Public debt, inflation, and their interaction effects on economic growth (Case of middle-income countries)

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Abstract :

The purpose of the study is to analyze the effect of public debt as an instrument of fiscal policy, inflation as an instrument of monetary policy (inflation), and the interaction between them on economic growth for middle-income countries, and then for `newly industrialized` and `least developed` sub-samples, during the period from 2000 to 2019, using statistic and econometric methods. However, our regressions focused on the fixed effects panel regression, as well as on the interactions in the fixed effects regression model developed by Schmidt-Catran, (2018). The results showed a negative impact of public debt and inflation on economic growth for middle-income countries, as well as negative effects of their interaction on economic growth, which means that debt can affect economic growth through its effect on inflation. However, these effects are different depending on a sample or sub-sample. The findings indicated that debt is not the appropriate fiscal tool, and a government should avoid using easy money to finance their debt, also inflation of these countries should be maintained below a certain level or use an inflation target to ensure its recovery.

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1. Introduction

The global economic crisis of 2008 and its repercussions on the level of public debt ratio, followed by high inflation rate, has caused an important concern for policymakers and economists, especially for their impacts on economic growth.

According to the classical thought of Barro (1990), government spending stimulates global demand and thus promotes economic growth. Nevertheless, several economies cannot afford to finance their public spending either because tax revenue is too weak to cover spending size, or because seeking more taxes may cause serious damage to the economy. The government resorts to public debt as a fiscal tool to obtain additional revenue and foster economic growth. In several cases, especially in developing or transitional economies, governments use public debt unproductively (Kashif & Riffat , 2015; Cecchetti , Mohanty, & Zampolli, 2011) which crowds out his positive effect on growth. In the other words, high public debt triggers slow growth (Reinhart & Rogoff, 2010; Kumar & Woo , 2010; Minea & Parent , 2012).

Several studies have examined the relationship between public debt and economic growth; the most influential analysis of Reinhart and Rogoff (2010) showed an inverse relationship between GDP growth and debt, as well as a debt threshold equal to 90% of GDP, above which, debt can drop economic growth; the same results obtained by (Kumar & Woo , 2010; Chercherita & Rother, 2010; Minea & Parent, 2012; Kashif & Riffat, 2015). Also, Minea & Parent noted a negative impact of debt on growth but this effect switch from negative to positive when debt achieves too high levels (beyond 115% debt to GDP or 130% debt to GDP). Further, Lee and al. reexamined Reinhart and Rogoff's study and noted a negative and nonlinear relationship between debt and growth but no evidence for the 90 % debt to GDP threshold, rather they found a low debt threshold equal to 30% debt to GDP (Lee , Park, Seo , & Shin , 2015). Similarly, Aida Wade (2014) found a negative and no linear relationship between debt and growth when debt exceed 50% debt to GDP. Another stand of studies noted a negative effect of public debt on economic growth at high or low debt levels (Panizza & Presbitero, 2012; Nautet & Meensel, 2011).

The price level and inflation rate are also important instruments for economic growth, as monetary policy seeks to achieve stability at low levels for both prices and inflation. In this regard, various studies have affirmed a nonlinear and/or a negative impact of inflation on economic growth when inflation exceeds a certain level. However, previous studies have shown a positive or neutral impact of inflation on growth at a low inflation level, and negative effect at high inflation level (Khan & Senhadji,2000; Vinayagathasan,2013; Ndoricimpa, 2017). Further, Eggoh and Muhammad

(2014) showed that inflation can negatively affect economic growth through its impact on financial development, trade openness, capital accumulation, and government expenditure.

According to Sargent and Wallace (1981), high public debt leads to high inflation (Sargent and Wallace, 1981). In fact, at a high public debt level, government resorts to the central bank to erode the debt value by creating money which generates a favorable environment for high inflation. Furthermore, high debt may lead a government to issue new debt with a high-interest rate which makes bondholders richer and increases their future demand in a no-Ricardian regime. High future demand creates more inflation (Cochrane , 2011).

Many studies suggested that public debt can affect economic growth through several channels such as investment ((Kashif & Riffat , 2015; Chercherita & Rother , 2010), private saving (Chercherita & Rother , 2010), total factor productivity ((Kashif & Riffat , 2015; Chercherita & Rother , 2010), and inflation ((Nautet & Meensel , 2011; Nguyen , 2015).

