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Inflation-Growth Nexus in Developing Economies: New Empirical Evidence from a Dis-aggregated Approach

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Inflation–Growth Nexus in Developing Economies: New Empirical Evidence from a Dis–aggregated Approach

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Abstract

This study challenges the traditional way of examining the "inflation–output growth nexus". Research at the aggregate level yields mostly ambiguous results, we perform a dis-aggregated analysis of output growth and inflation. For each sector—industry, services and agriculture—we consider inflation and the value–added growth in a sample of 113 developing (low and middle income) economies over the period 1974–2013. Empirical investigation reveals that different sectors of the economy respond differently to various impulses of inflation. Specifically, inflation impacts the growth of industrial and services sectors negatively; whereas a growth enhancing relationship has been found for the agriculture sector. We further calculated a threshold level, for each sector, beyond which inflation is harmful to growth. These are 13.48 %, 14.48 %, 15.37 % and 40 % for aggregate GDP, industrial, services and agriculture sectors respectively. This implies that the central banks of developing economies must weigh the varying consequences of its actions on individual sectors bearing in mind each sector's share in the respective economy.

Keywords: Agriculture sector; developing economies; dis–aggregated approach; inflation–growth nexus; system GMM; threshold level.

JEL classification: E31, E58

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1 Introduction

The ultimate goals of macroeconomic policy makers 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 behavior of inflation (Blanchard et al., 2010). Following the global crisis, there is a renewed discussion on optimal inflation target[1]. The present study discusses optimal inflation in the development context and aims to derive new important insights for monetary policy in developing economies. In industrialized or developed economies, where the socioeconomic and financial system is developed, in general, the"issue of optimal inflation" has been widely researched and the threshold levels are also well-determined. Inflation is not really a big issue[2] in developed countries. Whereas, in the developing world, the financial system is not fully established, different sectors dominate the economy at different stages of development, structural change is taking place, more fundamentally, the relationship between inflation and growth differs along the development path.

The impact of inflation on growth has mostly been researched at the economy–wide macro–economic level[3]. Two approaches have been considered using aggregate GDP data. First, cross-section growth regressions and panel data estimation [e.g. Barro (1995); Sarel (1996); Ghosh & Phillips (1998); Bruno & Easterly (1998); Khan & Senhadji (2001); Burdekin et al. (2004); Gillman & Kejak (2005); López-Villavicencio & Mignon (2011); Crespo Cuaresma & Silgoner (2014); Muzaffar & Junankar (2014), among others], addressing the problem of causation, find a non-linear relationship between inflation and growth. The effect of low inflation on growth is unclear, while inflation clearly hurts 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 positive impact of inflation on growth, others a negative relationship. The overall conclusion, regarding the inflation–growth nexus, is

[1]There is a consensus that the optimal level of inflation differs along the development path. For example, the European Central Bank targets at inflation rates of less than, but close to 2%, US Federal Reserve System aims at the target, usually, between 1.5% to 2% and the Turkish Central Bank is currently considering it as 5%.

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

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

that it is still inconclusive. Considering the two–sector neoclassical growth model with different capital intensities across sectors, Huo (1997) demonstrated that the effect of inflation on economic growth depends on the capital intensity of the respective sector. It can have either a good or bad impact on economic growth. This stimulates for an analysis of this relationship at a dis–aggregated level. The dis–aggregated analysis looks at sector level data of inflation and growth. Hence, we provide new insights into the monetary policy transmission mechanism in developing economies[4]. Our approach, based on a panel of dis–aggregated data, is motivated by the idea that sectoral effects of inflation–growth relationship are more helpful in understanding this nexus, as compared to their aggregate counterpart[5]. This approach can be justified on the following grounds:

Firstly, short and long term growth determinants may vary across sectors and development levels of economies. Secondly, the information inherent in the heterogeneity[6] across sectors and countries, can be useful for understanding the growth patterns and monetary transmission mechanism. Lastly, the panel data (across sectors and countries) allow us to make progress on some difficult identification problems plaguing the study of aggregate GDP growth. To the best of our knowledge, the relationship between inflation and sectoral growth has widely been ignored so far. The relevant literature is limited. We may state that there is a thrust in economic literature to examine the long-term dynamics of sectoral growth with respect to the inflationary levels.

A number of considerations suggest a positive relationship between higher average rates of inflation and greater variability (or uncertainty) of inflation, which increases uncertainty in production, investment, and marketing decisions, and greater variability in real growth (Logue & Sweeney, 1981). Using annual data of the rate of CPI inflation and the rate of real growth of industrial production for twenty four countries; they find a positive relationship between the average inflation rate and the variability of real economic growth. Their results highlight the importance of devoting greater explicit attention to the impact

[4]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 macro–level growth interpretation on the basis of sectoral growth data is solid. We argue that the industrial, services and the agriculture sectors are the main stakeholders in GDP accounting and reflect the macro–trends in the economy. This method is helpful in drawing conclusions for the aggregate level as has been shown in the context of the "finance–growth nexus" [e.g. Rajan & Zingales (1998); Fisman & Love (2007); Arcand et al. (2015)].

[5]Many economists support a dis–aggregated analysis of monetary policy transmission mechanism [see Ganley & Salmon (1997); Carlino & DeFina (1998); Domac (1999); Dedola & Lippi (2005), among others].

[6]Major heterogenities among sectors are explained in sub–section 1.1

of inflation on uncertainty and variability in output.

İşcan & Osberg (1998) used quarterly data of 131 industries of the Canadian economy. By considering sectoral growth variances and inflation, they find no significant relation between output growth variability and inflation during the studied period of 1961:1 to 1995:4. In order to analyze sectoral output, they excluded the public sector from the data and divided the sample mainly into goods and services sectors. Their findings indicated that the variance of sectoral output growth and inflation (as measured by first differencing the logarithm of GDP deflator) been correlated with each other. Their study demonstrated further that lower inflation may be costly to achieve because monetary policy has an impact on the real exchange rate. The notable feature of their findings, also related to our study, is that they had drawn a clear distinction between goods producing sectors and service sectors. This is important because service industries normally smooth output in response to temporary relative price variability. İşcan & Osberg (1998) found the coefficients on the inflation variables to be insignificant in the goods sector, but significant for service sectors, when lagged inflation levels were excluded from the model.

Chaudhry et al. (2013) analyzed the effects of CPI inflation on sector–wise growth of the economy of Pakistan. By employing OLS methodology and annual time–series data (1972–2010), they reported that an increase in inflation affects the agriculture, manufacturing and services sectors's growth differently. They have obtained a negative relationship between the CPI inflation and growth of the manufacturing sector, whereas, inflation encourages growth of the agriculture and services sectors. They suggested generally to restricting inflation in the single–digit zone.

1.1 Heterogeneities across industrial, services and agriculture sectors

The structure of an economy is constituted by the output shares of different sectors. With the rise in national income, the industrial sector gains dominance over the agricultural sector, followed by an increase in the service sector. These stages are generally essential for all developing countries to pass through, which are elucidated by structural adjustment in the demand of the consumer and in the comparative labor yield of major sectors of the economy (Chaudhry et al., 2013).

