroeconomic management. It is also considered a good measure for better economic performance. In definition, inflation is a general and persistent increase in prices of goods and services and is directly connected with erosion and reduction of purchasing power of money. Meanwhile the majority of governments use public debt as a tool to finance the budget deficit, so public debt must be used effectively in order to promote the economic growth.

Taghavi (2000) empirically examines the hypothesis that public debt has potential adverse effects on investment, inflation and growth in large European economies in the period of 1970 - 1997. Using the hybrid co-integration and vector autoregressive models, the paper suggests that debt causes significant negative effects on investment but these effects on growth are not clear-cut. Furthermore, debt seems to be inflationary in long run, though its impact on inflation in short run is not clear.

Kwon *et al.* (2006) advocate the view of Sargent and Wallace (1981) that an increase in public debt typically leads to inflation in highly indebted countries. Authors empirically investigate the relationship between public debt and inflation in form of panel data for 71 countries from 1963 to 2004 using OLS regression estimation and VAR model. Estimated results indicate that the relationship holds strongly in indebted developing countries, weakly in other developing countries, but generally not in developed economies. However, this relationship becomes weak in inflexible

exchange rate regimes. Furthermore, the study also finds the importance of institutional and structural factors in the link between fiscal policy and inflation.

Bildirici & Ersin (2007) empirically studies the economic relationship between inflation and domestic debt for nine countries in the period of 1980 – 2004 using FMOLS (Fully Modified OLS estimation) and VEC model. The results show that in countries that experience high inflation, the inflationary process fed on increasing costs of domestic debt. As a result, the increasing debt to GDP ratios led these countries to borrow at higher interest rates and with lower maturity rates.

Ahmad *et al.* (2012) confirm that inflation is a critical problem in many countries, especially in the less developed countries. Using the OLS regression estimation, their paper empirically studies the effect of domestic debt on inflation in Pakistan for the period 1972 to 2009. The research observes domestic debt and domestic debt servicing enhance the price level in Pakistan. The estimated results show the volume of domestic debt and domestic debt servicing have significantly positive effects on price level. Authors argue the floating debt, i.e. treasury bills make up a large proportion of total domestic debt, and the interest rate, i.e. the cost of domestic borrowing or debt servicing are main reasons to enhance price level.

Harmon (2012) studies the impact of public debt on three major economic indicators (inflation, GDP growth and interest rates) in Kenya on the period 1996 to 2011. Adopting a descriptive research design and simple linear regression models, the research finds out there is a weak positive relationship between the public debt and inflation while links between public debt – GDP growth as well as public debt – interest rates are negative.

Akitoby *et al.* (2014) studies the influence of low or high inflation on the public debt in the G-7 countries. The results of stimulation indicate that if inflation were to fall to zero for five years, the average net debt would increase by about 5 percentage points over the next five years. In contrast, raising inflation to 6 percent for the next five years would decrease the average net debt by about 11 percentage points under the full Fisher effect and about 14 percentage points under the partial Fisher effect. It implies that higher inflation could help reduce the public debt somewhat in advanced economies.

According to Hilscher *et al.* (2014), theoretically higher inflation will lower the real value of outstanding government debt. In order to demonstrate this argues, these authors propose a method based on an ex-ante perspective of the government budget constraint, detailed information on debt, and a set of plausible counterfactuals. By applying this method to the United States in 2012, the authors estimate that the impacts of higher inflation on the fiscal burden are modest. Moreover, these authors also suggest a more promising route to inflate away the public debt is to use financial repression. Their estimation result indicates a decade of repression combined with high inflation could wipe out almost half of the debt.

Lopes *et al.* (2014) analyse the implications of public debt on economic growth and inflation in a group of 52 African economies between 1950 and 2012. Using a time series of historical data from 1950 until 2012, the results indicate public debt has a positive impact on inflation. It means that the high public debt leads high inflation.

Nastansky *et al.* (2014) use quarterly data for Germany over period of 1991 – 2010 to empirically investigate the interaction between public debt and inflation including mutual impulse response. Authors analysis the transmission from public debt to inflation through money supply and long-term interest rate within a vector error correction model estimated by Johansen approach. The estimated results show that the public debt level has a significantly positive effect on consumer prices. That means public debt statistically causes inflation vice versa.