Similar to Reinhart and Rogoff, Van Meensel and Nautet pointed that inflation can be a transmission channel of the impact of debt on growth. Indeed, when debt is higher, government tends to monetize it; however, this situation could trigger high or hyperinflation that reduces later economic growth. Nevertheless, they stressed that all hyperinflation periods that occurred in past have originated into a budget crisis (Nautet & Meensel , 2011).

Few studies have analyzed the combined effect of public debt and inflation on economic growth. Nguyen's (2015) examined the effects of public debt, inflation, and their interaction on economic growth for 60 developing countries, then for subsample grouped by continent namely, Asian, Latin American and African countries from 1990 to 2004. The results for full sample showed a negative impact of debt and inflation on growth, while their interaction had a positive effect on growth. The impact of public debt, inflation and their interaction on growth varied under the sample or subsamples. Veiga and al. (2014) examined the relationship between public indebtedness, economic growth, and inflation for 52 African countries divided into three geographical areas (North Africa, Sub-Saharan Africa, and Southern African countries) from 1950 to 2012. Results showed an inverted relationship between public debt and economic growth, as well a high level of inflation. Also, Chudik and al. (2015) studied public debt impact on growth for 40 advanced and developing countries during 1965-2010 and checked the robustness of results by analyzing mixed economy (fiscal and monetary) impact through introducing inflation in the model. Results showed a negative relationship between debt and economic growth

– with and without inflation – if debt rise permanently, and no negative effect of if debt rise temporarily. According to them, the path of debt is more important than its level.

Whilst, Rahman & al. (2019) highlighted the lacking in the number of studies on public debt impact on economic growth in the case of low and middle-income economies, and the weak flexibility effect of the fiscal and monetary policy for these economies in the financial crisis context (Aizenman , Eichengreen , & Park , 2017).Thus, given the importance of middle-income countries, which are the engines of the economy, that is, representing one third of the global GDP, and containing a group of countries with diverse characteristics (least developed countries, newly industrialized countries ... etc.), we focused our study on middle-income economies.

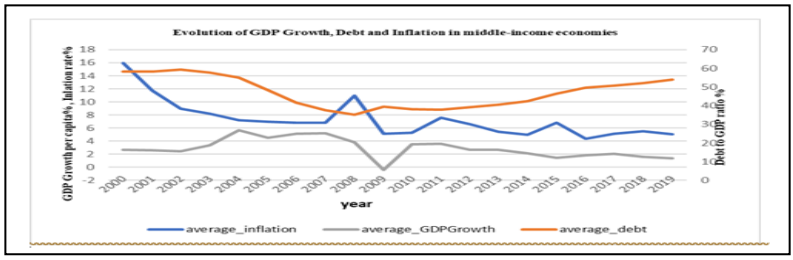
The purpose of our study is to examine the effects of debt and inflation on economic growth for middle-income countries (All panel), then for newly industrialized economies, and least developed economies sub-samples, that's between 2000-2019. Thus, we study the combined effect of debt and inflation on economic growth to see if public debt affects economic growth through its effect on inflation rate.

The paper is set as follows, in section 1 we provide introduction which contain a literature review on the relationship between public debt, inflation, and their combined effect on economic growth. Section 2 presents some stylized facts for debt, inflation, and economic growth. While section 3 exhibits the analysis framework, where we present a data description, the methodology, the results of our econometric model. We finalize our work with conclusion and some recommendations.

2. Stylized fact

Before presenting the econometric model, we describe the relationship between debt, inflation, and economic growth for middle-income countries between 2000-2019.

Figure No 1: Evolution of GDP growth , inflation rate, and debt to GDP ratio for middle-income countires over the periode 2000 to 2019.

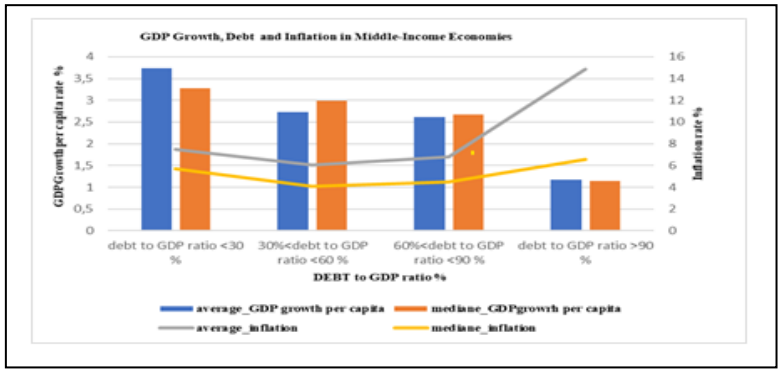


Source: data from IMF data Mapper and tranding economics.