The main drivers of long–term growth in each sector are factor accumulation (labor and capital) and technological progress (efficiency), but the dynamics of each sector are different from the other. 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, the 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[7].

In industry, production is organized within global value chains (vertical specialization). It leads to longer term contracts and price changes are transmitted slowly. In services, price changes are felt immediately by producers and consumers. Whereas the agriculture sector is subject to the external supply side factors that determine output and prices at the same 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.

Motivated from the discussion above, this study addresses 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? The new contribution of this study is that it examines a new dimension in the inflation–growth nexus by looking at heterogeneity across sectors and by incorporating the developmental aspect. By examining a large panel data set from the developing world, it also examines how inflation may impact on structural change happening in developing economies. We have used an appropriate method, the system GMM, to control for the problem of regression endogeneity and reverse causation[8]. The remainder of paper is organized as follows. In Section 2, theoretical underpinnings of the inflation–growth relationship are briefly discussed. It helps to prepare a ground for the empirical data analysis. The economic model is specified in 3. Section 4 outlines the econometric methodology used to examine the inflation–sectoral growth relationship. Discussion regarding data,

[7]The common exception is the situation when growth of the agriculture sector depends heavily on agricultural exports and, therefore, on world price developments.

[8]Limited existing literature [e.g. Chaudhry et al. (2013)] on this particular topic so far has largely neglected the endogeneity issue.

variables and summary statistics is presented in 5. Section 6 elaborates important estimated results and discussion. A brief summary of the main results and suggestions for future research appears in section 7.

2 Theoretical framework

The main conclusion to be drawn from money–growth literature is that the theoretical impact of inflation on growth is ambiguous (Temple, 2000). According to López-Villavicencio & Mignon (2011), the effects of inflation on economic growth are mixed and depend on the way money is introduced into the models. Sidrauski (1967) introduces money in the utility function and puts forward a transitional effect of inflation on the output growth rate, *i.e.* money growth has no real effect on the steady–state. By considering a cash-in-advance economy, Ireland (1994) has also obtained the same effect, with an explicit credit sector.

Tobin (1965) considers money as a substitute for capital, as a result higher monetary growth enhances capital accumulation, causing inflation to have a positive effect on long–run growth. If inflation increases, it will cause an increase in the nominal interest rate. Consequently the economic agents will hold less in money balances and more in other assets, which would drive the real interest rate down. Hence, investment and capital: labor ratio will increase. When money is regarded for purchasing capital goods (Stockman, 1981), higher anticipated inflation decreases steady–state real balances and capital stock, and hence a reversed Tobin effect emerges. It means if cash has to be held before the purchase of capital goods, then inflation may reduce the steady–state capital stock.

In endogenous growth (A_k, A_h) models, the inflation rate influences the growth rate through its effects on the marginal productivity of capital. Gillman & Kejak (2005) propose a general monetary endogenous growth model and include both physical and human capital. They have found a non–linear effect of inflation on growth, and explain it through the money demand elasticity.

Yilmazkuday (2013) summarizes different channels through which inflation can affect economic growth. These are: (i) increasing relative price variability: Bruno (1993) argues that inflation reduces profitability, hence, growth. Relative price variability can also have impacts on growth through investments. Ball & Romer (1993) suggest that relative price variability undermines the efficiency of long–term relationships. (ii) The effects on financial activity: In the context of search models, Benabou (1992) points out that an increase in inflation results in an increased price dispersion and lower profits. Thus, it is detrimental to growth due to the exit of some firms from the market. Boyd et al. (1996) show that the volume of bank lending and equity market activity are both negatively affected by inflation. Inflation interferes with the accurate valuation of firms. (iii) Higher macroeconomic volatilities: Little et al. (1993) find that inflation hurts growth through a sustained real appreciation of the currency. Cukierman et al. (1993) show that nominal and real interest rates are less variable at low–inflation countries. Gylfason (1999) argues that inflation hurts growth through lower ratios of exports to output.

Gylfason & Herbertsson (2001) develop a theoretical model and conclude that inflation and growth relationship depends on the changes in the underlying exogenous parameters of the model. It can be positive, negative or uncorrelated. Any association between inflation and growth must be the outcome of changes in their respective determinants. Relying upon the neo–classical growth framework and endogenous growth theory, we use the Gylfason & Herbertsson (2001) model as the theoretical foundation of our analysis.

In an extended Cobb–Douglas production function, output Y depends on labor N, real money balances $\frac{M}{P}$, where M is the supply of money, P the general price level, capital K, a technological shift parameter A, α, β and $1-\alpha-\beta$ are the elasticities of output Y, with respect to labor, real balances and capital:

$$Y = AN^{\alpha}\left(\frac{M}{P}\right)^{\beta}K^{1-\alpha-\beta} \quad (1)$$

It is assumed that spillovers across firms and capital–embodied technology has the form $A = BK^{\alpha}$ for the economy as a whole. Hence $Y = BN^{\alpha}\left(\frac{M}{P}\right)^{\beta}K^{1-\beta}$ implies increasing returns to scale to labor and constant returns to real money balances and capital (Romer, 1986). Hence the aggregate production function becomes:

$$Y = EK, \quad (2)$$

where

$$E = B^{\frac{1}{1-\beta}} N^{\frac{\alpha}{1-\beta}} \nu^{\frac{-\beta}{1-\beta}} \tag{3}$$

and $\nu = Y/(M/P)$ is the velocity of money. E is the efficiency of real capital, and is the inverse of capital:output ratio. An increase in velocity or a reduction in financial depth, results in an increase in inflation, which reduces efficiency as long as money plays a role in the production function ($\beta > 0$), ceteris paribus. Firms maximize profits by equating the marginal product of capital (MP_K) to the real interest rate:

$$(1 - \alpha - \beta)E = r. \tag{4}$$

Thus, maximization of profit demands equality between the MP of money and the nominal interest rate, where π is the inflation rate

$$\beta\nu = r + \pi \tag{5}$$

Equations (3, 4 and 5) together produce a Fisher–Mundell effect, which states that an increase in inflation causes an increase in velocity of money by Equation 5, so efficiency decreases by Equation 3 and the real interest rate decreases by Equation 4. The relationship has been established by combining the so–called Quantity Theory of Money (QTM) and portfolio choice with an optimal growth model that includes money. A general macroeconomic equilibrium requires equality between money supply and demand for money: $\frac{M}{P} = \frac{Y}{\nu}$. If ν is constant, the Fisher Equation $\left(\frac{M}{P} = \frac{Y}{\nu}\right)$ can be presented in rates of change:

$$\pi = m - g, \tag{6}$$

where π is the rate of inflation, m is the rate of monetary expansion, and g is any proxy for growth. If the government finances its budget deficit by printing money, the rate of monetary expansion equals the velocity times the ratio of the deficit to the output, d:

$$m = \nu d. \tag{7}$$

The deficit–output ratio can be written as $d = c - \frac{m}{\nu}$, where c is an exogenous component, and $\frac{m}{\nu}$ indicates inflation tax revenue as a proportion of GNP. Thus, $m = \frac{\nu c}{2}$. This states the following inverse relationship between inflation and growth:

$$\pi = \frac{1}{2}\nu c - g \tag{8}$$

Thus any rise in c increases inflation for given growth. Whereas, an increase in ν increases inflation for given growth. Consumers choose a path of consumption C_t that maximizes utility U_t over time. We may obtain Ramsey Rule yielding [for a detailed derivation, see Gylfason & Herbertsson (2001)]:

$$g = \frac{1}{\theta}[(1 - \alpha - \beta)E - \rho] \tag{9}$$

where g is the growth rate of consumption and, therefore, also of output and capital along the optimal consumption path. The optimal rate of growth can be presented as

$$g = [s - (1 - s)\psi]E, \tag{10}$$

where $\psi = \frac{m-\pi}{\nu}$. An increase in inflation reduces the real interest rate, decreases efficiency, and shrinks the saving rate independently of the elasticity of inter–temporal substitution. Hence, the inflation–growth relationship is expressed by the following equations:

$$\pi = \frac{\nu c}{2} - \frac{sE}{1 + ((1 - s)/\nu)E} \tag{11}$$

$$g = \frac{sE}{1 + ((1 - s)/\nu)E} \tag{12}$$

Any increase in the autonomous part of s and E enhances growth and brings inflation down, other things remain equal, an increase in the autonomous part of ν increases both inflation and growth. An increase in the budget deficit leads to a decline in the saving rate and efficiency and, thus, reduces growth.

3 Economic model specification

Based on discussion in Section 2, and following Huo (1997); Gylfason & Herbertsson (2001); Gillman & Kejak (2005), the following economic framework has been proposed for selected sectors.

3.1 Relationship between inflation and growth of industrial and services sectors

Keeping in mind the structural situation and heterogeneities of industrial and services sector in developing countries, it can be stated that an increase in inflation causes an increase in the implicit tax on capital and, hence, uncertainty in the economy, which reduces the level of investment, productivity, and in turn, growth.

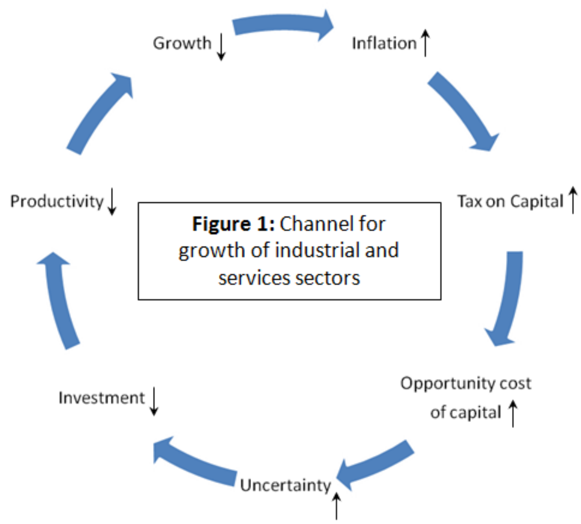

Figure 1: Channel for growth of industrial and services sectors

3.2 Relationship between inflation and growth of agriculture sector

Since the dynamics of agriculture sector and factors influencing its growth are different than industrial and services sectors, it is proposed that the mechanism to describe the relationship between value–added growth of agriculture sector and inflation is also different. It is further supposed that excess demand in the economy prevails as a whole. As a consequence, an increase in employment emerges, which causes an increase in wages and demand for food. It brings an increase in the general price level and, hence, agriculture

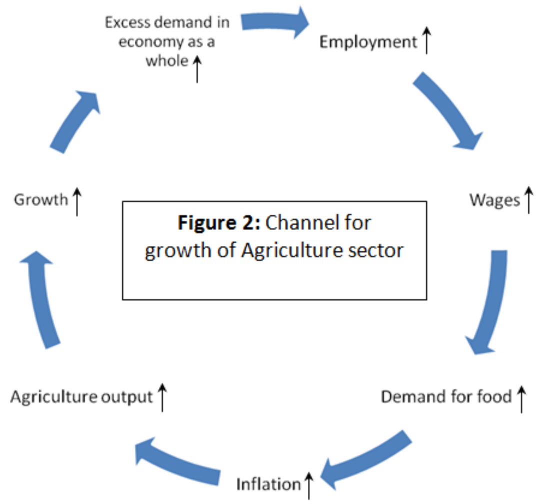

Figure 2: Channel for growth of Agriculture sector

output increases. This circular flow result in a growth enhancing effect of inflation.

4 Methodology

Inference derived on the basis of non–dynamic fixed–effects (FE) and randon–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. But a difficulty with this estimator is to find appropriate instrumental variables for inflation and other economic variables to cope with the endogeneity problem. In order to address this problem, the dynamic panel data estimation method, one–step system generalized method of moments[9], based on Arellano & Bover (1995); Blundell & Bond (1998), has been chosen for benchmark set of estimations. The system GMM estimator combines the standard set of moment conditions in first differences with lagged levels as instruments, with an additional set of moment conditions derived from the equation in levels. This method takes into account the biases (e.g. endogeniety) that appear due to country–specific effects, time–invariant factors and control variables , especially the presence of the initial level of GDP as an explanatory variable. Moreover, lagged values of the regressors might be used to prevent the issues of simultaneity and reverse causation. One–step estimator has been used to obtain reliable estimates. Bond et al. (2001) recommend the system GMM estimator specifically for empirical growth

[9] Blundell et al. (2000) state that inference, based on aysmptotic variance matrix, from one–step GMM estimators is more reliable than for the asymptotically more efficient, two–step estimator.

analysis. By the same token, we prefer the system GMM estimator over fixed effect or random effect estimator, since FE and RE estimators are biased in the presence of lagged dependent variables.

The standard assumption of cross–sectional panel data models is that the disturbance terms are cross–sectionally independent. Since 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 cross–sectional dependence. The system GMM post–estimation test for cross-sectional dependence has not been introduced so far. Nevertheless, we tried to perform Pesaran's (Pesaran, 2004) CD test to examine cross–sectional dependence for variables separately. The estimation is not possible due to too few observations in the data set. Assuming cross–sectional independence, we rely on Sarafidis et al. (2009), who affirm that a system GMM estimator is consistent, even in the situation when heterogenous error cross–sectional dependence is present in the sample data. The model described in Equation 13 analyzes the inflation–(sectoral)growth relationship in a panel data set of 113 developing countries for data spanning 1974-2013.

$$g_{it}^{s} = \beta_1 g_{i,t-1}^{s} + \beta_2 \pi_{it} + \beta_3 \pi_{it}^{2} + \beta_4 X_{it} + \mu_{it} \tag{13}$$

where i = 1,2,....,113, t = 1,2,...,40 and s = 1,2,3. g_{it}^{s} is the annual growth rate of value–added in the sector s, country i at time t, and $g_{i,t-1}^{s}$is its lagged value. π_{it} is the annual rate of CPI inflation, π_{it}^{2} is the squared term of CPI inflation and X_{it} is a vector of control variables, specified separately for each sector. The error term is specified as:

$$\mu_{it} = \nu_i + \epsilon_{it} \tag{14}$$

Time invariant country–specific effects (e.g. geography and demographics), can be correlated with right–hand side variables, are limited in the error term μ_{it}, which are comprised of unobserved country–characteristics ν_i and the observation-specific errors ϵ_{it}.

$$\Delta g_{it}^{s} = \alpha_1 \Delta g_{i,t-1}^{s} + \alpha_2 \Delta \pi_{it} + \alpha_3 \Delta \pi_{it}^{2} + \alpha_4 \Delta X_{it} + \epsilon_{it} \tag{15}$$

To deal with fixed effects ν_i, which do not vary with time, the difference GMM technique uses first differences to convert Equation 13 into Equation 15, which is free from fixed country effects. The first–differenced lagged dependent variables are also instrumented with its previous levels. The system GMM estimator is also compatible with a data format where $T < N$.