Martin (2015) theoretically analyses the independence of central bank under relationship between debt and inflation. According to the author, although this reform would bring benefit to the society

and initially reduce inflation, it would not lower inflation permanently. The smaller anticipated policy distortions implemented by a more independent central bank would make the fiscal authority trade-off higher current deficits for lower future deficits. As a result, in the long run, a higher level of public debt will lead to an increase in inflation. The author suggests that imposing a strict inflation target would lower inflation permanently and prevent the primary deficit from political distortions.

According to Nguyen (2015), high inflation is considered to be an adverse factor to the economic growth in developing countries. High economic growth at a stably low inflation is one of major objectives for most of governments worldwide. However, most of developing countries have to borrow debts to finance budget deficits and to promote economic growth. In the paper, the author empirically investigates the effects of public debt on inflation in 15 developing economies of Asia in the period of 1990 – 2012. The estimated results from both methods of PMG estimation and panel differenced GMM Arellano – Bond regression show that public debt has statistically positive effects on inflation. It implies that fiscal policy with high level of public debt to finance budget deficits is inflationary in these selected economies of Asia.

3. METHODOLOGY AND DATA

3.1. Methodology

In order to empirically investigate the relationship between public debt and inflation for a whole sample of 60 developing countries and for three sub-samples of developing countries (22 in Asia, 11 in Latin America, and 27 in Africa) over the period 1990 – 2014, the paper proposes two empirical equations as follows:

$$\Delta INF_{it} = \alpha_{it} + \beta_0 INF_{it-1} + \beta_1 DEB_{it} + Z_{it}\beta'_2 + \eta_i + \xi_{it} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$\Delta DEB_{it} = \alpha_{it} + \beta_0 DEB_{it-1} + \beta_1 INF_{it} + Z_{it}\beta'_2 + \eta_i + \xi_{it} \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where $\eta_i \sim iid(0, \sigma_\eta)$; $\zeta_{it} \sim iid(0, \sigma_\zeta)$; $E(\eta_i \zeta_{it}) = 0$. Variable *INF* is inflation and *DEB* is public debt; Z_{it} is a set of control variables; η_i is an unobserved time-invariant, country-specific effect and ζ_{it} is an observation-specific error term.

Equation (1) is a dynamic model. $\Delta INF_{it} = INF_{it} - INF_{it-1}$ is the first difference of *INF*, proxy for growth rate of inflation. Variable INF_{it-1} on the right side of equation is proxy for initial level of inflation. Similarly, in equation (2), $\Delta DEB_{it} = DEB_{it} - DEB_{it-1}$ is the first difference of *DEB*, proxy for growth rate of public debt and DEB_{it-1} on the right side of equation is proxy for initial level of public debt.

The set of variables Z_{it} includes some following determinants, which have impacts on inflation/public debt: real GDP per capita, private investment, labor force, government revenue, infrastructure, and trade openness.

For the empirical equations (1) and (2), the presence of the lagged dependent variable gives rise to autocorrelation. It can make OLS inconsistency and estimates bias for short time dimension (small T) (Judson & Owen, 1999). Therefore, we decided to use the Arellano – Bond (1991) difference GMM estimator first proposed by Holtz-Eakin *et al.* (1988). The Arellano – Bond estimator was designed for dynamic "small-T large-N" panels (Judson & Owen, 1999; Roodman, 2006). In the standard GMM procedure, it is essential to distinguish *instrumented variables* and *instruments*. Endogenous variables are put in the group of instrumented variables by lags of these variables (Judson & Owen, 1999). Strictly exogenous regressors as well as extra instruments are put in the group of instrument variables and included in standard IV procedure. For exogenous variables, level and lags of them are the suitable instruments (Judson & Owen, 1999).