Figure 1 represents the evolution of GDP growth per capita, inflation rate , and debt to GDP ratio[1] for middle-income countries[2] from 2000 to 2019. We observe a sharp decline in GDP growth per capita from 5,20% in 2007 to -0,4 in 2009, with an increase in inflation from 6,83% (one digit) in 2007 to 11%(>one digit) in 2008, while a government debt reaches its minimum 35 % to GDP between2007-2009.

Higher inflation and lower debt-to-GDP ratio may be the results of the governement`s policy (debt monetization) that seek to erode the value of debt. As in the economies that are almost dependent on the United States of America and the eurozone. The Great recession (the 2007 subprime crisis followed by high inflation in 2008) has a signifcant impact on the growth of middle-income countries and causes significant decline in GDP growth. After 2011, we see rising debt as GDP growth per capita declines, which means that the level of debt can slowdown economic growth.

Figure 2: relation between debt, inflation and economic growth in middle-income countries.



Source: own calculations from IMF data Mapper, and trading economics.

Similar to Reinhart & Rogoff (2010) and Veiga and al. (2014) studies, figure 2 presents a summary of average and median GDP growth per capita as well inflation at different levels of debt to GDP ratio.

the bars in figure 3 show that the highest real GDP growth (3.73 percent) is associated with a lower debt level (below to 30 % of debt to GDP). We observe that average GDP Growth per capita decline weakly from the first

[1] Debt to GDP ratio is the general government gross debt to GDP ratio from the IMF data Mapper and trading economics for the missing value

[2] middle-income countries (upper-middle and lower-middle income countries) take it from World Bank classification 2020. Our panel is limited to 82 countries due to missing data for some countries.

to the third debt group. Above 90% debt to GDP, average GDP growth per capita knows a matter decline (1,17%). Thus, there is a gap of 2,6 percentage point (69,7%) between the first and the last group of debt. Consequently, the figure shows an inverse relationship between average debt to GDP ratio and economic growth, similar to the study of (Reinhart & Rogoff, 2010; Veiga, Jose and Ferreira, Sequeira, & Tiago, 2014; Nautet & Meensel , 2011)

The lines in figure 2 show a constant inflation level -average and median- at the three first groups of debt, but once debt exceed 90% to GDP ratio, We observe that inflation rise simultaneously with debt level, similarly to (Reinhart & Rogoff, 2010; Nautet & Meensel , 2011). Thus, assume that `fiscal dominance is a plausible interpretation of this pattern' when debt is high. Besides, we observe a decline of average GDP growth per capita when average inflation is high; the highest average GDP growth is associated with low average inflation (7,5 %), while the lower GDP growth is associated with a higher average inflation rate (14,9%).

3. Analysis framework

3.1 Model

Firstly, we analyze the linear effect of debt and inflation on economic growth. We employ a generalized theoretical economic growth model (Cobb Douglas function) augmented by including debt and inflation variables. The model is formulated as follows:

$$\Delta y_{i,t} = \mu_i + \beta_1 X_{i,t} + \beta_2 Z_{i,t} + \epsilon_{i,t}$$

Where Δy is GDP growth per capita at time t for individual i ,($\Delta y_{i,t} = y_{i,t} - y_{i,t-1}$), X_{it} represent a vector of control variables which allows the determinants of economic growth, such as, gross fixed capital formation (as a proxy for investment), expenditure as an indicator of size of government, broad money, population growth rate to incorporate the impact of population dynamics, trade openness (economy`s competitiveness), current account balance , Z_{it} represents a vector of core explanatory variables that we are interested in, as well as inflation rate and debt to GDP ratio, $\mu_i$unobserved country-specific effect, and $\epsilon_{i,t}$ observed specific error terms.

Secondly, we extend the first model to study a non-linear effect of debt on economic growth through inflation, by introducing the interaction between debt to GDP ratio and inflation in the first model.

