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Inflation-growth nexus in developing economies: New empirical evidence from a disaggregated approach

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Abstract

This paper examines the "inflation-growth nexus" by considering sectoral growth data of 113 developing economies. Research at the aggregate level yields mostly ambiguous results. Here, we perform a disaggregated analysis of inflation and output growth. For each sector—agriculture, industry, and services—inflation and value-added sectoral growth, for the period 1981–2015, are considered, and sectoral inflationary spillovers are captured. Empirical analysis reveals that three major sectors of the economy react differently to various impulses of inflation, and the significance of sectoral inflation is evidenced. Inflation is found to be detrimental to the growth of industrial sector only, and when sectoral inflation is accounted for, no significant impact of inflation is found in services and agricultural sectors. The policy relevance for developing economies is that the central banks of these economies must carefully consider the differing consequences of their actions on individual sectors while taking into consideration the value-added share of each sector in the respective economy.

KEYWORDS

developing economies, disaggregated approach, inflation-growth nexus, inflationary spillovers, sectoral growth

JEL CLASSIFICATION

E31; E58; O41

1 | INTRODUCTION

The ultimate goals of monetary policymakers are to achieve high and sustained output growth and optimal inflation. They are supposed to keep an eye on the composition of output and the complex behaviour of inflation (Blanchard, Dell'Ariccia, & Mauro, 2010). Following the global crisis, there has been a renewed discussion on optimal inflation targets.[1] The present study continues the debate to discuss optimal inflation in the context of development and aims to derive new valuable insights for monetary policy in developing economies.

In industrialized or developed economies, socio-economic and financial systems are developed, and in general, the "issue of optimal inflation" has been widely researched. The threshold levels for aggregate gross domestic product (GDP) specifications are also well-determined. Therefore, we can conclude that, in advanced economies, "inflation" is no more a big issue.[2] Whereas in the developing world, the financial system is not entirely established as different sectors dominate the economy at various stages of development; as structural change is taking place. More fundamentally, the relationship between inflation and growth differs along the development path. This is why many economists argue that the "inflation-growth nexus" is still one of the most debatable issues in developing economies.[3]

The impact of inflation on growth has mostly been researched at the economy-wide macroeconomic level.[4] Two approaches have been considered using only aggregate GDP data. First, cross-section growth regressions and panel data estimation (e.g., Barro, 1995; Bruno & Easterly, 1998; Khan & Senhadji, 2001; Kremer, Bick, & Nautz, 2013, among others), addressing the problem of causation, find a nonlinear relationship between inflation and growth. Although the effect of low inflation on growth is unclear, inflation has been shown to clearly hurt economic growth at higher levels. Secondly, studies based on time-series data and VARs (e.g., Bullard & Keating, 1995; Rapach, 2003), report that the effect of inflation on growth varies across countries. Some countries show a positive impact of inflation on growth, whereas others a negative relationship. The overall conclusion, regarding "inflation-growth nexus," is therefore still inconclusive.

Huo (1997) has pointed out that the impact of inflation on growth is subject to the capital intensity of the particular sector. In light of the two-sector neoclassical growth model with varying degrees of capital intensities across sectors, the author concludes that inflation can either have a positive or negative impact on economic growth. His finding calls for an analysis of this relationship at a disaggregated level. The disaggregated analysis looks at the sector level data of inflation and growth. We provide new insights into the monetary policy transmission mechanism in developing economies by taking this approach.[5]

Based on a panel of disaggregated data, our approach is motivated by the idea that the sectoral effects of "inflation-growth relationship" are more helpful in understanding this nexus compared with their aggregate counterpart.[6] This approach, the *conjecture of disaggregation*, can be justified on the following grounds: First, short- and long-term growth determinants may vary across sectors and development levels of economies. Second, the information inherent in the heterogeneity across sectors and countries can be useful for understanding growth patterns and monetary transmission mechanism.[7] Lastly, the panel data (across sectors and countries) enable us to overcome some difficult identification problems that have continuously hindered the study of aggregate GDP growth.

Following the discussion above, this study addresses more specifically the impacts of inflation on long-run sectoral growth in developing (low and middle income) economies. What is the reaction of sectoral growth to different measures of inflation and different control variables? There is a dearth of relevant literature examining the relationship between inflation and sectoral growth. To the best of our knowledge, not many studies have been carried out in this area. Nevertheless, there have been attempts in economic literature to examine the long-term dynamics of sectoral growth with respect to varying degrees of inflation.

The contribution of this study is that it examines a new dimension in the "inflation-growth nexus" by looking at heterogeneity across sectors while also incorporating the aspect of development. By analyzing a large panel data set from the developing world, it also throws light upon examining how inflation may impact on structural change happening in developing economies. Through the application of the widely acknowledged system GMM, we are able to checkmate the problem of regression endogeneity in our model.[8]

The main findings from our research can be summarized as follows. Our estimation results show that the responses of individual sectors to various impulses of inflation differ in developing economies. However, the relationship in question is subject to the role of sectoral inflation, which is referred to as the value-added deflator of each sector. Specifically, on the basis of statistical significance, inflation is found to be detrimental to the growth of the industrial sector only. In the presence of sectoral inflation, no significant impact of inflation is found in the services and agricultural sector growth models. A growth-conducive impact of agri-sector-specific deflator has been found in industrial and services sectors. On the contrary, industrial-sector-specific deflator is found to be detrimental to the agricultural sector growth.

The remainder of the paper is structured as follows. The next section highlights the limited existing literature on inflation and sectoral growth and various heterogeneities to be essentially considered as a baseline framework of our empirical model. The theoretical perspectives on "inflation-growth nexus" are briefly discussed in Section 3, and Section 4 outlines the empirical methodology used to examine the inflation-sectoral growth relationship. Discussion regarding data, variables, and summary statistics is also presented in Section 4. In Section 5, we discuss significant estimated results, followed by Section 6, which comprised a brief summary and suggestions for future research.

2 | LITERATURE REVIEW

As we stated earlier, the inflation-sectoral growth relationship is largely ignored in the economic literature. We briefly review the existing literature on the subject in the following two subsections.

2.1 | Inflation and sectoral growth

Logue and Sweeney (1981) measured the variability of real economic growth by using growth of industrial production as a proxy for 24 countries. By using annual data, they found a positive relationship between the average inflation rate and real economic growth variability. Their results highlight the importance of allocating greater explicit attention to the impact of inflation on variability in output. Their analysis is built upon assumptions from earlier studies that suggest a positive relationship between higher average rates and greater variability of inflation. This relationship is found to raise the level of uncertainty in production, investment, and marketing decisions, which in turn leads to higher variability in real growth.

By considering sectoral growth variances and inflation, Íscan and Osberg (1998) were unable to find significant relation between output growth variability and inflation during the studied period of 1961:1 to 1995:4. They use quarterly data of 131 industries of the Canadian economy, exclude the public sector from the data, and divide the sample mainly into goods and services sectors. Furthermore, they indicate that the variances of sectoral output growth and inflation (first difference of the logarithm of GDP deflator) are correlated with each other. Their study demonstrates that the achievement of lower inflation is a hard bargain due to the influence monetary policy has on real exchange rate. The key feature of their findings, also related to our study, is that they have clearly distinguished between goods-producing sectors and service sectors. This is also important because service industries typically smooth output in response to temporary relative price variability. Íscan and Osberg (1998) find the coefficients of inflation variables to be insignificant in the goods sector, but significant for service sectors, after excluding lagged inflationary levels from the model.

Chaudhry et al. (2013) examined the impact of CPI inflation on sector-wise growth of the economy of Pakistan. By employing OLS methodology and annual time-series data (1972–2010), they report that an increase in inflation affects agriculture, manufacturing, and services sectors' growth differently. They found an inverse relationship between consumer price index (CPI) inflation and the growth of manufacturing sector, whereas inflation was found to encourage the value-added growth of agricultural and services sectors. Their suggestion is that inflation should generally by restricted within the single-digit zone.