The validity of instruments in GMM estimator is assessed through Sargan statistic and Arellano-Bond statistic. The Sargan test with null hypothesis H_0: the instrument is strictly exogenous, which

means that it does not correlate with errors. Thus, the p-value of Sargan statistic is as big as possible. The Arellano-Bond test is used to detect the autocorrelation of errors in first difference. Thus, the test result of first autocorrelation of errors, AR(1) is ignored while the second autocorrelation of errors, AR(2), is tested on the first difference series of errors to detect the phenomenon of first autocorrelation of errors, AR(1).

3.2. Data

Cross-sections and time series are extracted to accommodate the panel data of 60 developing countries over period of 1990 - 2014 from World Bank (World Development Indicators) and International Monetary Fund (World Economic Outlook). Some missing values of the data set in some countries are filled with reference to www.tradingeconomics.com. The list of 60 developing countries consists of 22 in Asia (Bangladesh, Bhutan, Cambodia, India, Jordan, Kazakhstan, Kyrgyzstan, Lao, Lebanon, Malaysia, Mongolia, Nepal, Pakistan, Philippines, Sri Lanka, Tajikistan, Thailand, Turkey, UAE, Uzbekistan, Vietnam, and Yemen), 11 in Latin America (Bolivia, Brazil, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Peru, Uruguay, and Venezuela) and 27 in Africa (Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Congo Democratic Republic, Congo Republic, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Lesotho, Liberia, Malawi, Mali, Niger, Rwanda, Senegal, Sierra Leone, South Africa, Sudan, Swaziland, Togo, and Uganda). We define and calculate the variables as follows:

- PDEB: public debt, a share of GDP (%).
- INFL: inflation per year (%).
- lGDP: a real gross domestic product per capita, proxy for the economic growth of a country. This variable is used in form of natural logarithm.
- PINV: private investment, a share of GDP (%).
- LABO: labor force, a ratio between working age people (15-64) and total population of a country (%).
- REV: government revenue, a share of GDP (%).
- TELE: infrastructure development. The infrastructure can be measured in some different ways such as the length of high way per square kilometer (Du *et al.*, 2008), the length of railway (Kuzmina *et al.*, 2014) or the fixed telephone subscriptions per 100 people (Bissoon, 2011; Nguyen, 2015). In this study, it is the fixed telephone subscriptions per 100 people.
- OPEN: trade openness, a share of GDP (%).

The statistical description of all variables is presented in the Table 1.

Table 1: Statistical description

Variables	Obs	Mean	Std.Dev.	Min	Max
Public debt PDEB (%GDP)	1126	68.175	66.502	2.69	786.438
Inflation INFL (%)	1126	13.012	56.170	-18.108	1568.33
GDP per capita lGDP (USD/year)	1126	2321.7	4526.5	113.87	47081.2
Private investment PINV (% GDP)	1126	15.375	7.523	-16.905	53.189
Labor force LABO (% of population)	1126	69.141	10.443	40.5	88.3
Government revenue REV (% GDP)	1126	23.552	9.814	0.637	68.283
Infrastructure TELE (Fixed telephone subscriptions per 100 people)	1126	5.956	7.183	0	33.922
Trade openness OPEN (% GDP)	1126	78.510	40.668	10.748	220.407

The matrix of correlation coefficients for variables is given in Table 2. Accordingly, real GDP per capita, private investment, labor force, government revenue, and infrastructure are negatively correlated to public debt at significance level of 1% while only real GDP per capita is negatively associated with inflation at 5% significance level. In addition, all correlation coefficients between

independent variables are relatively low, which helps to eliminate the possibility of co-linearity between these variables.

Table 2: Matrix of correlation coefficients

	PDEB	INFL	lGDP	PINV	LABO	REV	TELE	OPEN
PDEB	1.000							
INFL	0.031	1.000						
lGDP	-0.243***	-0.072**	1.000					
PINV	-0.109***	-0.025	0.185***	1.000				
LABO	-0.167***	-0.041	-0.332***	-0.105***	1.000			
REV	-0.168***	0.011	0.319***	0.217***	-0.056*	1.000		
TELE	-0.167***	-0.023	0.760***	0.088***	-0.160***	0.223***	1.000	
OPEN	-00.023	-0.048	0.268***	0.248***	-0.109***	0.424***	0.111***	1.000

Note: ***, ** and * denote significance at 1%, 5% and 10% respectively

4. RESULT AND DISCUSSION

4.1. The relationship between public debt and inflation in 60 developing countries (the whole of sample)

The estimated results derived from the method of panel difference GMM Arellano – Bond is shown in Table 3. The positive sign of real GDP per capita coefficient is opposite to the negative sign of correlation coefficient between real GDP per capita and inflation given in Table 2. It implies that there exists an endogenous phenomenon between the regressand and regressors. Therefore, the method of panel difference GMM Arellano – Bond estimation with instrumental variables seems to be appropriate for this empirical model.