3.2 Methodology:

The previous studies showed that the estimation with pooled OLS method gives us inconsistent and biased estimators (Catherine Pattillo, 2002; Eggoh & Khan , 2014; Kumar & Woo , 2010) due to heterogeneity problem. Besides, the descriptive analysis above shows huge heterogeneity of our

panel, so to avoid this problem, we use fixed effect (FE) panel regression that allows us to control time-invariant as well observed and unobserved country-specific effects. More, the fixed-effect model permits us to take into consideration the difference between countries in terms of history and economic structure. Obviously, the choice of the (FE) model is made based on Hausman[3] test and Fisher test [4].

Moreover, debt can affect economic growth directly or indirectly through several channels, in this study we are interested in the inflation channel (Barro & Sala-i-Martin, 2004; Cochrane, 2011; Nautet & Meensel, 2011), Which has not been experimentally tested before, to see whether debt negatively affects economic growth through its effect on inflation, or whether fiscal policy dominates monetary policy.

Therefore, to estimate the indirect effect of debt on economic growth through inflation, we should introduce the combined (interaction) variable between debt and inflation in the fixed-effect model. Initially, the interaction in a fixed effects regression is usually determined by demeaning the product term (Jaccard, 2003), but this does not provide true within estimator of the interaction, because it does not control heterogeneity effect, especially when we interact two-time dependent variable –variation within unit-. Giesselmann and Schmidt-Catran (2018) proposed "double demeaned" estimator that takes heterogeneity in consideration in interaction fixed effect model. This estimator is obtained by first, demeaning each variable then demeaning the product term (see (Schmidt-Catran, 2018)). To date, no study has dealt with fiscal or monetary policy with this model.

3.3 Data:

In this study, we use a panel of 70 [5]middle income-countries from 2000 to 2019. As reported in previous studies, many factors can affect the long-run growth of a country. Previous researches have not identified any precise set of growth determinants. According to (Wei & Han, 2015; Aizenman , Eichengreen , & Park , 2017) the variables listed below play an important role in determining the economic growth of middle-income countries.

[3] The Hausman test was used to choose between random and fixe- effect model, the null hypothesis is that random-effect model fits better, however, when - value is low than the fixed effect model is preferred over the random-effects model.

[4] This test used to test between pooled OLS and fixed effect, the null hypothesis is Pooled OLS is preferred than the fixed effect model , so when p value low the fixed effect is the better, it is the same when we test the significance of the fixed effect parameters.

[5] Our panel is limited to 70 countries due to the data availability of each variable included in the model, and also we have delete countries outliers .

Our variables are defined as follows:

Table No 1: variables definition

Variables		
GDP growth	Gross Domestic Product per capita	WDI
debt	is the general government gross debt as percent of GDP	IMF
Inflation	is the average consumer price index CPI	IMF
GFCF	is the investment proxied by Gross fixed capital formation % GDP	WDI
Population	is the population growth rate	WDI
Trade Open	is trade openness which is a sum of imports and exports as percent to GDP	WDI
CAB	Is Current account balance as percentage of GDP	IMF
Expenditure	Is public expenditure proxied by general government final consumption expenditure as percentage of GDP	WDI
Debt_inflation	interaction between debt and inflation . it is calculated by demeaning debt and inflation then demeaning the product term debt_inflation.	WDI

To provide different information about the relationship between debt, inflation, and their interaction on economic growth, as well as to verify the strength of our results, we have divided our panel into two sub-samples: Newly Industrialized Countries (NIC) and Least Developed Countries (LDC).

3.4 Results and discussion

Effect of debt and inflation on economic growth for middle-income countries

Table No 2: effect of debt and inflation on economic growth for middle-income countries

	Fixed Effect model (FE)
GDP growth per capita	Panel (All)
Debt	-0,017**
Inflation	-0,04**
GFCF	0,11*
Trade Open	0,03*
Expenditure	-0,27*
Population	-0,87*
CAB	0,03***
Constant	4,40*
F-test	22,7
P-value	0
R-sq Within Between Overall	0,11 0,41 0,17
Observations	1400
Countries	70
Rho	0,23

*, **, *** significant at 1%, 5%, 10% respectively.

Source: Own calculations in Stata 16 program.

The table above presents the estimation of the direct (linear) effect of debt and inflation on economic growth by the fixed effects (FE) regression model for panel of middle-income countries[6].