5 Data, variables and descriptive statistics

5.1 The sample

The data set includes 113 developing (low and middle income) countries, covering the period 1974–2013 and comprises 8 units of 5–year averages for all variables, for each country. The selection of economies and estimation are subject to the data availability. Outliers have been excluded in line with Bruno & Easterly (1998). All considered economies are listed in Appendix A. Due to unavailability of complete information on variables, the data set is unbalanced. The data are taken from WDI World Bank, IMF's International Financial Statistics, Penn World Tables 7.1 and individual country sources. Estimation has been carried out for developing economies listed by IMF's World Economic Outlook, April 2014 and the World Bank data.

5.2 Growth regressors

In order to examine the inflation–sectoral growth relationship, key determinants relating to structural change, demand and supply shocks, macroeconomic policies and international spillover effects have been considered. These economic factors influence the relationship between inflation and sectoral growth–thus by building our parsimonious models for empirical analysis. The choice of growth regressors is mainly based on the neo–classical growth framework. Some determinants have also been inspired by the endogenous growth theory [e.g. Barro (1991); Romer (1994); Barro & Sala-i Martin (1995); Sala-i Martin (1997); Mankiw et al. (1992), among others].

5.2.1 Sectoral growth

The dependent variable in each sector's model is annual value–added (% growth) of aggregate GDP, industrial, services and agriculture sector respectively. In order to examine dynamic aspects of the inflation–sectoral growth relationship, lagged growth [(-1) and (-2)] of industrial, services and agriculture sector is taken on the right–hand side. It helps to capture the spillovers of different sectors and also to measure the possibility of partial adjustment towards the steady–state.

5.2.2 Inflation

Inflation defined as growth rate of the CPI index, alternatively the GDP deflator and sectoral inflation have been used as main variable of interest in various growth regressions. The sector–wise inflation rate 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 the Formula 16.

$$\left(\frac{VA_cp}{VA_kp}\right) \times 100 \tag{16}$$

where VA_cp and VA_kp are value–added current dollar prices and value–added constant dollar prices respectively, in each sector.

5.2.3 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 agriculture sectors: Total investment (% of GDP), general government expenditures (% of GDP), external debt stocks (% of exports of goods, services and primary income) and the log of final consumption expenditures (constant 2005 USD) have been chosen, to capture the effects of aggregate demand–supply factors and government macroeconomic policies. Solow–type key growth determinant, investment, also fundamental in endogenous growth models, appears in growth regressions, with the positive expected sign. General government expenditures variable is included to measure the effect of fiscal policy, the expected sign is unclear. A negative sign of general government expenditure would indicate that higher government expenditures are inflationary, that is not good for growth. Moreover, an increase in government expenditures may crowd–out the private sector, thus negatively affecting sectoral growth. Whereas, positive sign can also be expected in the situation when government spending is beneficial in boosting the productive capacity of the economy, thus growth. The external debt factor may affect sectoral growth either positively or negatively, depending upon the utilization of foreign debt resources. A variable of consumption expenditures has been included in specific services sector growth regressions. A positive association between the growth of the services sector and consumption expenditures is expected in the analysis.

The real interest rate, as a monetary policy indicator, has been taken as a control for industrial sector growth regressions, to capture the effects of monetary policy with a negative expected sign. Population growth and rural–urban population growth rates have been chosen as control variables in different specifications to capture the effects of population dynamics of sectoral growth. As the 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. Population growth, especially in the agricultural sector, will have a positive effect on growth, due to the fact that agriculture sector in the developing world is still based mainly on labor input.

The initial level of per capita GDP is taken to control for conditional convergence, following neo–classical growth theory [e.g. Barro & Sala-i Martin (1995), among others]. A negative sign of the coefficient of the initial level of per capita GDP variable is expected. Per capita health expenditures and school enrollment ratios in an economy reflect the development of human capital. These two growth determinants are supposed to have a positive impact on sectoral growth. Trade openness (measured as the summation of exports and imports, in % of GDP) and the 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 economic growth of developing economies by the "channel of export promotion incentives". It states that in the situation when local currency depreciates, investment and foreign direct investment inflow will rise, that results in growth of the import substitute industry. Generally, currency depreciation stimulates exports and, as a result, boosts economic growth. Rapetti et al. (2012) find that the impact of undervaluation on growth is larger and more robust for developing countries.

Institutional stability index has also been incorporated in all growth regressions, to capture effects of democratic behavior, institutional stability and autonomy of the institutions. The index is expected to correlate positively with growth. Arable land (% of land area), live stock index (2004–2006 = 100) and food exports (% of merchandise exports) are included in the agriculture sector growth model only. These variables are supposed to control for the effect of fixed resources of an economy and agricultural productivity in estimating the relationship between agriculture sector growth and inflation. The sign of these coefficients is expected to be positive.

5.3 Descriptive statistics

Before we turn to the econometric analysis, summary statistics of all relevant variables (for the whole sample period) are presented in Table 1. Generally, the un–weighted long–run average of sector–wise growth in the sample is below 5%. The averages of GDP deflator and CPI inflation are around 10%. The standard deviation values of these variables indicate that measures of inflation are more volatile than all measures of sectoral growth over this time–period. The average sector–wise inflation values are around 3.5%, 4% and 3% for industrial, services and agriculture sectors respectively. Their standard deviations also show more volatility than their respective sectoral growth standard deviations.