2.2 | Heterogeneities across industrial, services, and agricultural sectors

As the structure of an economy comprised the output shares of different sectors, Singh (2016) pointed out that the symbiotic interdependence of sectors relates them in a way that the output of one sector serves as an input for another sector(s). The dynamic process of economic growth encompasses a monotonically decreasing share of agriculture and the growing segment of services in aggregate output. Chaudhry et al. (2013, p. 79) opined that "with the rise in national income, industrial sector gains dominance over the agricultural sector followed by an increase in the services sector. These stages are essential for all developing countries to pass through, and it is elucidated by structural adjustment in the demand for the consumer and the comparative labour yield of major sectors of the economy." They further elaborate that the key levers of long-term growth in each sector are factor accumulation (labour and capital) and technological progress (efficiency). However, the dynamics of each sector are different from the others.

While discussing heterogeneity across industries in a different empirical setting, Peersman and Smets (2005) discovered that the monetary policy impact on industries that manufacture nondurable goods is about three times less robust than the effect on industries that manufacture durable goods. They argued that sectors with higher capital intensity are more exposed to variations in the user cost of capital. Meanwhile, the alterations in interest rates play a significant role in the determination of the user cost of capital. Therefore, by this assertion, we can claim that capital- and labour-intensity also matter in a setting when sectoral growth is being examined subject to inflation.

We conclude that the industrial and services sectors are relatively urban based, more capital intensive, and they build on a developed financial system. Therefore, output growth of these sectors is more sensitive to inflation variability, uncertainty, international factors, and macroeconomic volatility. In contrast, agricultural sector, in developing economies, is generally rural based, mainly dependent on fixed natural resources and, hence, less sensitive to price variability, uncertainty, and macroeconomic volatility.[9]

In industry, production is organized within global value chains (vertical specialization). This leads to longer term contracts and slow transmission of price changes. In services, price changes are felt immediately by producers and consumers. The agricultural sector is subject to external supply side factors that determine prices and output at a point in time (e.g., droughts and floods). Imported inflation (or price stability) matters differently via exchange rate and monetary policy regimes, in these three sectors. Other considerable heterogeneities are relative price differentials, feedback effects, and production lags.

3 | THEORETICAL CONSIDERATIONS

We start by quoting the words of Temple (2000) who opined that the money-growth literature draws no "conclusion" regarding the theoretical impact of inflation on growth, whereas according to López-Villavicencio and Mignon (2011), the effects of inflation on growth depend mainly on the way money is introduced into the models, and they report mixed evidence of inflation–growth relationship. If we go back to the 1960s, Sidrauski (1967) also introduced money into the utility function, and his results offer a transitional effect of inflation on output growth. In his words, "money growth has no real effect on the steady-state.″ Ireland (1994), by considering a cash-in-advance economy, concludes that money growth has no real impact on output growth if a specific credit sector is taken into account.

On the other hand, Tobin (1965) views money as an alternative for capital; as a result, higher monetary growth enhances capital accumulation that causes inflation to bring a positive impact on long-run economic growth. Consequently, if inflation increases, it will also put an increase in the nominal interest rate. As a result, the economic agents will hold more in other assets by reducing their holdings for money balances. This will tend to drive the real interest rate down, and as a result, investment and *capital-labour* ratio will likely be increased. According to Stockman (1981), if money is considered for purchasing capital goods, higher anticipated inflation causes a decrease in the steady-state real balances and capital stock. Therefore, a reverse Tobin effect emerges. This means if cash is held for purchasing the capital goods, inflation may reduce the steady-state capital stock.

According to Hineline (2010), many theoretical models highlight the significance and role of certain sectors in the economy. For instance, significance of the sectors that are intensive in research and development is emphasized by many endogenous growth models. Likewise, opined by Boyd, Levine, and Smith (2001), "financial-development-growth" studies suggest that, as it is particularly important to the long-run growth, the financial sector can be particularly affected by the inflation rate. Hineline (2010) argues that, even if the impact on the aggregate GDP growth is not large, and the impact of inflation on various sectors is significantly different, it might help explain why some stakeholders in an economy feel stronger about inflation than others. In addition, according to Walsh (1995), this conjecture becomes consistent with the models that estimate the effects of the preferences of the optimal central banker.

Most of the empirical growth models are built on the assumption of one sector modelling and consider only the *intertemporal effect* of inflation. Hence, the *distributional effect* of inflation is widely ignored. However, as a first attempt, Foley and Sidrauski (1970, 1971) considered a two-sector (consumption investment) model and argued that inflation, along with the *intertemporal effect*, may also have a *distributional effect*.

On the same line of reasoning, for a two-sector neoclassical cash-in-advance growth model with different capital intensities, Huo (1997) demonstrated that, as it depends on which sector is relatively capital intensive, inflation can either "grease the wheels" of the economy or could have a "sand effect" for economic growth across sectors. To assess the effects of inflation on capital accumulation, he divided the total production into credit goods and cash goods. The results illustrated that permanent inflation initiated to increase the relative demand of credit good resulted in an increase of its price. According to Huo (1997), this happened because, in order to meet the increased demand of the credit good compared with the cash good, more capital is required for the production of credit good. Therefore, by altering the supply of factor inputs, inflation caused an increase in capital accumulation in the credit sector.

More recently, in an endogenous growth model of commodity-rich economies (i.e., Australia, Canada, New Zealand, and the United States), Ferraro and Peretto (2017) examined the relationship between commodity prices and growth. They argued that long-run growth is endogenous and independent of commodity prices whereas short-run growth is affected through transitional dynamics in aggregate total factor productivity. The findings show that the changes in commodity prices tend to generate movements in real income and market size and, as a result, overall substitutability of commodity and labour. In a multisector economy, according to the theory, the properties of commodity-labour substitutability are dependent on the price elasticity of demand for commodity in materials and manufacturing.

On the same grounds, for our empirical analysis, we assume that there exists more than one sector in the economy, and inflation can cause the redistribution of factor inputs. More specifically, we argue that the relative price and expansion of one sector (at the expense of the other) is subject to changes in the rate of inflation. In the long-run, given the assumed structure of production, this argument leads to a change in investment and growth. Borrowing from Huo (1997), we elaborate the mechanism with the help of an example. Initially, the economy is in the steady-state condition; we assume different capital intensities for the industrial and agricultural sectors and the following production (and growth) functions:

$$Y_{ind} = f(L, K) \quad (1)$$

$$Y_{agr} = f(L, \bar{N}) \quad (2)$$

Where L, K, and $\bar{N}$ denote labour, capital, and fixed natural resources, respectively, and Equation (1) and Equation (2) are, of course, subject to different capital intensities. An increase in the rate of inflation tends to raise the opportunity cost of buying the output of one sector (e.g., industrial) relative to the other (e.g., agricultural) and causes the redistribution of factor inputs. As a result, inflation encourages a substitution of demand for the industrial sector and, consequently, a shift of labour supply from that to the agricultural sector. Hence, the supply is less in the industrial sector and more in the agricultural sector thus resulting in more growth in the agricultural sector and less in the industrial sector. However, it can be implied that there will be an excess supply for the "industry good" and excess demand for the "agri good." Hence, in order to achieve equilibrium, the relative price (P_{agr}/P_{ind}) must also rise. In the long-run, the relative price (P_{agr}/P_{ind}) is higher to justify more production in the agricultural sector and less in the industrial sector, which also implies more growth in the agricultural sector and less in the industrial sector.