To assess the validity of instruments in GMM first-difference estimation and the serial auto-correlation of residuals, the study performs the Sargan test (test of over-identifying restrictions with the null hypothesis "the instruments as a group are exogenous") as well as the Arellano – Bond test for serial correlation (AR 2), which is applied to the difference residuals to purge the unobserved and perfectly auto correlated. The results of these tests show that all null hypothesizes are rejected. Thus, instruments are appropriate and there is no phenomenon of serial correlation for residuals in second differences.

To check the robustness of the difference panel GMM Arellano-Bond estimation, the estimated results are usually verified by removing/adding some variables. Accordingly, this estimation begins at Model 1, then continues with Model 2 and ends at Model 3 (the full variables model). The results show sign, size and significance of estimated coefficients in table 3, table 4, table 5, table 6, table 7, table 8, table 9, and table 10 are nearly unchanged. It confirmed that results of the difference panel GMM estimation are strongly robust.

The estimated result in Table 3 showed public debt, real GDP per capita (economic growth), and private investment have significantly positive effects, whereas labor force, infrastructure, and trade openness have significantly negative influences on inflation.

Indeed, the positive effect of public debt on inflation advocates the view of Sargent and Wallace (1981) that an increase in public debt typically leads to inflation in highly indebted countries. In fact, the previous papers such as Taghavi (2000), Kwon *et al.* (2006), Ahmad *et al.* (2012), Nastansky *et al.* (2014), Nguyen (2015), Martin (2015) empirically approved that public debt has a positive influence on inflation.

Bashir *et al.* (2011) and Gyebi & Boafo (2013) showed that economic growth is one of determinants of inflation in developing countries. According to them, high economic growth leads to high inflation.

In models of economic growth, capital stock and human capital are two major endogenous inputs to promote economic growth. In the case of developing countries, the ineffective use of private investment leads to increased inflation. This is consistent with the conclusion of Buffie (1995) that in long run to some extent private investment leads to high inflation. Contrary to private investment, an increase in labor force reduces inflation.

Looney (1990) indicated that infrastructure in Saudi Arabia achieved its main aim: reduction in structural sources of inflationary pressures in the non-oil sectors. Wurstbauer & Schäfers (2015) empirically approved that infrastructure provides a long-term hedge against inflation. It implies that the impact of infrastructure on inflation is negative.

Providing evidence from different countries, the effect of trade openness on the inflation rate could be positive or negative. In this study, trade openness has a negative influence on inflation. It supports the hypothesis first documented by Romer (1993) that inflation is lower in more open economies. Samimi *et al.* (2012) confirmed the negative impact of openness on inflation.

Table 3: The effect of public debt on inflation for the whole sample (60 developing countries) Dependent variable: Δ Inflation

	Model 1	Model 2	Model 3
Inflation (-1)	-1.279***	-1.280***	-1.280***
Public debt	0.403**	0.388**	0.405**
GDP per capita	1.034**	1.312***	1.301***
Private investment	6.568***	6.045***	5.869***
Labor force	-16.671*	-22.132**	-21.482**
Government revenue			0.365
Infrastructure		-3.146**	-3.091**
Trade openness	-1.856***	-1.781***	-1.828***
Obs	1006	1006	1006
AR(2) test	0.349	0.165	0.165
Sargan test	0.222	0.266	0.223

Note: ***, ** and * denote significance at 1%, 5% and 10% respectively

The estimated result about the effect of inflation on public debt for the whole of sample is presented in Table 4. Accordingly, inflation, real GDP per capita, and government revenue have significantly negative effects, whereas private investment and trade openness have significantly positive influences on public debt.