We observe a significant negative effect of debt on economic growth for our panel, similar to (Panizza & Presbitero , 2012; Chercherita & Rother , 2010; Chudik A. , Mohaddes , Pesaran , & Raissi , 2013; Nguyen , 2015). As a one percent increase of debt to GDP ratio reduces GDP growth per capita by 0,017 percent. The effect is also consistent with the conventional view of debt (Elmedorf & Mankiw, 1998). However, the negative effect of debt on economic growth is not surprising, particularly in the case of developing or emerging economies because most of the governments may use borrowed funds (debt) for consumption expenditure rather than for productive spending (investment) or may use a small part of it in production capital. Moreover, we note that the estimation results of (FE) model is consistent with the histogram that shows a decline of average GDP growth when debt rises.

The table also indicates a negative significant effect of inflation on GDP growth per capita for our panel, similar to the theoretical model of (Stockman, 1981), and empirical results of (Eggoh & Khan , 2014; Ndoricimpa , 2017). However, we note that a rise of inflation by one percent leads to decrease GDP growth per capita by 0.04 percent. The negative effect of inflation may be due to the transaction costs of economic activities. As high inflation involves an increase of goods and services prices, which lead to increase living cost, the cost of doing business, borrowing money, and more.

Regarding control variables, we observe a significant positive effect of investment (GFCF) on GDP growth, which is consistent with economic theory that emphasized capital as an important input to boost production and then economic growth (Slimani , El Abbassi , & Tounsi , 2016; Nguyen , 2015). As well as, a positive significant effect of Trade openness on economic growth, which may be due to the fact that a high degree of openness provides access to goods and services, permits an efficient allocation of resources, and facilitates the adaptation of new technology that improves output and subsequent growth (Barro & Sala-i-Martin, 2004). The current account balance has also a positive effect on economic growth, similar to (Alves, 2014)

[6] The choice of fixed effect model is based on the Hausman test that is presented in table E in appendix

Whereas for public expenditure, we note a significant negative effect on economic growth, since the public expenditure is proxied by general government final consumption expenditure which drains out private investment, then hampers economic growth (Slimani , El Abbassi , & Tounsi , 2016). According to (Barro R. , 1990) the negative effect of public expenditure may be due to the existence of a threshold level above which, expenditure decelerates economic growth. The population growth rate also has a detrimental effect on growth, similar to the growth literature and (Kashif & Riffat , 2015; Nguyen , 2015; Afonso & Arana , 2018).

Effect of debt and inflation on economic growth for NIC and LDC subsamples

Table No3:effect of debt and inflation on growth newly industrialized countries subsample

	NIC	LDC
GDP growth per capita	NIDC	NIDC
Debt	-0,04**	0,015
Inflation	-0,08*	0,029
GFCF	0,06	0,13**
Openness	0,004	0,1
Expenditure	-1,04*	-0,11
Population	-1,23	1,35
CAB	-0,062	0,16
Constant	19.81*	-9,02
F-test (u_i=0)	8.41	2,94
P-value	0,00	0,015
R-squr within between overall	0,24 0,12 0,11	0,18 0,2 0,15
Observations	200	120
Countries	10	9
Rho	0,74	0,59

*, **, *** significant at 1%, 5%, 10% respectively.
Source: Own calculations in Stata 16 program.

The above table presents the effects of debt and inflation on economic growth for Newly industrialized subsample then for least developed sub sample [7].

The Results show a significant negative effect of debt on economic growth for the newly industrialized sub-sample, similar to the `All` panel regression. We note that a one percent increase of debt-to-GDP ratio reduces GDP growth per capita by 0,04 percent.

[7] Hausman test for NIC and LDC subsamples are presented in tables F and G respectively in appendix

We Also note, a significant negative effect of inflation on economic growth, similar to `All` panel regression, since a one percent rise of inflation reduces economic growth by 0.08 percent. Hence, we suggest that inflation plays an important role in the economic slowdown of newly industrialized countries.

With regard to control variables, we note that investment, and trade openness have insignificant positive impact on economic growth, contrary to `All` panel estimation and theoretical and empirical studies. Moreover, public expenditure has a significant negative effect on economic growth similar to the `All` panel results. In addition to the negative economic impact that is explained by the crowding-out of private investment, the negative effect of public expenditure on growth for newly industrialized sub-sample can also explained by the high inflation rate (Eggoh andMuhammed2014).

Population growth rate and current account balance (CAB) have a negative but insignificant effect on economic growth, in contrast to the `All` panel regressions.