4 | METHOD AND DATA

4.1 | Empirical methodology

Due to the potential issue of endogeneity, inference derived on the basis of nondynamic fixed effects (FE) and random effects (RE) models could be deceptive. The dynamic panel estimation allows us to include lagged-dependent variable along with explanatory variables, hence, overcoming the biasedness of FE and RE estimators. However, a difficulty with these estimators is finding appropriate instrumental variables for inflation and other regressors to cope with the endogeneity problem. To address this challenge, we follow Arellano and Bover (1995); Blundell and Bond (1998) by adopting the one-step system generalized method of moments (GMM), which is a dynamic panel data estimation technique.

We prefer system GMM estimator over FE or RE estimators because the latter estimators are biassed in the presence of lagged-dependent variables. Whereas, the system GMM estimator uses the lagged levels as instruments and combines them with moment conditions in first differences and additionally a set of moment conditions stemmed from the equation in levels. This method takes into account the biases (e.g., endogeneity) that appear because of country-specific and time-invariant effects and control variables (e.g., initial income level) on the right hand side. Additionally, the system GMM estimator can use the lagged values of the regressors to cope with other econometric issues (e.g., simultaneity). One-step estimator has been used to obtain reliable estimates. Many econometricians (e.g., Bond, Hoeffler, & Temple, 2001) recommend the system GMM estimator as more suitable for empirical growth analysis.

Based on an extended neoclassical view (e.g., Barro & Sala-i-Martin, 1995; Barro, 1995) in which some standard growth determinants are considered as constant, and following the mechanism in Section 3, we test our hypothesis by using a system of regression equations. To quantify the impact of inflation on the sectoral growth in a panel data set of 113 developing countries for data spanning 1981–2015, and testing whether inflation and other relevant factors can explain the relationship with the sectoral growth rate, our baseline dynamic panel model derived from the theory is:

$$g^s_{it} = \beta_1 g^s_{i,t-1} + \beta_2 \tilde{\pi}_{it} + \beta_3 \pi^s_{it} + \beta_4 X^s_{it} + \mu^s_{it} \quad (3)$$

where $i = 1, 2, ..., 113$, $t = 1, 2,..., 40$ and $s = 1, 2, 3$. g^s_{it} is the annual value-added growth rate of sector s, country i at time t, and $g^s_{i,t-1}$ is its lagged value. $\tilde{\pi}_{it}$ is the semilogged transformed 5-year averaged rate of inflation, π^s_{it} is the 5-year averaged rate of sectoral inflation and X^s_{it} is a vector of control variables, specified separately for each sector. The sector-wise error term is specified as:

$$\mu^s_{it} = v^s_i + \epsilon^s_{it} \quad (4)$$

Time invariant sector-specific effects are limited in the error term μ^s_{it}, which comprised the unobserved sectoral characteristics v^s_i and the observation-specific errors ϵ^s_{it}.

$$\Delta g^s_{it} = \alpha_1 \Delta g^s_{i,t-1} + \alpha_2 \Delta\tilde{\pi}_{it} + \alpha_3 \Delta\pi^s_{it} + \alpha_4 \Delta X^s_{it} + \epsilon^s_{it} \quad (5)$$

To deal with the fixed effects v^s_i, which do not vary with time, the difference GMM technique uses first differences to convert Equation (3) into Equation (5), which is free from fixed country effects. The first-differenced lagged-dependent variables are also instrumented with their previous levels. The system GMM estimator is also compatible with a data format where $T < N$.

Given that the standard assumption of cross-sectional panel data models is that the disturbance terms are cross-sectionally independent, we relied on Sarafidis, Yamagata, and Robertson (2009), who affirm that a system GMM estimator is consistent, even situation where heterogeneous error cross-sectional dependence is present in the sample data. Although the system GMM postestimation test for cross-sectional dependence has not been introduced so far, we tried to perform Pesaran's 2004 CD test to examine cross-sectional dependence for variables separately. The estimation is not possible due to lesser observations in the data set. However, because the data sample is unbalanced (i.e., number of observations included in the analysis is different for each country group), we believe that the construction of the sample of this study minimizes the potential problem of the cross-sectional dependence.

As a robustness check, we utilize the bias-corrected least square dummy variable ($LSDV_{bc}$) estimator initiated by Kiviet (1995), Kiviet (1999), Bun and Kiviet (2003), and extended by Bruno (2005a, 2005b) for unbalanced dynamic panel data models, with a strictly exogenous selection rule. We initialize the FE approach for an approximation of $O(1/NT)$. Fulfilling the requirement of the bias-correction procedure, the estimation is initialized, similar to Sequeira and Maçãs Nunes (2008) and Binici, Cheung, and Lai (2012), with the Blundell and Bond (1998) estimator to account for first round consistent estimates. Another worth noting point is that we have assumed that inflation predicts growth, but we did not implement a test to verify this assumption.

4.2 | The sample

Our unbalanced data set comprised 113 developing (low and middle income) countries, covering the period 1981–2015. As this is now a standard in the growth literature, we have subjugated the time variation factor of our sample by dividing 35 years of data into seven nonoverlapping 5-year spells for all variables, for each country that gives a maximum of 791 observations. The selection of economies and estimations is subject to the data availability. All considered economies are listed in the Appendix A. The data are taken from the World Bank (WDI), IMF (IFS), Penn World Table 8.1, Polity IV Project, and individual country sources.

4.3 | Sectoral growth regressors

In order to examine the inflation-sectoral growth relationship, key determinants relating to macroeconomic policies, demand and supply shocks, structural change, and international spillovers have been considered. These economic factors influence the relationship between inflation and sectoral growth. Hence, they are relevant for building our parsimonious models for empirical analysis. The choice of sectoral growth regressors is mainly based on the neoclassical growth framework. Some determinants have also been inspired by the endogenous growth theory (e.g., Barro, 1991; Romer, 1994; Barro & Sala-i-Martin, 1995; Mankiw, Romer, & Weil, 1992, among others).

For each country, sectoral growth rate defined as value-added percentage growth of each sector ($indg_{it}$, $srvg_{it}$ and $agrg_{it}$ for industrial, services, and agricultural sectors, respectively) is the dependent variable. In order to examine the dynamic aspects of inflation-sectoral growth relationship in each of the three models, lagged growth of industrial ($indg_{i,t-1}$), services ($srvg_{i,t-1}$), and agricultural ($agrg_{i,t-1}$) sectors, respectively, are considered as the right-hand side variables. This helps to capture the spillovers of various sectors. Furthermore, possibility of partial adjustment towards the steady-state equilibrium can also be ensured by the lagged-dependent variables.

4.4 | Inflation

In all regressions, inflation ($\tilde{\pi}_{it}$), key independent variable, is taken as semilog transformation of the annual CPI rate of inflation. The transformation is done in line with Khan and Senhadji (2001) and Kremer et al. (2013) as:

$$\tilde{\pi}_{it} = \pi_{it} - 1 \quad \text{if} \quad \pi_{it} \leq 1\%$$

and

$$\tilde{\pi}_{it} = ln(\pi_{it}) \quad \text{if} \quad \pi_{it} > 1\%.$$

Where $\tilde{\pi}_{it}$ is the semilogged transformed 5-year averaged rate of inflation, and π_{it} is the 5-year averaged inflation from the annual CPI rate of inflation. This is necessary to avoid distortion of the regression results by a few extreme inflationary observations. Based on our arguments in Section 2.2, we expect a differentiated (either positive or negative) sign of this variable in different regressions.

In order to capture the effects of spillovers and heterogeneities across sectors, another key variable of interest, sectoral inflation rate for each sector (i.e., π_{it}^{ind}, π_{it}^{srv}, and π_{it}^{agr} for industrial, services, and agricultural sectors, respectively), has been calculated by taking the growth rate of the nominal deflator of the relevant sector. The nominal deflator for each sector has been calculated by: $\left(\frac{VA_cp}{VA_kp}\right) \times 100$. VA_cp and VA_kp are value-added current dollar prices and value-added constant dollar prices, respectively, in each sector.