Several eminent economists including Ken Rogoff, Olivier Blanchard and Paul Krugman suggested using high inflation to erode the real value of public debt. According to these economists, highly indebted countries can escape from the debt crisis via higher inflation. In this study, the estimated result supports this suggestion that is inflation reduces public debt. In fact, Akitoby *et al.* (2014) and Hilscher *et al.* (2014) empirically approved that high inflation could be used as an effective tool to erode the real value of public debt.

Economic growth is one of effective tools to reduce public debt. High growth helps governments to increase budget revenue and decrease fiscal deficit, which leads to reduce public debt. Panizza & Presbitero (2014), Greiner & Fincke (2015), and Pereima *et al.* (2015) provided empirical evidence that economic growth has a negative effect on public debt. Consistent with these conclusions, this study shows the impact of economic growth on public debt is significantly negative.

In some developing countries, public investment is complementary to private investment (Erden & Holcombe, 2005; Erden & Holcombe, 2006; Hassan *et al.*, 2011). To finance public investment, most of developing countries have to borrow debts. Therefore, when public investment increases, private investment also increases, which is accompanied by growing public debt. Thus, the estimated result shows private investment is positively linked to public debt.

Although government revenue can distort the economy, in some developing countries it is one important factor to promote the economic growth (Okafor, 2012; Worlu & Nkoro, 2012). Thus, an increase in government revenue will result, ceteris-paribus, in a decrease in fiscal deficit, which leads to reducing public debt.

According to Combes & Saadi-Sedik (2006), trade openness consists of natural openness and trade-policy induced openness. Their empirical evidence showed natural openness deteriorates budget balances whereas the latter improves them. Kizilgol & Ipek (2014) indicated that increasing trade openness affects external debt positively in both the short run and long run in Turkey. Similar to Kizilgol & Ipek (2014), in this study trade openness has a positive impact on public debt.

Table 4: The effect of inflation on public debt for the whole sample (60 developing countries) Dependent variable: Δ Public debt

	Model 1	Model 2	Model 3
Public debt (-1)	-0.548***	-0.543***	-0.549***
Inflation	-0.598**	-0.631***	-0.554**
GDP per capita	-0.345***	-0.311***	-0.433***
Private investment	2.215***	2.267***	2.246***
Labor force			3.428
Government revenue	-2.662***	-2.685***	-2.435***
Infrastructure		-0.762	-.447
Trade openness	0.599***	0.610***	0.623***
Obs	826	826	826
AR(2) test	0.955	0.923	0.853
Sargan test	0.125	0.155	0.147

Note: ***, ** and * denote significance at 1%, 5% and 10% respectively

In short, the relationship between public debt and inflation for the whole sample of 60 developing countries is empirically assessed. Accordingly, in the direction from public debt to inflation, public debt has a significantly positive effect on inflation, whereas in the opposite direction, inflation has a significantly negative effect on public debt. It shows that in developing countries, high public debt causes inflation, whereas high inflation erodes the real value of public debt.

4.2. The relationship between public debt and inflation in developing countries in Asia, Latin America, and Africa (the sub-samples)

The estimated results of the relationship between public debt and inflation in three continents are given in table 5, table 6, table 7, table 8, table 9, table 10. Accordingly,

(1) The relationship between public debt and inflation in all three continents is consistent with the whole sample. It means public debt has a significantly positive effect on inflation, while inflation has a significantly negative effect on public debt.

(2) Similar to the whole sample, economic growth has a significantly negative impact on public debt in all three continents. It implies that economic growth is an effective tool to reduce public in developing countries. Furthermore, like the whole sample, in developing countries of Latin America and Africa, private investment also causes inflation.

(3) Contrary to the whole sample, private investment in developing countries of Asia and Latin America has a significantly negative impact on public debt. Mitra (2006) and Gjini & Kukeli (2012) showed public investment may crowd out private investment. So, in these two continents a growing private investment will result in a decrease in public investment, which leads to a reduction in fiscal deficit and public debt.