Concerning least developed countries, we note insignificant positive effect of debt on economic growth, in contrast to the `All` panel regressions. Which means that the relationship between government debt to GDP ratio and economic growth can be no-linear in this group of countries (Chercherita & Rother , 2010; Kumar & Woo , 2010; Kashif & Riffat , 2015; Eberhardt & Presbitero , 2015; Minea & Parent , 2012).

We also note a negative insignificant effect of inflation on economic growth which implying that a relationship between inflation and economic growth in least developing countries group may also be no-linear, similar to previous studies (Eggoh & Khan , 2014; Vinayagathasan , 2013; Ndoricimpa , 2017).

As for the control variables we note positive effect of investment, trade openness, and the current account balance (CAB) on economic growth. Where, we point out one percent rise of gross fixed capital formation (GFCF) enhances economic growth by 0.13 percent. We Also, note one percent increase of trade openness boosts economic growth by 0,1 percent, and we even note one percent rise of CAB leads to increase economic growth by 0,16 percent. These results are congruent with the `All` panel regression and previous studies (Tahir & Khan, 2014; Darku & Yeboah, 2017; Alves, 2014). Hence, we assume that investment, trade openness and current account balance are important macroeconomic factors that stimulate growth in least developed countries, and this is due to the fact that they increase economic resources, improves the quality of life, and improves production efficiency.

Further, population growth rate and public expenditure have insignificant effect on economic growth, in contrast to the `all` panel regression.

Interaction effect of debt and inflation on economic growth

Table No 4: effect of debt and inflation and their interaction on growth.

GDP growth per capita	All	NIC	LDC
debt	-0,016**	-0,04**	0,012
Inflation	-	-	-
GFCF	0,11*	0,05	0,13
Expenditure	-0,27*	-0,97*	-0,15
Trade Open	0,03*	0,0003	0,09
Population	-0,87*	-1,07	0,79*
CAB	0,03***	-0,05	0,19
debt_inflation	-0,002**	-0,004*	0,02
constant	3,56*	17,49*	-1,95**
R-squ	0,107 0,408 0,17	0,25 0,08 0,09	0,23 0,04 0,08
Observations	1400	200	120
Countries	70	10	6
Fisher p-value	22,66 0,00	8,73 0,00	4,77 0,0001
Rho	0,23	0,73	0,65

*, **, *** significant at 1%, 5%, 10% respectively.
Source: Own calculation in Stata 16 program.

The above table presents the effects of debt, inflation, and their interaction on economic growth for panel of middle-income countries, then for sub-samples NIC and LDC respectively. For “All” panel we see the same result obtained in a linear model. The estimated coefficients of variables are the same as in linear model. Concerning the combined effect between debt and inflation, we notice a significant negative effect of debt_inflation interaction on economic growth, where one percent rise of debt to GDP ratio leads inflation to reduce economic growth by 0,002 (Nautet & Meensel , 2011; Cochrane , 2011; Reinhart & Rogoff, 2010). In generally government resort to inflation to erode the value of government debt to boost their economy. However, in many cases, inflation created to reduce the level of debt can rise sharply and then reverse its effect on economic growth, as we see here that debt leads inflation to slow economic growth. Hence, we can conclude that there is fiscal dominance (Reinhart & Rogoff, 2010), and that inflation is transmission channel of the negative effect of debt on economic growth.

Similar to “all” panel, NIC sub-sample estimation results show practically the same estimated value of variables in a linear model. However, for the

interaction variable, we note a significant negative effect of debt-inflation interaction on economic growth. As one percent rise of debt to GDP ratio leads inflation to reduce economic growth by about 0,004 percent.

Looking at 'LDC' sub-sample, we note the same estimated coefficient of variables in linear model, while for the interaction effect, we refer to the significant positive effect of debt-inflation on economic growth, in contrast to the `All` panel and the NIC subsample. The positive effect can be attributed to the fact that inflation erodes the level of debt and thus boost economic growth. Here we observe two effects, the first is the high level of inflation that has a negative effect on growth, and the decrease in the level of debt resulting from the high level of inflation -debt monetization- which subsequently affects positively on growth, in this sub-sample the second effect is greater than the first.

Overall, we conclude that inflation can be a transmission channel of the effect of debt on economic growth for the 'All' panel and newly industrialized sub-sample, similarly to Nautet & Van Meensel (2011) and Cochrane (2011).