Based on our hypotheses, we generally expect a differentiated sign for π_{it}^{ind}, π_{it}^{srv}, and π_{it}^{agr}. More specifically, for industrial sector growth model, we expect a positive sign of the coefficient of π_{it}^{agr}. For services sector growth model, positive coefficient estimates are expected for π_{it}^{agr} and π_{it}^{ind}. Similarly, positive sign of the coefficient of π_{it}^{ind} is hypothesized in agricultural sector growth model. We should mention that, in the services sector growth model, the most appropriate specification will include the sector-specific VA deflator of two remaining sectors (i.e., agricultural and industrial). This is in contrast with the industrial and agricultural sectors growth models. The explanation is simple. As raw material for the industrial sector production comes mainly from the agricultural sector, the most appropriate specification for the industrial sector growth model will require to include only the agricultural-sector VA deflator. However, although the services sector growth is affected by both of the remaining sectors, we consider it appropriate to consider sector-specific VA deflator of agricultural and industrial sectors in the services sector growth model.

It is a well-established fact that the rate of inflation and changes in money supply are highly correlated (Crowder, 1998). Being a major instrument of the central bank's monetary policy, and depending on the level of inflation, money supply may have important implications for sectoral growth. As a robustness check, an alternative to the variable of sectoral inflation, broad money as percentage of GDP (m_{it}) is taken to capture the effects of monetary policy with an expected negative sign.

4.5 | Other explanatory variables

X_{it} is the k-dimensional vector of control variables, which includes the following important sectoral growth determinants for industrial, services, and agricultural sectors. To capture the effects of population dynamics on sectoral growth, overall ($popg_{it}$), urban ($popu_{it}$), and rural ($popr_{it}$) population growth rates (annual percentage) have been chosen as control variables in industrial, services, and agricultural growth model, respectively. As capacity increases with the growth of effective population, if there is a feasible proportion of the working force to the dependents and other factors of production, it impacts growth positively and vice versa. Rural population growth is assumed to have a positive impact on agricultural sector growth because agricultural sector in the developing world is still mainly based on labour input.

The Solow-type key growth determinant, investment, also fundamental in endogenous growth models, appears in all growth regressions. Total investment as percentage share of GDP (inv_{it}) with the expected positive sign is taken to capture the effects of aggregate demand-supply factors and government macroeconomic policies. Following neoclassical growth theory (e.g., Barro & Sala-i-Martin, 1995, among others), natural logarithm of GDP per capita (constant 2010 USD) of the previous period as the convergence variable ($initial_{i0}$) is taken to control for conditional convergence. A negative sign of the coefficient of $initial_{i0}$ is expected.

Given that the school enrollment ratios in an economy reflect the development of human capital, industrial, and services sectors growth models include human capital index (hci_{it}) based on years of schooling and returns to education. Whereas, agricultural sector growth model considers secondary school enrollment ($enroll_{it}$) ratio as percentage of gross. These two growth determinants are assumed to positively influence the sectoral growth.

Trade openness ($opns_{it}$), measured as the summation of exports and imports in percentage of GDP, exports of goods and services (exp^{gs}_{it}) as percentage share of GDP and the lag of exchange rate have been taken as indicators reflecting trade policy, macroeconomic stabilization, and international impact on the economy. Exchange rate factor can contribute to the sectoral growth of developing economies by the "channel of export promotion incentives." It states that in the situation when the local currency depreciates, investment and foreign direct investment inflow will rise, which results in the growth of the import substitute industry. Currency depreciation stimulates exports and, therefore, boosts economic growth. Rapetti, Skott, and Razmi (2012) report that undervaluation in developing economies causes to bring a robust impact on economic growth.

Institutional stability index ($polstab_{it}$) has also been incorporated in all growth regressions to capture the effects of democratic behaviour, institutional stability, and autonomy of the institutions. Fortunato and Panizza (2015) have pointed out that democratic institutions alone do not guarantee direct contribution towards economic growth. However, in the presence of other controls, we expect this index to be correlated positively with sectoral growth.

Whereas, $\boldsymbol{X}_{it}$ for the agricultural sector growth model contains three sector-specific additional control variables. The agricultural sector growth model contains the log of land area in square kilometres ($land_{it}$), forest area as percentage of land area ($forest_{it}$), and livestock production index ($livestock_{it}$). These variables help to capture the effect of fixed resources of an economy and agricultural productivity while estimating the relationship between agricultural sector growth and inflation. The positive signs are expected for parameter estimates of these variables in Model 3.

4.6 | Descriptive statistics

Before presenting the econometric analysis of the estimation results of our model, based on 5-year averages, we present the descriptive statistics of all variables in Table 1. The unweighted long-run average of sector-wise growth in the sample is below 5%. The averages of semilogged transformed CPI inflation (i.e., 2.08) and sectoral inflation (i.e., 3.38, 3.58, and 2.85 for industrial, services, and agriculture sectors, respectively), compared with the standard deviation values of these variables, indicate that the measures of sectoral inflation are more volatile than all measures of sectoral growth over this time period.

On average, population growth rates (i.e., overall, urban, and rural) ranged from 1.14% in rural areas to 3.66% in the urban areas. Investment share of GDP was relatively volatile with a range of around 0% to 63.81% around the mean value of 23.13%. Similarly, dispersion in secondary

TABLE 1 Descriptive statistics, 1981–2015; 113 developing countries

Description	Variables	Obs.	*M*	*SD*	Min.	Max.
GDP growth rate	$gdpg_{it}$	756	3.71	4.22	−21.66	39.79
Industrial sector growth rate	$indg_{it}$	693	4.24	6.08	−23.64	34.72
Services sector growth rate	$srvg_{it}$	689	4.45	4.63	−17.94	66.47
Agricultural sector growth rate	$agrg_{it}$	693	2.77	3.55	−13.04	24
Inflation	$\tilde{\pi}_{it}$	756	2.08	1.56	−8.36	8.78
Industrial-sector VA deflator	π_{it}^{ind}	685	3.38	8.53	−32.18	75.21
Services-sector VA deflator	π_{it}^{srv}	675	3.58	8.84	−28.73	135.95
Agricultural-sector VA deflator	π_{it}^{agr}	689	2.85	7.31	−21.48	42.07
Broad money	m_{it}	723	41.23	27.84	0.003	186.60
Population growth rate	$popg_{it}$	784	1.82	1.21	−4.11	6.59
Urban population growth rate	$popu_{it}$	791	3.66	7.89	−3.96	87.55
Rural population growth rate	$popr_{it}$	790	1.14	2.05	−6.02	22.80
Total investment	inv_{it}	686	23.13	9.55	0	63.81
Initial per capita GDP	$initial_{i0}$	736	7.43	1.04	5.06	9.94
Human capital index	hci_{it}	610	1.96	0.58	1.02	3.56
Primary school enrollment	$enroll_{it}$	721	101.67	20.01	25.78	172.93
Trade openness	$opns_{it}$	739	77.22	42.42	0.20	436.38
Exports of goods & services	exp_{it}^{gs}	734	34.64	26.52	0.13	367.03
Exchange rate	xr_{it}	723	2.69	4.10	−23.45	9.95
Political stability index	$polstab_{it}$	681	0.97	6.23	−10	10
Land area	$land_{it}$	785	11.83	2.40	2.00	16.06
Livestock index	$livestock_{it}$	752	90.27	29.65	22.74	245.57
Forest area	$forest_{it}$	674	33.78	24.30	0.04	98.91

Note. Table 1, obtained from STATA, reports the summary statistics of all variables of interest. Obs. is the reported number of observations of each variable. *M* is the average of values for each variable and *SD* is the standard deviation. Min. and Max. are the intervals representing minimum and maximum values of each variable.

school enrollment (i.e., ranges 25.78% to 172.93%), money share in GDP (i.e., ranges 0.003% to 186.6%), trade openness (i.e., ranges 0.20% to 436.38%), and exports (of goods and services) share in GDP (i.e., ranges 0.13% to 367.03%) of the sample economies are high. Descriptive statistics of the rest of the considered variables show a relatively stable pattern.