6 Results and discussion

6.1 Static panel estimation results

This section presents static panel results. These results are mainly based on fixed–effects (FE) and random–effects (RE) models, which are most frequently used in cross–sectional studies. FE and RE panel estimators are more efficient to OLS estimators as they can capture the economies' heterogeneities. Table 2 presents GDPFE, GDPRE, INDFE, INDRE, SRVFE, SRVRE, AGFE and AGRE as FE and RE estimation results for GDP,

Table 1: Descriptive statistics, 1974-2013; 113 developing countries

Variable	Observations	Mean	Std. dev.	Minimum	Maximum
GDP growth	796	3.9	3.2	-8.5	17.3
GDP per capita growth	823	1.8	4.2	-30.9	40.3
Industrial sector growth	705	3.9	4.5	-12.7	19.6
Services sector growth	707	4.3	3.8	-10.3	21.9
Agriculture sector growth	737	2.8	3.4	-11.2	21.2
CPI inflation	633	9.8	7.7	-3.4	38.9
GDP deflator	734	9.7	7.8	-8.1	39.2
Industry sector inflation	720	3.5	7.8	-15.5	34
Services sector inflation	665	4	7.4	-15.5	33.8
Agriculture sector inflation	725	3.2	6.9	-15	29.7
Population growth	896	1.9	1.1	-3	4.9
Urban poulation growth	888	3.2	1.9	-2	9.7
Rural population growth	890	1.1	1.3	-3.5	4.7
Investment	669	22.2	7.7	0.5	49.4
Real interest rate	597	5.9	12.9	-91.7	76.3
Initial per capita income	781	1871.1	1851.7	53.8	12279.6
School enrollment (sec.)	890	61.2	39.6	4.4	180.9
School enrollment (prim.)	874	83.1	30.5	13.1	258.1
Health expenditure (Per capita)	443	136.9	154.4	4.2	974.3
Institutional stability index	742	-3.9	15.7	-88	10
Exchange rate	861	405.7	1528.3	0	18065.1
Trade openness	857	71	38.1	9.6	254.6
Debt-exports ratio	724	246.4	317.6	7	3377.5
Gross domestic savings	792	13.4	16.4	-84.7	80.1
Arable land	858	13.7	13.4	0.2	71.1
Food exports	857	12.8	9.2	1.3	64.2
Live stock index	774	28.5	11.6	4.6	74

Notes: Table 1 presents summary statistics of variables of interest, obtained from the Stata. Number of observations of each variable are reported. Mean is the average of values for each variable. Std. dev. is the standard deviation. Minimum and Maximum is the interval representing the minimum and maximum values of each variable in the panel data set.

industrial, services and agriculture sectors respectively. The major interest of this estimation is to compare and examine the coefficient of inflation–squared (CPI Inflation^2) variable with our preferred estimation technique, which indicates the significant negative impact on industrial and services sector growth. According to these estimates, inflation has also a negative, but insignificant relationship with agriculture sector growth. We prefer to consider the results from FE estimates of GDP growth and industrial sector, since the Hausman test indicates that the FE models are preferable to the RE models of these

Table 2: Fixed– and Random–Effects panel regressions

	(1) GDPFE	(2) GDPRE	(3) INDFE	(4) INDRE	(5) SRVFE	(6) SRVRE	(7) AGFE	(8) AGRE
CPI Inflation	0.0607	0.0674	0.1832*	0.1529	0.079	0.1157	-0.0101	-0.013
	(0.0504)	(0.0483)	(0.1079)	(0.1069)	(0.0826)	(0.0762)	(0.0252)	(0.0196)
CPI Inflation^2	-0.0036**	-0.0031**	-0.0078**	-0.0067**	-0.0048**	-0.0054**	–	–
	(0.0015)	(0.0014)	(0.0034)	(0.0031)	(0.0024)	(0.0022)		
Investment	0.1072***	0.1243***	-0.0003	0.0568	0.0473**	0.0446**	-0.0087	-0.0045
	(0.0253)	(0.0188)	(0.0609)	(0.0431)	(0.0216)	(0.0196)	(0.0255)	(0.0197)
Initial PC GDP	-3.3573***	-1.012***	-5.5681*	-0.9693	-2.4288***	-1.2599***	-1.3659	-0.5929**
	(0.700)	(0.245)	(3.1247)	(0.7134)	(0.851)	(0.3159)	(0.9513)	(0.254)
Population Growth	0.1317	0.0095	–	–	–	–	–	–
	(0.3367)	(0.2582)						
Institutional Stab.	0.0365***	0.0463***	0.0819**	0.0568	0.0406**	0.0399**	0.0303**	0.0238
	(0.011)	(0.0116)	(0.0404)	(0.0486)	(0.0194)	(0.0191)	(0.0119)	(0.0168)
School Enrollment	0.0211**	0.0107	-0.0749**	-0.0333**	0.0249***	0.0185**	0.0001	-0.005
	(0.009)	(0.0088)	(0.0312)	(0.0159)	(0.008)	(0.0077)	(0.0129)	(0.0068)
Trade Openness	0.0055	0.0053	0.0254	0.0032	0.0143	0.0098	–	–
	(0.0093)	(0.007)	(0.0251)	(0.0103)	(0.0104)	(0.0076)		
Exchange Rate	0.1297	0.0599	-0.6515	-0.1676	0.0963	0.0557	0.0289	0.0137
	(0.0986)	(0.0546)	(0.3182)	(0.1647)	(0.1101)	(0.088)	(0.0853)	(0.0447)
Debt-Exports Ratio	-0.0005	-0.0014**	–	–	–	–	–	–
	(0.0009)	(0.0006)						
Govt. Cons. Exp.	0.023***	0.0023	–	–	–	–	–	–
	(0.0078)	(0.007)						
Real Interest Rate	–	–	0.0193	0.0121	–	–	–	–
			(0.0262)	(0.0207)				
Urban Pop. Growth	–	–	0.4747	0.4612*	0.0972	-0.0499	–	–
			(0.4256)	(0.2361)	(0.1864)	(0.1352)		
Health Expen.	–	–	-0.1664	-0.4421	–	–	0.0088	0.0124
			(1.2705)	(0.6622)			(0.041)	(0.0244)
Agriculture Growth (-1)	–	–	-0.0273	0.0322	–	–	–	–
			(0.1385)	(0.116)				
Agriculture Growth (-1)	–	–	–	–	0.0381	0.0494	–	–
					(0.04)	(0.0393)		
Gross D. Savings	–	–	–	–	0.025	0.0264	–	–
					(0.0251)	(0.0171)		
Rural Pop. Growth	–	–	–	–	–	–	-0.4453	-0.113
							(0.2925)	(0.1625)
Live Stock Index	–	–	–	–	–	–	0.3492	1.1713**
							(2.2056)	(0.6588)
Food Exports	–	–	–	–	–	–	0.0435	0.0055
							(0.0518)	(0.016)
Arable Land	–	–	–	–	–	–	0.0479	0.1236***
							(0.0492)	(0.042)
Constant	20.307***	6.8064***	46.7431**	12.0492***	15.9877***	9.4159***	11.5559*	3.817*
	(4.922)	(2.1315)	(17.8712)	(4.4067)	(5.9348)	(2.5288)	(6.8147)	(2.2491)
Observations	408	408	212	212	372	372	370	370
Country Groups	84	84	75	75	80	80	84	84
R^2 within	0.318	0.24	0.238	0.187	0.173	0.16	0.036	0.018
R^2between	0.065	0.302	0.031	0.048	0.075	0.092	0.065	0.122
R^2 overall	0.086	0.265	0.059	0.104	0.092	0.142	0.018	0.044
Hausman test	43.32		23.5		8.52		15.44	
Chi^2 /(p-value)	0.000		0.024		0.666		0.163	

Standard errors of the estimates are presented in parenthesis. ***,** and * denote the level of significance at 1%, 5%, and 10% respectively.

two sectors. Whereas, the Hausman test shows that both the FE and RE models are appropriate for services and agriculture sectors growth. Therefore, we prefer RE estimator, based on its efficiency in static panel estimations.