4.2.1. For the sub-sample of 22 developing countries in Asia

Similar to the whole sample, trade openness has a significantly negative impact on inflation and government revenue has a significantly negative impact on public debt. Contrary to the whole sample, trade openness has a significantly negative impact on public debt. As above-mentioned, Combes & Saadi-Sedik (2006) showed trade-policy induced openness improves budget balances. Thus, under this situation in developing countries of Asia, trade openness can decrease fiscal deficits, which leads to reduce public debt.

Furthermore, labor force has a significantly positive impact on public debt. When labor force increases, unemployment could increase. Governments have to increase expenditures of unemployment compensation for jobless people, which lead to enhance fiscal deficit and public debt.

Table 5: The effect of public debt on inflation for the sub-sample 1 (22 developing countries of Asia) Dependent variable: Δ Inflation

	Model 1	Model 2	Model 3
Inflation (-1)	-1.318***	-1.318***	-1.319***
Public debt	0.712*	0.721*	.654*
GDP per capita	-0.205	-0.130	-.043
Private investment	2.842	2.838	2.711
Labor force		-3.275	-4.072
Government revenue	3.980	3.683	2.998
Infrastructure			-1.705
Trade openness	-1.252**	-1.286**	-1.286**
Obs	391	391	391
AR(2) test	0.289	0.277	0.243
Sargan test	0.236	0.204	0.169

Note: ***, ** and * denote significance at 1%, 5% and 10% respectively

Table 6: The effect of inflation on public debt for the sub-sample 1 (22 developing countries of Asia) Dependent variable: Δ Public debt

	Model 1	Model 2	Model 3
Public debt (-1)	-0.513***	-0.510***	-0.513***
Inflation	-0.212**	-0.197**	-0.189*
GDP per capita	-0.193***	-0.206***	-0.201***
Private investment			-0.103***
Labor force	5.897***	6.265***	6.125***
Government revenue	-0.513***	-0.492***	-0.479***
Infrastructure		0.202	0.188
Trade openness	-0.120*	-0.121*	-0.122*
Obs	347	347	347
AR(2) test	0.675	0.695	0.686
Sargan test	0.205	0.208	0.162

Note: ***, ** and * denote significance at 1%, 5% and 10% respectively

4.2.2. For the sub-sample of 11 developing countries in Latin America

Similar to the whole sample, labor force and infrastructure have significantly negative impacts on inflation. However, contrary to the whole sample, government revenue has a significantly positive impact on public debt. In these countries, high tax rate (tax revenue) can distort the economy, and so inhibit economic growth (Zhang & Zou, 1998; Barro, 1990; Jin & Zou, 2005), which leads to high public debt.

Furthermore, infrastructure has a significantly negative impact on public debt. Infrastructure has a positive impact on economic growth in developing countries (Calderón & Servén, 2004; Canning & Pedroni, 2004; Palei, 2015). In its turn, economic growth reduces public debt (Panizza & Presbitero,

2014; Greiner & Fincke, 2015; and Pereima *et al.*, 2015). Thus, infrastructure could have an indirect influence on reducing public debt in developing countries of Latin America.

Table 7: The effect of public debt on inflation for the sub-sample 2 (11 developing countries of Latin America) Dependent variable: Δ Inflation

	Model 1	Model 2	Model 3
Inflation (-1)	-0.325*	-0.399*	-0.379*
Public debt	0.169**	0.184**	0.185**
GDP per capita	0.516***	0.593***	0.616***
Private investment	1.059***	1.206***	1.228***
Labor force	-1.328**	-1.626**	-1.587*
Government revenue			-0.141
Infrastructure	-1.077**	-1.182**	-1.227**
Trade openness		-0.084	-0.060
Obs	134	134	134
AR(2) test	0.430	0.431	0.461
Sargan test	0.132	0.183	0.171

Note: ***, ** and * denote significance at 1%, 5% and 10% respectively

Table 8: The effect of inflation on public debt for the sub-sample 2 (11 developing countries of Latin America) Dependent variable: Δ Public debt