5 | RESULTS AND DISCUSSION

Before presenting our estimation results, we argue that Table 2 fully confirms our motivation for the *conjecture of disaggregation*. The system GMM (Column 1), robust system GMM (Column 2), and bias-corrected least square dummy variable estimates (Column 3) report contrasting results for the coefficient estimates of the variable of aggregate inflation ($\tilde{\pi}_{it}$). For instance, if we place emphasis on dealing with the issue of endogeneity and simultaneity, by considering both the aggregate GDP and inflation as endogenous variables in the system, inflation is positively associated with the growth rate of developing economies. Whereas, if we take into account the argument of persistence in the growth rate—when, in growth regressions, the lagged growth rate appears as a significant explanatory variable—and a panel estimator relevant for a persistent dependent variable (i.e., $LSDV_{bc}$) is employed, the relationship between inflation and GDP growth rate appears to be negative. However, Table 2 indicates that the change in estimators does not alter the signs and significance of the remaining explanatory variables.

By considering all heterogeneities and sector-specific factors, this section reports sector-wise growth and inflation estimates. The specifications and explanatory variables are different in each of the three models. Our choice of estimations is complemented by various diagnostic checks, and the findings are also passed through a battery of specification tests. For example, to see if the time fixed-effects are required, after running the FE model, we examined the joint test to find out if the year dummies are equal to zero. The results (p-value = 0.000 and 0.0349 in services and agricultural sectors respectively) indicate that the time fixed-effects are needed. The post-regression diagnostic test estimations are reliable.

To test the overidentifying assumption of our estimates, Sargan and Hansen test results do not support rejection of the null hypothesis that overidentifying restrictions are valid. The numbers of instruments are less than the number of country groups in all sectoral growth regressions. Arellano and Bond's (1991) AR(1) and AR(2), under the null that the residuals show no serial correlation, was used to test each regression for serial correlation. The AR(1) and AR(2) results, in all regressions, state that these condi-

TABLE 2 Aggregate GDP and inflation regression estimates

Dependent variable $gdpg_{it}$	(1) $SysGMM$	(2) $SysGMM_{robust}$	(3) $LSDV_{bc}$
$gdpg_{i,t-1}$	0.218***	0.164	0.194***
	(0.069)	(0.104)	(0.052)
$gdpg_{i,t-2}$	−0.118***	−0.112*	—
	(0.043)	(0.067)	
$\tilde{\pi}_{it}$	0.449*	0.402	-0.183*
	(0.269)	(0.415)	(0.107)
$popg_{it}$	0.836***	0.922***	0.826***
	(0.146)	(0.244)	(0.133)
inv_{it}	0.083***	0.096***	0.058***
	(0.017)	(0.029)	(0.017)
$initial_{i0}$	−0.690***	−0.486*	−0.418***
	(0.339)	(0.733)	(0.108)
hci_{it}	1.531***	2.132***	1.384***
	(0.339)	(0.733)	(0.325)
exp_{it}^{gs}	0.003	−0.052	0.012
	(0.008)	(0.043)	(0.008)
$xr_{i,t-1}$	0.176***	0.194	0.214***
	(0.060)	(0.126)	(0.035)
$polstab_{it}$	0.008	0.010	0.051**
	(0.023)	(0.043)	(0.023)
Time effects	Yes	Yes	No
Observations	380	380	448
Country groups	81	81	80
No. of Instruments	41	40	28
$F/Wald$: p value	0.000	0.000	0.000
AB test for AR(1): p value	0.000	0.001	0.002
AB test for AR(2): p value	0.230	0.311	0.152
Hansen test: p value	—	0.220	—
Sargan test: p value	0.053	0.100	0.000

Note. Standard errors of the estimates are presented in parenthesis below the coefficient estimates.
***Level of significance at 1%. **Level of significance at 5%. *Level of significance at 10%.

tions have been satisfied, and in accordance with Baltagi, Demetriades, and Law (2009), we can significantly reject the null hypothesis of the absence of first-order serial correlation. Whereas, our results do not reject the hypothesis of absence of second-order serial correlation. All these diagnostic tests justify that our choice of picking the estimators and the inference based on them is econometrically valid. However, time and panel-effects estimations are not reported here.

The panel data regression results (Table 3, 4, and 5) fully confirm our conjecture about signs of parameter estimates. In general, all control variables' estimates are in accordance with the standard empirical literature. Keeping robustness of the coefficients in mind and for the sake of comparison with the results obtained from our preferred choice of estimator, system GMM with robust standard errors ($SysGMM_{\tilde{\pi}+\pi^s}$, Column 3), we also estimate our sample with the bias-corrected least square dummy variable ($LSDV_{bc}$) estimator.

Although the two sets of estimates are not much different at least in terms of significant variables, our results demonstrate that the inference relies noticeably on the choice of the estimator. For example, some of the parameter estimates are insignificant in $SysGMM_{\tilde{\pi}+\pi^s}$ estimates whereas the same estimates are highly significant in $LSDV_{bc}$ estimates. $SysGMM_{\tilde{\pi}+\pi^s}$ estimates indicate more confidence in the overall view of the factors affecting sectoral growth and also demonstrate robustness across all three specifications regarding the significance of most of the considered variables. In line with our conjecture established in section 3, in all regressions (*i.e.*, Table 3, 4 and 5), $SysGMM_{\tilde{\pi}+\pi^s}$ results, compared with $SysGMM_{\tilde{\pi}}$ and $SysGMM_{\tilde{\pi}+m}$, are preferred sets of estimates.

In general, at 95% confidence interval, sectoral growth in the sample of selected developing countries is positively related to the growth rate of population, increased share of investment, the rise in secondary school enrollment and quality of human capital and greater maintenance of institutional stability. In accordance with the standard literature on growth, the negative coefficient of the initial GDP per capita variable ($initial_{i0}$), in all models, reports that the conditional convergence hypothesis is valid for the sample under study. This means that the countries with lower income per capita tend to grow faster as compared to the countries with higher income per capita. The initial state of the economy, holding other sectoral growth determinants constant, is also a valid factor to explain the phenomenon of sectoral growth.

Our results lend support to the theoretical considerations of Huo (1997) and Ferraro and Peretto (2017). The results for the control variables are consistent with the standard literature. For instance, coefficient estimates of $polstab_{it}$ and $enroll_{it}$ are in accordance with those of Easterly and Levine (1997), Aisen and Veiga (2013), and Bittencourt, Eyden, and Seleteng (2015).

Overall, the estimates of one of our key variables of interest (i.e., $\tilde{\pi}_{it}$) are consistent with our hypothesis. Among the three considered models (Models 1–3), the sign of the coefficient of inflation ($\tilde{\pi}_{it}$) is significantly negative in the industrial sector growth model only. More specifically, our preferred set of estimates (i.e, Model 1: $SysGMM_{\tilde{\pi}+\pi^s}$) reports that if all other controls are held constant, an annual increase of 10% in average inflation rate tends to reduce the growth of industrial sector by about 0.19 percentage points. However, in the rest of the models (Models 2 and 3), it does not present any statistically significant evidence.