6.2 Dynamic panel estimation results

6.2.1 Aggregate GDP growth and inflation

Although our major emphasis is on the estimations of sectoral growth, yet we also examine aggregate GDP in relation with CPI inflation and GDP deflator. This exercise is to have a comprehensive comparison of the results. These results are classified in Table 3. GDP4 is our preferred estimated equations. By adding different growth determinants, we have found 13.41 % as the threshold level. Beyond this point, inflation is harmful to economic growth of developing economies, otherwise encourages growth. All signs of coefficients of variables are as per expectations and post–estimation diagnoses are satisfactory.

6.2.2 Sectoral growth and inflation

This section describes major results regarding sector–wise growth and inflation, by considering all heterogeneities and sector–specific factors. The specifications and regressors are different in each sub–section.

Industrial sector growth and inflation

Table 4 presents results by regressing industrial sector growth with different relevant regressors. By adding different explanatory variables, the coefficient of variable "CPI inflation" remains almost unchanged, which is around 0.30 in all regressions. It shows that the relationship between the industrial sector growth and inflation is significantly positive until the achievement of the threshold level of 14.48 %, negative afterwards. This relationship has also been examined with other measures of inflation (IND5 and IND6). By regressing industrial sector growth with GDP deflator, it also reveals the significant positive relationship until a threshold level of 16.059 %. The only change is that the value of the coefficient of sectoral inflation is proved insignificant. The threshold level is even smaller (12.9 %) in this case. The results are robust and the benchmark equation is IND4.

Table 3: GDP growth and inflation
Dependent variable is GDP growth

	(1) GDP1	(2) GDP2	(3) GDP3	(4) GDP4	(5) GDP5
GDP Growth (-1)	-0.123	-0.139	-0.117	-0.115	-0.329
	(0.166)	(0.165)	(0.163)	(0.170)	(0.243)
CPI Inflation	0.093*	0.096*	0.092*	0.107**	–
	(0.052)	(0.053)	(0.053)	(0.053)	
CPI Inflation^2	-0.004**	-0.004**	-0.004**	-0.004**	–
	(0.002)	(0.002)	(0.002)	(0.002)	
Investment	0.167***	0.168***	0.162***	0.161***	0.185***
	(0.032)	(0.032)	(0.032)	(0.031)	(0.040)
Initial PC GDP	-0.224*	-0.322**	-0.326**	-0.356**	-0.358**
	(0.131)	(0.152)	(0.149)	(0.160)	(0.174)
Population Growth	0.351**	0.359**	0.305*	0.263	0.469**
	(0.154)	(0.155)	(0.163)	(0.200)	(0.227)
Institutional Stab.	0.052***	0.051***	0.051***	0.046***	0.042***
	(0.012)	(0.012)	(0.012)	(0.013)	(0.011)
School Enrollment	0.015	0.015	0.014	0.016*	0.020*
	(0.009)	(0.009)	(0.009)	(0.009)	(0.010)
Trade Openness	–	0.0010*	0.010*	0.009	0.007
		(0.005)	(0.005)	(0.007)	(0.007)
Exchange Rate	–	–	0.092*	0.092*	0.003
			(0.055)	(0.055)	(0.068)
Debt-Exports Ratio	–	–	–	-0.0004	-0.001
				(0.001)	(0.001)
Govt. Cons. Exp.	–	–	–	0.001	0.002
				(0.007)	(0.008)
GDP Deflator	–	–	–	–	0.117*
					(0.059)
GDP Deflator^2	–	–	–	–	-0.004**
					(0.001)
Threshold Level	12.17	12.59	12.41	13.41	15.49
Observations	423	422	422	397	431
Country Groups	84	84	84	83	86
No. of Instruments	15	16	17	19	19
F. Test	91.5	85.37	78.38	64.68	54.23
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
AB test for AR(1)	-2.23	-2.14	-2.24	-2.00	-1.01
	(0.026)	(0.032)	(0.025)	(0.045)	(0.313)
AB test for AR(2)	-0.27	-0.52	-0.45	-0.49	-1.07
	(0.789)	(0.602)	(0.655)	(0.628)	(0.283)
Sargan test / p-value	23.1	21.8	19.35	13.61	15.59
	(0.001)	(0.003)	(0.007)	(0.059)	(0.029)

Notes: Estimations are based on 5-years averages of annual secondary data. All robust standard errors are reported in parenthesis below the coefficient estimates. ***, ** and * denote the level of significance at 1%, 5%, and 10%, respectively. Regressions use Blundell & Bond (1998) system GMM estimator. Arellano–Bond first and second order serial correlation tests, AR (1) and AR (2), have been performed under the null hypothesis that the residuals show no serial correlation. Over–identifying restrictions have been checked by the Sargan test, under the null hypothesis that all restrictions are valid. GDP4 is our preferred estimated equation.

Table 4: Industrial sector growth and inflation
Dependent variable is industrial sector growth

	(1) IND1	(2) IND2	(3) IND3	(4) IND4	(5) IND5	(6) IND6
Industrial Growth (-1)	0.385	0.382	0.399	0.244	0.061	-0.254
	(0.244)	(0.244)	(0.246)	(0.238)	(0.231)	(0.251)
CPI Inflation	0.266**	0.268**	0.275**	0.336**	–	–
	(0.107)	(0.113)	(0.114)	(0.132)		
CPI Inflation^2	-0.011***	-0.011***	-0.011***	-0.012**	–	–
	(0.003)	(0.003)	(0.003)	(0.004)		
Investment	0.032	0.034	0.034	0.134*	0.178**	0.235***
	(0.102)	(0.108)	(0.109)	(0.080)	(0.081)	(0.085)
Initial PC GDP	-0.014	-0.058	-0.052	-1.712*	-2.368**	-1.762*
	(0.414)	(0.686)	(0.692)	(0.913)	(0.982)	(0.922)
Urban Pop. Growth	0.109	0.1095	0.122	0.439*	0.537**	0.649**
	(0.207)	(0.199)	(0.208)	(0.256)	(0.244)	(0.247)
Institutional Stab.	0.038	0.038	0.040	0.052*	0.011	0.018
	(0.039)	(0.038)	(0.039)	(0.027)	(0.034)	(0.039)
School Enrollment	0.010	0.011	0.012	0.022*	0.025	0.014
	(0.008)	(0.01)	(0.011)	(0.020)	(0.020)	(0.020)
Agriculture Growth (-1)	0.100	0.102	0.104	0.218*	0.190	0.214*
	(0.095)	(0.101)	(0.102)	(0.120)	(0.118)	(0.117)
Trade Openness	–	0.003	0.003	0.010	0.010	0.012
		(0.021)	(0.021)	(0.010)	(0.010)	(0.011)
Exchange Rate	–	–	-0.071	0.020	0.083	0.155
			(0.084)	(0.143)	(0.152)	(0.172)
Real Interest Rate	–	–	–	0.062	0.049	0.049*
				(0.028)	(0.030)	(0.025)
Health Expen.	–	–	–	1.559	2.533**	1.740*
				(1.092)	(1.150)	(1.035)
GDP Deflator	–	–	–	–	0.270**	
					(0.128)	–
GDP Deflator^2	–	–	–	–	-0.008**	–
					(0.004)	
Industry Sector Inflation	–	–	–	–	–	0.084
						(0.069)
Industry Sector Inflation^2	–	–	–	–	–	-0.003
						(0.004)
Threshold Level	12.66	12.74	12.86	14.48	16.059	12.79
Observations	363	363	363	213	226	233
Country Groups	84	84	84	76	80	78
No. of Instruments	21	22	23	21	21	21
F. Test	61.03	57.46	52.18	32.34	34.59	28.56
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
AB test for AR(1)	-2.29	-2.3	-2.34	-1.77	-1.88	-1.81
	(0.022)	(0.022)	(0.019)	(0.077)	(0.060)	(0.071)
AB test for AR(2)	0.67	0.68	0.7	0.53	0.82	-0.79
	(0.502)	(0.497)	(0.486)	(0.596)	(0.414)	(0.427)
Sargan test / p-value	8.76	8.8	8.66	10.94	10.21	11.13
	(0.724)	(0.720)	(0.731)	(0.205)	(0.251)	(0.194)