4. Conclusion

The high risks associated with the high level of public debt make the relationship between public debt and economic growth under discussion since 2008 until now. According to previous studies and policy makers, the impact of public debt on growth is not clear and there is no consensus on the link between them. The aftermaths of 2008 financial crisis that sums up on high level of public debt as well as the high inflation rate permit us to suppose that inflation rate can be a transmission channel of the effect of debt on growth, which has not been analyzed previously, and if it so, it is treated theoretically (Sargent and Wallace, 1991; Cochrane, 2011; Nautet & Meensel, 2011). In addition, the groups of countries selected in our study have not been previously tested in this context.

In this paper, we have built our methodology on the empirical literature examining relationship between public debt, inflation, and economic growth. The previous studies indicated that high levels of debt harm growth at (Reinhart Rogoff, 2010; Panizza and Presbitero,2012), and also at moderate levels (Aida Wade 2014; Lee and All, 2015; Riffat and Munir 2015). Also, high inflation levels have detrimental effects on economic growth (Chudik and al.2015; Nguyen 2015; Mohammed and Eggoh;2014 Khan and Senhadji,2001), While the relationship between debt and inflation can be negative or positive, depending on the extent of the dominance of monetary or fiscal policies.

The study also explores the direct effect of debt and inflation on economic growth and test whether debt can affect economic growth through inflation for middle-income countries, then for newly industrialized (NIDC) and least developed (LDC) sub-samples, over the period between 2000 and 2019. The Histogram shows an inverse relationship between public debt and GDP growth as well, between inflation and GDP growth for middle-income countries, while a positive relationship between debt and inflation which allowed us to suppose that debt can affect negatively economic growth through its effect on inflation. Moreover, the significant negative effect of debt and inflation on economic growth is also confirmed by fixed effect regression for `All' panel and NIC sub-sample, which means that both debt and inflation have detrimental effect on long-term economic growth of middle-income countries.

However, we note an insignificant negative effect of debt and inflation on economic growth for the least developed sub-sample, which also means that the relationship between debt-growth and inflation-growth can be no linear.

Concerning the interaction effect, the results show a negative effect of the combined variable between debt and inflation on economic growth for `All' panel and NIC subsample which means that debt affect economic growth through its effect on inflation. While the effect of interaction between debt and inflation is positive for LDC subsample which means that inflation erodes the value of debt and later enhance economic growth.

In general, public debt declines economic growth of middle-income countries because it is used wastefully, and/or its high level leads to increase price level, then rise inflation which ultimately decrease**s** economic growth.

5. Recommendations:

From these findings, we can suggest that public debt is not the best fiscal tool to finance government spending or to foster economic growth in middle-income countries, also this group of countries should maintain inflation rate below a certain level, or relies on an inflation target in order to ensure their economic growth. Besides, monetary policy should be independent of fiscal policy, and a government should avoid using easy money to finance their debt, as this leads to impairing the economic growth of middle-income countries.

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Appendix

Table A: descriptive statistics

Variable	Obs	Mean	Std.Dev	Min	Max
GDP growth	1400	3.04	3.65	-14.69	32.99
GFCF	1400	23.88	7.52	6.29	69.67
Inflation	1400	6.01	6.40	-3.7	96.1
Debt	1400	46.34	27.13	3.2	183.3
Expenditure	1400	14.85	6.92	0.95	61.45
Trade Open	1400	80.21	33.14	18.87	220.40
Population	1400	1.29	1.08	-9.08	7.78
CAB	1400	-3,78	8.22	-49.5	33.6

Source: own calculation in STATA16 program.

Table B: detail descriptive statistics

Variable	Mean	Std.Dev.	Min	Max	Observations
GDP growth per capita	3,03	3,65	-14,69	32.99	N=1400
Between		1.80	0,1	8,41	n=70
Within		3.16	-17,29	28,58	T=20
Debt to GDP ratio	46,34	27,13	3.2	183,3	N=1400
Between		23,98	12.69	154,73	n=70
Within		12,99	11,07	108,05	T=20
Inflation rate	6,018	6,40	-3,7	96,1	N=1260
Between		3,64	1,52	17,87	n=70
Within		5,29	-7,14	91,91	T=18
GFCF	23,88	7,52	6,29	69,67	N=1400
Between		6,05	14,99	54,04	n=70
Within		4.53	2,80	53,94	T=20
Trade Open	80,21	33,14	18,87	220,40	N=1400
Between		30,09	25,96	167,62	n=70
Within		14,32	-13,48	156,69	T=20
Population	1,3	1,08	-9,08	7,78	N=1400
Between		0,96	-0,81	3,48	n=70
Within		0,52	-7,22	9,64	T=20
CAB	-3,78	8,22	-49,5	33,6	N=1400
Between		6,00	-20,22	8,32	n=70
Within		5,66	-41,42	23,14	T=20
Public expenditure	14,85	6,92	0.95	61,45	N=1400
Between		6,72	5.27	57,51	n=70
Within		1,81	8,73	23,24	T=20