The estimates of our second key variable of interest (i.e., sectoral inflation [π_{it}^s]) are also consistent with our hypothesis. The sign of the coefficient of sectoral inflation (π_{it}^s)

TABLE 3 Industrial sector growth and inflation

Dependent variable $indg_{it}$	(1) $SysGMM_{\tilde{\pi}}$	(2) $SysGMM_{\tilde{\pi}+m}$	(3) $SysGMM_{\tilde{\pi}+\pi^s}$	(4) $LSDV_{bc}$
$indg_{i,t-1}$	0.052	0.013	-0.110	0.101*
	(0.123)	(0.122)	(0.145)	(0.057)
$\tilde{\pi}_{it}$	−1.894**	−1.734*	−1.894**	−0.296
	(0.933)	(0.526)	(0.933)	(0.209)
m_{it}	—	−0.039	—	—
		(0.041)		
π_{it}^{agr}	—	—	0.105*	0.026
			(0.055)	(0.032)
$popu_{it}$	0.665***	0.650***	0.663***	0.837***
	(0.224)	(0.217)	(0.203)	(0.145)
inv_{it}	0.175***	0.220***	0.169***	0.104***
	(0.056)	(0.067)	(0.061)	(0.031)
$initial_{i0}$	−2.237***	−2.099***	−2.240***	−0.637***
	(0.620)	(0.582)	(0.624)	(0.188)
hci_{it}	3.327*	3.691**	3.271*	1.439**
	(1.833)	(1.579)	(1.853)	(0.618)
$opns_{it}$	−0.075	−0.058	−0.048	0.003
	(0.060)	(0.051)	(0.061)	(0.007)
$xr_{i,t-1}$	−0.492	−0.601**	−0.508	0.255***
	(0.355)	(0.265)	(0.358)	(0.065)
$polstab_{it}$	0.127	0.069	0.134	0.048
	(0.090)	(0.077)	(0.088)	(0.041)
Time effects	No	No	No	No
Observations	427	417	425	418
Country groups	80	78	80	79
No. of instruments	24	25	24	29
$F/Wald$: p value	0.000	0.000	0.000	0.000
AB test for AR(1): p value	0.007	0.001	0.026	0.000
AB test for AR(2): p value	0.348	0.968	0.219	0.416
Sargan test: p value	0.081	0.031	0.113	0.000
Hansen test: p value	0.253	0.202	0.263	—

Notes: Table 3 displays coefficient estimates obtained from one-step system GMM estimator with robust standard errors (Columns 1–3) and bias-corrected least square dummy variable estimator (Column 4). Standard errors are reported in parenthesis below the coefficient estimates. The panel data used for our estimation were obtained from 113 developing economies. They are 5-year averages of annual secondary data covering the period 1981–2015.
***Level of significance at 1%. **Level of significance at 5%. *Level of significance at 10%.

is not only different in considered sectors but also statistically significant. Ceteris peribus, an annual increase of 10% in average agri-sector VA deflator (π_{it}^{agr}) tends to increase the growth of industrial sector by about 1%, and the same amount of industrial-sector inflation (π_{it}^{ind}) tends to reduce the agricultural sector growth by about 0.5%. Whereas, if all other controls are held constant, an annual increase of 10% in average agri-sector inflation rate (π_{it}^{agr}) tends to reduce the growth of services sector by about 2.7%. More clearly, by employing a suitable methodology, there is clear evidence for the differentiating impact of aggregate and sectoral inflations. Thus, we can summarize that sectoral inflation is one of the robust variables across the specifications affecting sectoral growth. Now, we highlight and discuss the key parameter estimates and the mechanism of interplay between various sectors of the economy.

5.1 | Model 1: Industrial sector growth and inflation

Table 3 presents parameter estimates by regressing industrial sector growth, inflation, and sectoral inflation, while keeping all predictors as constants. The significant positive signs associated with the coefficients of population growth, investment, and human capital development highlight that those factors contribute to the growth of industrial sector in developing economies. The results are robust, and the benchmark equation is $SysGMM_{\tilde{\pi}+\pi^s}$ (Column 3).

TABLE 4 Services sector growth and inflation

Dependent variable $srvg_{it}$	**(1)** $SysGMM_{\tilde{\pi}}$	**(2)** $SysGMM_{\tilde{\pi}+m}$	**(3)** $SysGMM_{\tilde{\pi}+\pi^s}$	**(4)** $LSDV_{bc}$
$srvg_{i,t-1}$	0.090	0.097	0.040	0.0004
	(0.125)	(0.126)	(0.143)	(0.048)
$\tilde{\pi}_{it}$	−0.452	−0.634	−1.456	−0.691***
	(0.714)	(0.697)	(1.051)	(0.186)
m_{it}	—	-0.032*	—	—
		(0.016)		
π_{it}^{agr}	—	—	0.267**	-0.007
			(0.133)	(0.036)
π_{it}^{ind}	—	—	−0.085	0.080**
			(0.091)	(0.032)
$popu_{it}$	1.085***	0.836***	1.186***	1.028***
	(0.304)	(0.162)	(0.277)	(0.128)
inv_{it}	0.144**	0.126***	0.109	0.138***
	(0.068)	(0.042)	(0.093)	0.028
$initial_{i0}$	−0.667*	−0.777***	−1.203*	−0.877***
	(0.342)	(0.289)	(0.645)	(0.168)
hci_{it}	3.297***	2.319***	4.483***	3.024***
	(1.124)	(0.717)	(2.648)	(0.531)
exp_{it}^{gs}	−0.067	—	−0.046	−0.012
	(0.058)	—	(0.048)	(0.013)
$opns_{it}$	—	0.002	—	—
		(0.008)		
$polstab_{it}$	0.012	0.095**	0.040	0.069*
	(0.097)	(0.040)	(0.095)	(0.037)
$xr_{i,t-1}$	0.051	−0.044	−0.127	0.068
	(0.191)	(0.120)	(0.297)	(0.057)
Time effects	Yes	Yes	Yes	No
Observations	424	417	422	415
Country groups	79	78	79	78
No. of instruments	25	33	25	30
$F/Wald$: p value	0.000	0.000	0.000	0.000
AB test for AR(1): p value	0.034	0.022	0.014	0.010
AB test for AR(2): p value	0.562	0.111	0.846	0.400
Sargan test: p value	0.499	0.076	0.663	0.304
Hansen test: p value	0.175	0.210	0.183	—

Note. Table 4 displays coefficient estimates obtained from one-step system GMM estimator with robust standard errors (Columns 1–3) and bias-corrected LSDV estimator (Column 4). Standard errors are reported in parenthesis below the coefficient estimates. The panel data used for our estimation were obtained from 113 developing economies. They are 5-year averages of annual secondary data covering the period 1981–2015.
***Level of significance at 1%. **Level of significance at 5%. *Level of significance at 10%.

From Table 3, we can observe that, by including various industrial sector growth determinants and agricultural sector inflation, coefficient of variable inflation ($\tilde{\pi}_{it}$) remains almost unchanged (i.e., around −1.9 in our preferred regression with $SE = 0.93$) in three system GMM specifications (Columns 1–3). This reveals that the link between industrial sector growth ($indg_{it}$) and inflation ($\tilde{\pi}_{it}$) is negative and statistically significant. As hypothesized, positive association between the agricultural sector inflation (π_{it}^{agr}) and $indg_{it}$ is evidenced. However, in Specification 4, where $\tilde{\pi}_{it}$ is considered as an exogenous variable, it loses its statistical significance. In this situation, lagged industrial sector growth ($indg_{i,t-1}$) becomes statistically significant and positively affects $indg_{it}$. The point estimates attached with the variable of exchange rate (xr_{it}) are also in line with standard literature, which states that exchange rate increments (depreciation) tend to have a positive impact on exports and negative impact on imports by making them more expensive.