Notes: Estimations are based on 5-years averages of annual secondary data. All robust standard errors are reported in parenthesis below the coefficient estimates. ***, ** and * denote the level of significance at 1%, 5%, and 10%, respectively. Regressions use Blundell & Bond (1998) system GMM estimator. Arellano–Bond first and second order serial correlation tests, AR (1) and AR (2), have been performed under the null hypothesis that the residuals show no serial correlation. Over–identifying restrictions have been checked by the Sargan test, under the null hypothesis that all restrictions are valid. IND4 is our preferred estimated equation.

The post–regression diagnostic test estimations are reliable. Estimated results of AR (1) and AR (2) tests help to reject the null hypothesis of the absence of the first order serial correlation and do not reject the absence of second order serial correlation [see Baltagi et al. (2009)]. These conditions have been satisfied in our models.

In order to test the over-identifying assumption, Sargan test does not reject the null hypothesis that over identifying restrictions are valid. Numbers of instruments are less than the number of country groups in all 6 regressions. Considering other coefficient estimates of IND4, the negative coefficient of the initial GDP per capita variable shows that the conditional convergence hypothesis is valid for the studied sample. It means that holding other growth determinants constant, countries with lower GDP per capita tend to grow faster. The initial state of the economy is valid determinant of the industrial sector growth. The significant positive signs associated with the coefficients of population growth, institutional stability, trade openness and exchange rate indicate that the industrial sector of developing economies is getting the benefit of international trade liberalization, human capital development and development of autonomy of government institutions.

Services sector growth and inflation

Table 5 presents results by regressing services sector growth with different relevant explanatory variables. By adding up different regressors, the coefficient of variable "CPI inflation" remains almost unchanged, which is around 0.25 in all regressions. This unveils the fact that the relationship between services sector growth and inflation is significantly positive until the threshold level of 15.37 %, negative afterwards. This relationship has also been examined with other measures of inflation (SRV5 and SRV6). By regressing services sector growth on the GDP deflator, reveals a significant negative relationship beyond an inflation scale of 19.45 % (SRV5). Whereas, it has been found to be significantly positive with sectoral inflation [10]. The results are robust, whereas the preferred equation is SRV4, since the post-regression diagnostic tests are satisfactory showing that the underlying assumptions of the model are valid. The estimated results of AR (1) and AR (2) tests help to reject the null hypothesis of the absence of the first order serial cor-

[10] Maximum value in services sector inflation is 33.8 %. It means, in this situation, services sector growth has a higher threshold level of sectoral inflation, as compared to 15.37 % and 19.45 % respectively, in earlier cases.

relation and do not reject the absence of second order serial correlation. These conditions have been satisfied with our test results. In order to test the over-identifying assumption, the value of the Sargan test (7.62) does not ask to reject the null hypothesis that over identifying restrictions are valid. Numbers of instruments are less than the number of groups in all 6 regressions.

Agriculture sector growth and inflation

Contrasting results have been found by regressing agriculture sector growth and inflation along with other relevant explanatory variables. Table 6 indicates that by adding up and experimenting with different regressors, the significant positive relationship between agriculture sector growth and inflation has been found. The effect of CPI inflation becomes stronger by gradually adding variables of exchange rate, food exports and arable land. A positive linear relationship between inflation and agriculture sector growth implies that inflation enhances the growth of this sector until the upper limit of inflation (that is 40 % in our case). This reveals the fact that the dynamics and growth mechanism of the agriculture sector is different from industrial and services sectors. This relationship has also been examined with other measures of inflation (AGR4 and AGR5). Excluding CPI inflation and by including GDP deflator and sectoral inflation measures in the model, the relationship becomes insignificantly positive. Our preferred equation is AGR3, because it satisfies all post-regression diagnostic tests of serial correlation and over-identifying restrictions. The negative coefficient of lagged agriculture growth variable in all equations shows that structural change is happening in the agriculture sector of developing economies. Food exports and livestock production contribute positively towards the growth of agriculture sector in developing economies. Numbers of instruments are less than the number of country groups in all 5 regressions of the agriculture growth model.

Table 5: Services sector growth and inflation
Dependent variable is services sector growth