	Model 1	Model 2	Model 3
Public debt (-1)	-0.503***	-0.502***	-0.480***
Inflation	-0.525***	-0.529***	-0.516***
GDP per capita	-0.327**	-0.344**	-0.351**
Private investment	-1.460***	-1.427***	-1.407***
Labor force			.399
Government revenue	2.150**	2.293**	2.153*
Infrastructure	-2.040**	-1.921**	-1.792*
Trade openness		-0.053	-0.054
Obs	156	156	156
AR(2) test	0.929	0.854	0.862
Sargan test	0.258	0.229	0.154

Note: ***, ** and * denote significance at 1%, 5% and 10% respectively

4.2.3. For the sub-sample of 27 developing countries in Africa

Similar to the whole sample, trade openness has a significantly positive impact on public debt. Furthermore, like Latin America, infrastructure in Africa also has a significantly negative impact on public debt.

Table 9: The effect of public debt on inflation for the sub-sample 3 (27 developing countries of Africa) Dependent variable: Δ Inflation

	Model 1	Model 2	Model 3
Inflation (-1)	-0.739***	-0.739***	-0.739***
Public debt	0.091***	0.090***	0.090***
GDP per capita	0.100	0.102	0.103
Private investment	0.464**	0.455**	0.455**
Labor force	1.077	1.053	1.051
Government revenue			-0.003
Infrastructure		-0.700	-0.702
Trade openness	-0.134	-0.127	-0.126
Obs	437	437	437
AR(2) test	0.556	0.561	0.561
Sargan test	0.932	0.910	0.881

Note: ***, ** and * denote significance at 1%, 5% and 10% respectively

Table 10: The effect of inflation on public debt for the sub-sample 3 (27 developing countries of Africa) Dependent variable: Δ Public debt

	Model 1	Model 2	Model 3
Public debt (-1)	-0.571***	-0.576***	-0.563***
Inflation	-1.135**	-1.118**	-1.009**
GDP per capita	-1.278***	-1.265***	-1.104***
Private investment	-0.155	-0.162	-0.229
Labor force		-1.516	-2.509
Government revenue			-0.951
Infrastructure	-49.942***	-54.150***	-49.377***
Trade openness	0.800**	0.828**	0.882***
Obs	356	356	356
AR(2) test	0.852	0.884	0.859
Sargan test	0.491	0.537	0.449

Note: ***, ** and * denote significance at 1%, 5% and 10% respectively

5. CONCLUSION AND POLICY IMPLICATIONS

The paper empirically assessed the relationship between public debt and inflation with control variables of real GDP per capita, private investment, labor force, government revenue, and infrastructure and trade openness for 60 developing countries in Asia, Latin America and Africa over the period 1990 – 2014 via the estimation method of difference panel GMM Arellano-Bond.

The estimated results showed that in the direction from public debt to inflation, public debt has a significantly positive effect on inflation while in the opposite direction, inflation has a significantly negative effect on public debt for the whole sample and three sub-samples. It means that in these developing countries, high public debt causes inflation, whereas high inflation could erode the real value of public debt. Furthermore, the study also found the significant determinants of public debt and inflation in developing countries of Asia, Latin America and Africa.

Although public debt leads to inflation, governments in developing countries cannot give up borrowing debts to finance fiscal deficits. Public debt is also an indirect instrument of fiscal policy to help governments to promote economic growth and stabilize social security. Recent literature research showed a threshold effect of public debt on economic growth (Rogoff & Reinhart, 2010; Topal, 2013; Kourtellos *et al.*, 2013). Accordingly, below the threshold value public debt has positive impact on economic growth but above this value it is harmful to economy.

On the contrary, inflation can erode the real value of public debt. However, Bick (2010), Kremer *et al.* (2013), Seleteng *et al.* (2013) and Vinayagathasan (2013) confirmed that there exists a threshold impact of inflation on economic growth. The impact of inflation on economic growth is significantly positive or insignificant below this threshold value but the economy is adversely affected if inflation is larger than this threshold.

From the policy perspective, governments in developing countries should harmoniously implement fiscal and monetary policies. It means that governments should run the economy based on inflation targeting (based on the threshold level of inflation) and public debt should be below the threshold value in their country in order to make sure a stable economic development and prevent a public debt crisis in future.

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