Unit root test We have used Levin-Lin-Chu test to test stationarity of our variables, where

$$\begin{cases} H_0 : panel\ contain\ unit\ root \\ H_1 : all\ panel\ are\ stationary \end{cases}$$

Table C: unit root test

Unit root Test	GDP growth	GFCF	inflation	Debt	Expenditure	Trade	population	CAB
t* adjusted	-10,3	-5,69	-13,48	-3,47	-3,69	-4,07	-13,02	-7,10
P-value	0	0	0	0,003	0,0001	0	0	0

Source: own calculation in STATA16 program.

The p-values presented in table above show a stationarity of all variable of our study.

Correlation matrix

Table D: correlation matrix

	GDP growth	GFCF	inflation	debt	expenditure	trade	population	CAB
GDP growth	**1**							
GFCF	**0,25***	**1**						
inflation	**-0,0009**	**-0,04*****	**1**					
Debt	**-0,15***	**-0,019**	**0,025**	**1**				
Expedniture	**-0,18***	**0,03**	**-0,13***	**-0,01**	**1**			
Trade Opn	**0,10***	**0,1***	**-0,08***	**-0,03**	**0,22***	**1**		
Population	**-0,24**	**-0,03**	**0,005**	**0,12**	**-0,14***	**-0,11***	**1**	
CAB	**0,026**	**-0,31***	**0,08***	**-0,3***	**0,1***	**-0,13***	**-0,04**	**1**

Source: own calculation in STATA16 program.

Table E: Hausman test (fixed effect vs random effect) for middle-income countries

	(b) fixed	(B) random	(b-B) Difference	Sqrt(diag(v_b-v_b))
GFCF	**0.108**	**0.12**	**-0.011**	**0.014**
Inflation	**-0.04**	**-0.025**	**-0.015**	**0.0059**
Debt	**-0,017**	**-0.016**	**-0.0012**	**0.0049**
Expenditure	**-0.27**	**-0.16**	**-0.11**	**0.041**
Trade Open	**0.03**	**0.02**	**0.01**	**0.004**
Population	**-0.87**	**-0.82**	**-0.04**	**0.11**
CAB	**0.03**	**0.031**	**-0.001**	**0.0089**
Chi2 Prob	**21.53** **0.0031**			

Source: own calculation in STATA16 program.

Table F: Hausman test (fixed effect vs random effect) for NIC subsample

	(b) fixed	(B) random	(b-B) Difference	Sqrt(diag(v_b-v_b))
GFCF	**0.06**	**0.119**	**-0.059**	**0.0507**
Inflation	**-0.08**	**-0.058**	**-0.024**	**.**
Debt	**-0,04**	**-0.029**	**-0.012**	**0.006**
Expenditure	**-1.04**	**-0.51**	**-0.53**	**0.117**
Trade Open	**0.004**	**0.0008**	**0.005**	**0.009**
Population	**-1.23**	**-1.30**	**0.071**	**0.42**

CAB	**-0.06**	**0.008**	**-0.071**	**0.028**
Chi2 Prob	**37.08** **0.000**			

Source: own calculation in STATA16 program.

Table G: Hausman test (fixed effect vs random effect) for LDC subsample.

	(b) fixed	(B) random	(b-B) Difference	Sqrt(diag(v_b-v_b))
GFCF	**0.13**	**0.097**	**0.036**	**0.043**
Inflation	**0.029**	**-0.022**	**0.051**	**0.032**
Debt	**0.015**	**-0.018**	**0.033**	**0.01**
Expenditure	**-0.11**	**-0.044**	**-0.068**	**0.17**
Trade Open	**0.099**	**0.04**	**0.06**	**0.034**
Population	**1.35**	**-2.17**	**3.53**	**1.19**
CAB	**0.162**	**0.142**	**0.020**	**0.017**
Chi2 Prob	**12.15** **0.095**			

Source: own calculation in STATA16 program.