More important for our objectives, three significant points emerge from the empirical analysis of industrial

TABLE 5 Agricultural sector growth and inflation

Dependent variable $agrg_{it}$	**(1)** $SysGMM_{\tilde{\pi}}$	**(2)** $SysGMM_{\tilde{\pi}+m}$	**(3)** $SysGMM_{\tilde{\pi}+\pi^s}$	**(4)** $LSDV_{bc}$
$agrg_{i,t-1}$	0.074	−0.119	0.145*	0.143**
	(0.141)	(0.195)	(0.087)	(0.061)
$\tilde{\pi}_{it}$	−1.152**	−1.029**	−0.683	−0.084
	(0.470)	(0.435)	(0.483)	(0.158)
m_{it}	—	−0.0002**	—	—
		(0.0001)		
π_{it}^{ind}	—	—	−0.051*	−0.042**
			(0.027)	(0.021)
$popr_{it}$	0.024	0.094	0.010	0.139
	(0.186)	(0.170)	(0.185)	(0.127)
$initial_{i0}$	-0.743***	−0.800**	−0.624**	−0.331**
	(0.252)	(0.256)	(0.254)	(0.159)
inv_{it}	−0.027	−0.006	−0.017	−0.003
	(0.024)	(0.021)	(0.020)	(0.021)
$enroll_{it}$	0.024**	0.028**	0.016*	0.016**
	(0.010)	(0.010)	(0.009)	(0.010)
$land_{it}$	0.386***	0.379***	0.319***	0.261***
	(0.094)	(0.095)	(0.104)	(0.072)
$livestock_{it}$	−0.0014	−0.0007	−0.0007	−0.0007
	(0.005)	(0.006)	(0.008)	(0.006)
$forest_{it}$	−0.009	−0.010	−0.007	−0.006
	(0.006)	(0.007)	(0.006)	(0.007)
exp_{it}^{gs}	0.010	0.005	0.011	0.014
	(0.010)	(0.009)	(0.010)	(0.010)
$xr_{i,t-1}$	−0.132	−0.147	−0.062	0.070
	(0.112)	(0.100)	(0.102)	(0.053)
Time effects	No	No	Yes	No
Observations	486	473	483	478
Country groups	97	94	97	96
No. of instruments	35	33	50	31
F/*Wald* : *p* value	0.002	0.000	0.012	0.000
AB test for AR(1): *p* value	0.001	0.060	0.000	0.000
AB test for AR(2): *p* value	0.655	0.273	0.489	0.421
Sargan test: *p* value	0.335	0.407	0.224	0.043
Hansen test: *p* value	0.153	0.349	0.150	—

Notes: Table 5 displays coefficient estimates obtained from one-step system GMM estimator with robust standard errors (Column 1-3) and bias-corrected LSDV estimator (Column 4). Standard errors are reported in parenthesis below the coefficient estimates. The panel data used for our estimation was obtained from 113 developing economies. They are 5-year averages of annual secondary data covering the period 1981-2015.
***, **, and * are used to denote the level of significance at 1%, 5%, and 10% respectively.

sector growth and inflation in developing economies. First, although the agricultural-sector inflation significantly matters for industrial sector growth, the *conjecture of disaggregation* holds for this sector. Secondly, when sectoral inflation is taken into account, the relationship between CPI inflation and industrial sector growth is negative. Finally, in sectoral growth analysis, given that endogeneity and simultaneity exist, CPI inflation should be treated as an endogenous variable.

5.2 | Model 2: Services sector growth and inflation

Table 4 presents results by regressing services sector growth with different relevant explanatory variables. Although all estimates are robust, Column 1 shows the estimates by including only inflation ($\tilde{\pi}_{it}$) as a key independent variable, and Column 2 additionally includes the variable broad money (m_{it}). The most appropriate specification (i.e., $SysGMM_{\tilde{\pi}+\pi^s}$ in Column 3) includes, along with $\tilde{\pi}_{it}$, π_{it}^{agr} and π_{it}^{ind}.

By adding up different regressors, in all the system GMM estimates (Columns 1–3), the coefficient of $\tilde{\pi}_{it}$ remains statistically insignificant. This unveils the fact that the relationship between services sector growth and inflation is different than that of Model 1. However, as hypothesized, the coefficient attached with π_{it}^{agr} is significantly positive and in line with that of Model 1. However, in Specification 4, where $\tilde{\pi}_{it}$ is considered as an exogenous variable, it becomes statistically significant and negative. In this situation, contrary to the system GMM specifications, industrial-sector inflation (π_{it}^{ind}) becomes statistically significant and positively affects srv_{it}. The point estimates attached with the variable of π_{it}^{ind} are also in line with our hypothesis. In all regressions, other significant determinants of services sector growth are urban population growth, initial per capita GDP, quality of human capital, investment (except for Specification 3), and institutional stability (only in Specifications 2 and 4).

Likewise Model 1, three significant points can be drawn from the empirical analysis of services sector growth and inflation in the developing economies. First, although the agricultural-sector inflation significantly matters for this sector, the *conjecture of disaggregation* holds for services sector growth of the developing economies. Secondly, when the sectoral inflation of other sectors in the economy is taken into account, no significant relationship is found between CPI inflation and services sector growth. Finally, when CPI inflation is employed as an exogenous variable of the system, the relationship between CPI inflation and services sector growth becomes significantly negative, and as expected, the industrial-sector inflation positively and significantly affects the services sector growth of developing economies.

5.3 | Model 3: Agricultural sector growth and inflation

We estimate agricultural sector growth model by controlling the effects of lagged agricultural sector growth, rural population growth rate, convergence variable, investment, school enrollment, lagged exchange rate, and exports of goods and services. Additionally, agricultural sector specific variables of land area, livestock production index, and forest area are included.

Table 5 demonstrates that, in general, agricultural sector growth in developing economies is adversely affected by CPI inflation if the industrial-sector inflation is not accounted for. Also, the industrial-sector inflation is negatively associated with the growth of agricultural sector of the developing economies. Furthermore, the results demonstrate that the agricultural sector growth in developing economies is enhanced by the growth in the previous period, the amount of fixed resources, and increase in school enrollment.

More specifically, for our key variable of CPI inflation, Table 5 reports that the estimated coefficient of $\tilde{\pi}_{it}$ is statistically significant only in Specifications 1 and 2. This finding is in line with Hineline (2010) who found the agricultural sector of seven industrialized economies (i.e., France, Germany, Italy, Japan, Spain, the United Kingdom, and the United States) to be adversely affected by the rate of inflation. After adding the industrial-sector inflation (π_{it}^{ind}), the point estimates of $\tilde{\pi}_{it}$it become insignificant in our preferred specification (i.e., $SysGMM_{\tilde{\pi}+m}$). However, the coefficient of π_{it}^{ind} is not only significant but negative in Specifications 3 and 4.

We want to stress two points here. The first is that without the inclusion of industrial-sector inflation (i.e., π_{it}^{ind}), the relationship between CPI inflation and agricultural sector growth is negative. Although this is partially in accordance with the existing inflation-growth relationship, it cannot be generalized in a situation where agricultural sector growth is treated as the dependent variable. Therefore, it is necessary to consider π_{it}^{ind} as an explanatory variable along with $\tilde{\pi}_{it}$. Second, more important for our purposes, after considering π_{it}^{ind} in Specifications 3 and 4, though the results demonstrate the persistence of $agrg_{i,t-1}$, but $\tilde{\pi}_{it}$ turns to be statistically insignificant.

These findings are, on one hand, partially in line with our *conjecture of disaggregation*, but on the other hand, the estimated sign of π_{it}^{ind} differs from our expectation. As this finding for sectoral inflation variable differs greatly with the results reported in Model 1 and Model 2, we can conclude that although our empirical findings for this sector validate the hypothesis of disaggregation, however, the mechanism through which the agricultural sector growth is affected by the sectoral inflation differs from the mechanism, which works for the industrial and services sectors growth.

6 | CONCLUDING REMARKS

This study examines the "inflation-growth nexus" in developing economies by considering sectoral growth data of 113 developing economies spanning the period 1981–2015. By adopting a new and different methodological approach, the disaggregated analysis of output growth and inflation has been performed while considering value-added growth rate of industrial, services, and agricultural sectors as the proxies for sectoral growth. In addition, the sectoral inflation—the growth rate of the nominal deflator of the relevant sector—is considered as the representation of sectoral heterogeneity and spillovers.