	(1) SRV1	(2) SRV2	(3) SRV3	(4) SRV4	(5) SRV5	(6) SRV6
Services Growth (-1)	0.239	0.248	0.231	0.269	0.505*	0.305*
	(0.2736)	(0.2696)	(0.2478)	(0.249)	(0.282)	(0.188)
CPI Inflation	0.237**	0.247**	0.230**	0.292***	–	–
	(0.098)	(0.098)	(0.103)	(0.098)		
CPI Inflation^2	-0.008***	-0.008***	-0.008***	-0.010***	–	–
	(0.002)	(0.002)	(0.003)	(0.002)		
Investment	0.066	0.052	0.061	0.083*	0.075*	0.093**
	(0.053)	(0.043)	(0.042)	(0.051)	(0.043)	(0.041)
Initial PC GDP	-0.875	-0.970	-1.027	-1.898*	-1.879**	-1.900*
	(0.800)	(0.697)	(0.662)	(0.978)	(0.925)	(0.958)
Urban Pop. Growth	0.202	0.216	0.120	0.140	0.108	0.394**
	(0.159)	(0.162)	(0.149)	(0.179)	(0.167)	(0.172)
Institutional Stab.	0.059**	0.058**	0.052**	0.045*	0.043*	0.039*
	(0.023)	(0.024)	(0.025)	(0.026)	(0.024)	(0.023)
School Enrollment	0.062	0.058	0.057*	0.084*	0.077*	0.091*
	(0.045)	(0.037)	(0.035)	(0.046)	(0.041)	(0.048)
Agriculture Growth (-1)	0.075	0.0759	0.075	0.078	0.139*	0.153**
	(0.058)	(0.057)	(0.056)	(0.061)	(0.070)	(0.066)
Trade Openness	–	0.017*	0.017*	0.032**	0.026**	0.027**
		(0.009)	(0.009)	(0.013)	(0.013)	(0.012)
Exchange Rate	–	–	0.222***	0.212***	0.086	0.0731
			(0.058)	(0.070)	(0.061)	(0.053)
Gross D. Savings	–	–	–	0.072**	0.067**	0.079***
				(0.029)	(0.028)	(0.028)
Services Sector Inflation	–	–	–	–	–	0.099***
						(0.026)
GDP Deflator	–	–	–	–	0.399***	–
					(0.121)	
GDP Deflator^2	–	–	–	–	-0.010***	–
					(0.003)	
Threshold Level	14.3	14.81	14.19	15.37	19.45	–
Observations	378	378	378	373	414	438
Country Groups	81	81	81	81	86	83
No. of Instruments	15	16	17	18	18	17
F. Test	60.81	53.36	50.65	35.08	39.7	39.98
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
AB test for AR (1)	-2.49	-2.47	-2.53	-2.39	-2.74	-2.84
	(0.013)	(0.013)	(0.012)	(0.017)	(0.006)	(0.005)
AB test for AR (2)	0.51	0.45	0.38	0.4	0.47	-0.35
	(0.607)	(0.651)	(0.703)	(0.693)	(0.641)	(0.727)
Sargan test / p-value	10.15	9.02	8.5	7.62	3.63	2.85
	(0.119)	(0.172)	(0.204)	(0.267)	(0.726)	(0.828)

Notes: Estimations are based on 5-years averages of annual secondary data. All robust standard errors are reported in parenthesis below the coefficient estimates. ***, ** and * denote the level of significance at 1%, 5%, and 10%, respectively. Regressions use Blundell & Bond (1998) system GMM estimator. Arellano–Bond first and second order serial correlation tests, AR (1) and AR (2), have been performed under the null hypothesis that the residuals show no serial correlation. Over–identifying restrictions have been checked by the Sargan test, under the null hypothesis that all restrictions are valid. SRV4 is our preferred estimated equation.

Table 6: Agriculture sector growth and inflation
Dependent variable is agriculture sector growth

	(1) AGR1	(2) AGR2	(3) AGR3	(4) AGR4	(5) AGR5
Agri. Growth (-1)	0.020	-0.083	-0.060	-0.039	0.239
	(0.209)	(0.340)	(0.309)	(0.262)	(0.177)
Agri. Growth (-2)	-0.359	-0.399	-0.419	-0.424	0.086
	(0.259)	(0.316)	(0.322)	(0.259)	(0.272)
Inflation	0.032	0.058*	0.049**	–	–
	(0.024)	(0.026)	(0.025)		
Investment	0.010	0.011	0.012	0.013	-0.012
	(0.029)	(0.034)	(0.034)	(0.029)	(0.022)
Initial PC GDP	-0.600**	-0.315	-0.341	-0.432*	-0.280
	(0.252)	(0.302)	(0.288)	(0.236)	(0.335)
Rural Pop. Growth	0.259	0.310	0.249	0.275	0.131
	(0.209)	(0.256)	(0.253)	(0.215)	(0.211)
Institutional Stab.	0.059**	0.057*	0.061**	0.063**	0.034*
	(0.024)	(0.031)	(0.029)	(0.022)	(0.028)
School Enrollment	0.000	0.003	0.003	-0.002	-0.012
	(0.009)	(0.009)	(0.009)	(0.009)	(0.012)
Health Exp.	0.048	0.027	0.029	0.064*	0.037
	(0.036)	(0.034)	(0.035)	(0.035)	(0.024)
Live Stock Index	2.036***	1.310**	1.385**	1.669***	1.241*
	(0.527)	(0.591)	(0.576)	(0.483)	(0.625)
Food Exports	–	0.050**	0.047**	0.027	0.010
		(0.021)	(0.020)	(0.027)	(0.031)
Exchange Rate	–	0.009	0.005	0.024	0.124
		(0.057)	(0.056)	(0.055)	(0.078)
Arable Land	–	–	0.183	0.119	-0.103
			(0.121)	(0.117)	(0.109)
GDP Deflator	–	–	–	0.025	–
				(0.030)	
Agri. Sector Inflation	–	–	–	–	0.002
					(0.030)
Observations	315	257	257	333	316
Country Groups	78	71	71	82	81
No. of Instruments	17	20	21	20	22
F. Test	21.29	17.78	18.01	17.77	36.84
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
AB test for AR (1)	-2.67	-2.13	-2.15	-2.13	-2.49
	(0.008)	(0.033)	(0.031)	(0.033)	(0.013)
AB test for AR (2)	0.5	0.52	0.55	0.59	-0.85
	(0.614)	(0.604)	(0.584)	(0.558)	(0.393)
Sargan test / p-value	9.16	7.26	6.94	12.3	13.03
	(0.242)	(0.509)	(0.543)	(0.091)	(0.161)

Notes: Estimations are based on 5-years averages of annual secondary data. All robust standard errors are reported in parenthesis below the coefficient estimates. ***, ** and * denote the level of significance at 1%, 5%, and 10%, respectively. Regressions use Blundell & Bond (1998) system GMM estimator. Arellano–Bond first and second order serial correlation tests, AR (1) and AR (2), have been performed under the null hypothesis that the residuals show no serial correlation. Over–identifying restrictions have been checked by the Sargan test, under the null hypothesis that all restrictions are valid. AGR3 is our preferred estimated equation.

7 Summary

This study examines the widely researched inflation–growth nexus in a new and different manner. Dis-aggregated analysis of output growth and inflation has been performed by considering value–added growth of industrial, services and agriculture sectors of 113 developing economies, spanning 1974–2013. The major message of this empirical investigation is that different sectors of the economy respond differently to various impulses of inflation. Specifically, inflation is detrimental to the growth of industrial and services sectors, whereas its growth conducive impact has been found for agriculture sector. This hypothesis has also been tested with different measures of inflation. We further calculated a threshold level, for each sector, beyond which inflation is harmful to growth. These are 13.48 %, 14.48 %, 15.37 % and 40 % for aggregate GDP, industrial, services and agriculture sectors respectively. It brings us to the conclusion that by adding up different explanatory variables in the regression analysis, no change in the mentioned pattern has been observed. Heterogeneities across sectors, international factors, non–linearity in relationship, catch–up effect, democratic institutional stability, autonomy and different measures of inflation significantly matter in examination of this nexus. The policy relevance for the central bank authorities of developing economies is that they must weigh the varying consequences of its actions on individual sector bearing in mind each sector's share in the economy.

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Appendices

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, Zimbabwe.