The upshot of this empirical investigation is that major sectors of developing economies respond differently to the various impulses of inflation. However, the relationship in question is subject to the role of sectoral inflation. Specifically, on the basis of statistical significance, CPI inflation is found to be detrimental to the growth of industrial sector only. In the presence of sectoral inflation, no significant impact of CPI inflation is found in services and agricultural sector growth models. A growth-conducive impact of sectoral inflation (*i.e.*, agricultural-sector inflation) has been found in industrial and services sectors. On the contrary, industrial-sector inflation is found to be detrimental to agricultural sector growth. In an economy, the growth mechanism and interplay of various sectors, in response to the impulses of CPI inflation, can potentially be explained as follows.

The underlying mechanism for differing sectoral dynamics of capital-intensive sectors (e.g., industrial sector) is that an increase in inflation tends to increase the implicit tax on capital, and thus reduces potential demand of the industrial sector, its productivity and in turn, the growth of the industrial sector. Whereas, in response to *intertemporal effect* of inflation on the industrial sector growth, the *distributional effect* comes into action for other sectors (i.e., agricultural sector). Consequently, relative demand for the agricultural sector tends to increase as predicted by Huo (1997). As a consequence, more capital is required, which causes an increase in wages and alters the supply of factor inputs and, again, results in an increase in demand for agriculture sector's production; which induces the agricultural-sector inflation. Hence, in response to an increase in CPI inflation, the output of the industrial sector falls and, consequently, industrial sector growth. In industrial and services sectors, this course of actions results in the growth-enhancing effect of the agricultural-sector inflation.

On the other hand, our results demonstrate that, in the agricultural sector growth model, only the *intertemporal effect* of inflation is found to be effective. Contrary to the mechanism predicted by Huo (1997), the *distributional effect* of inflation has not worked here. The potential explanation of this finding lies in the fact that the labour markets in developing economies are usually imperfect. Hence, the supply of factor inputs is flexible only from the industrial sector to the agricultural sector. Whereas, as a result of the *intertemporal effect* of CPI inflation, the alteration of the supply of factor inputs from the agricultural to industrial sector is restricted. Therefore, a reduction in the demand for agricultural goods does not induce the industrial-sector inflation to rise, and as a consequence, lower level of industrial-sector inflation ensures higher agricultural sector production. Hence, in response to increases in CPI inflation, the output of the agricultural sector may fall. However, the growth-enhancing impact of industrial-sector inflation on the agricultural sector growth is established.

On the whole, our empirical results demonstrate that once the sectoral heterogeneity and correct choice of estimator are accounted for, and high-frequency inflationary observations of the 1970s are excluded, inflation exerts its impact differently on various sectors, depending upon the capital intensity of the sector. Or it can be said simply that, in response to impulses of inflation in the economy, the growth of various sectors is more of a sector-specific phenomenon and the central bankers, in optimal monetary policy decision making, should take cognizance of the sectoral heterogeneity. Additionally, our findings point out that heterogeneities across sectors, international spillovers, catch-up effect, levels of investment, population growth, and the quality of human capital and democratic institutional stability and autonomy significantly matter for inflation-sectoral growth analysis. No doubt, the relative significance of these variables is likely to differ across the cross-sections. The policy relevance for the central bank authorities of developing economies is that they must carefully consider the differing consequences of their actions on individual sector bearing in mind each sector's value-added share of the economy.

We conclude this paper with a few limitations and caveats to our results.[10] First, as the effect of inflation on sectoral growth depends on the degree of capital intensity in each sector, it would be interesting to include the developed economies in the sample. Because the capital intensity in these countries tends to be larger than in developing economies, there is a possibility that the inclusion of developed economies in the sample may modify our results. Thus, an interesting task for future research would be to extend the analysis to developed countries as well. Second, we have been forced to assume the absence of interaction between the sample economies. For instance, due to its commercial relations, the agricultural sector growth in a country may depend on the industrial growth in another country and vice versa. As this kind of interaction is assumed to be absent in this study, we intend to address this issue also in our future work. Lastly, as Behr (2003) noted, the instrumental variable approach is very popular as an alternative to the OLS estimator. However, the downside of these estimators is that they are inefficient when compared with other competitive estimators. Having this limitation in mind, an interesting task for future research would be to extend the analysis by applying the orthogonal reparameterization approach, introduced by Lancaster (2002).

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ENDNOTES

1 There is a consensus that the optimal level of inflation differs along the development path. The targeted inflation rates for some central banks are as follows: European Central Bank (less than but close to 2%), U.S. Federal Reserve System (from 1.5% to 2%), and the Turkish Central Bank (5%).

2 Considering growth as real and inflation as a monetary phenomenon, many economists put a question mark on the long-term effects of inflation on economic growth (e.g., Barro & Sala-i-Martin, 1995).

3 A most recent illustration is Ibarra and Trupkin (2016).

4 For a detailed discussion on empirical literature on this issue, see Temple (2000).

5 Our ultimate interest is to explore the so-called "inflation-growth nexus," yet our focus is on sectoral growth data. One can question if a macrolevel growth interpretation on the basis of sectoral growth data is solid. We argue that the industrial, services, and the agricultural sectors are the main stakeholders in GDP accounting and reflect the macrotrends in the economy. This method is helpful in drawing conclusions at the aggregate level as has been shown in the context of the "finance-growth nexus" (e.g., Rajan & Zingales, 1998; Arcand, Berkes, & Panizza, 2015).

6 Many economists support a disaggregated analysis of monetary policy transmission mechanism (e.g., Carlino & DeFina, 1998; Dedola & Lippi, 2005, among others).

7 Predominant heterogeneities across sectors are explained in Section 2.2. A detailed discussion can also be found in Peersman and Smets (2005).

8 Limited existing literature (e.g., Chaudhry, Ayyoub, & Imran, 2013) on this particular topic so far has largely neglected the endogeneity issue.

9 The common exception is the situation when the growth of agricultural sector is highly dependent on agricultural exports and, therefore, on world price developments.

10 The authors are thankful to an anonymous referee for pointing out these caveats, which also helped to specify the possible extensions to our research work.

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APPENDIX A: COMPLETE LIST OF SELECTED ECONOMIES

All empirical estimations are carried out for the countries: Albania, Algeria, Angola, Argentina, Armenia, Azerbaijan, Bangladesh, Belarus, Belize, Benin, Bhutan, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Bulgaria, Burkina Faso, Burundi, Cambodia, Cameron, Central African Republic, Chad, China, Colombia, Comoros, Democratic Republic of Congo, Republic of Congo, The Costa Rica, Cote d'Ivoire, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Eritrea, Ethiopia, Fiji, Gabon, Gambia, Georgia, Ghana, Grenada, Guatemala, Guinea, Guyana, Honduras, India, Indonesia, Islamic Republic of Iran, Jamaica, Jordan, Kazakhstan, Kenya, Kyrgyzstan, People's Republic of Lao, Lebanon, Lesotho, Liberia, Macedonia, Madagascar, Malawi, Malaysia, Maldives, Mali, Mauritania, Mauritius, Mexico, Micronesia, Moldova, Mongolia, Morocco, Mozambique, Namibia, Nepal, Nicaragua, Niger, Nigeria, Pakistan, Panama, Paraguay, Peru, Philippines, Romania, Rwanda, Samoa, Senegal, Seychelles, Sierra Leone, South Africa, Sri Lanka The St.Lucia, St.Vincent and the Grenadines, Sudan, Suriname, Swaziland, Tajikistan, Tanzania, Thailand, Togo, Tonga, Tunisia, Turkey, Turkmenistan, Uganda, Ukraine, Uzbekistan, Vanuatu, Venezuela, Vietnam, West Bank and Gaza, Yemen, Zambia, and Zimbabwe.