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Spatial Inflation Dynamics in India: An Empirical Perspective

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This study provides a generalised perspective and empirical evidence for various demand, supply, policy and structural factors impinging on consumer price inflation for agricultural labourers and industrial workers across major Indian states. The empirical results show statistically significant effect of inflation persistence, per capita income growth, supply side factors, oil price, interest rate, state government expenditure and taxes, and structural factors such as power and water inputs on regional consumer price inflation. The multivariate dynamic panel data analysis and the empirical approach of the paper would facilitate further research on transmission mechanism at a disaggregated level.

JEL Classification : C31, C23, R11

Keywords : Inflation, regional economy, panel data

Introduction

Monetary policy across countries is known for its national character, as central banks enjoy the status of sole monetary authority with the policy objective defined in terms of price stability and economic growth postulated at the aggregate national level. The policy instrument *i.e.,* short-term interest rate, like the repo rate in India, also applies at the aggregate level. Fiscal policy, on the other hand, is of decentralised nature, as the instruments of government expenditure and taxes can be set differently by central, state and local governments owing to constitutional provisions (Dhal, 2010). A mute question arises here. Is there a need for research on transmission mechanism at the disaggregated regional level with regard to inflation and growth conditions? And, can monetary policy have a common stabilising

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effect on regional inflation? It is pertinent to note that after years of intense deliberations and taking sides between classical and Keynesian perspectives, economists in modern times recognise the usefulness of both fallacies; *what is true for the parts may not entirely hold for the aggregate and what is true for the aggregate may not entirely hold for the parts.* Though, there exists a large body of literature on regional inflation differential, studies in the Indian context are scarce. Thus, this paper is motivated by the need for an analysis of spatial inflation dynamics across major Indian states. We consider a generalised perspective, unlike the New Keynesian Phillips curve (inflation depends on unemployment or output gap or wage cost) and monetarist perspective (inflation is purely a monetary phenomenon), and recognise a variety of proximate factors. We use the dynamic panel data model to provide evidence on the role of some important demand, supply, structural, monetary and fiscal factors in regional inflation dynamics. Apart from the introduction, the paper is organised in four sections: review of literature, methodology and data, empirical findings and conclusion.

Section II
The Literature

Studies on regional inflation offer alternative perspectives relating to theoretical propositions, policy implications, underlying sources and empirical methodology. The literature generally owes to asymmetric effects of monetary policy (Bernanke and Gertler, 1995; Kashyap and Stein, 1995; Garrison and Kort, 1983), which emphasises the usefulness of a disaggregated monetary transmission mechanism across different sectors, industries and regions for policy analysis.

From a theoretical perspective, the literature provides contrasting viewpoints. One viewpoint is that regional inflation differential should not be a policy concern within a nation or group of nations characterised by a common monetary policy because the inflation differential might serve as an equilibrating mechanism, ensuring regional economic convergence between relatively poor and rich regions (De Grauwe, 2007). This viewpoint derives from the Balassa–Samuelson effect (Balassa, 1964; Samuelson, 1964) which states that regional inflation differentials in a monetary union can be attributed to differences in productivity growth between tradable and non-tradable sectors. Illustratively, Arnold and Kool (2003) suggested that

regional inflation differentials within a monetary union have an important role to play in the natural adjustment towards a new equilibrium following asymmetric shocks. Instead of investigating the sources of regional price or inflation differences or their speed of convergence, it is important to know how regional inflation differentials are transmitted through national or regional economies and contribute to the adjustment mechanism within a monetary union.

A contrasting perspective in this context is that inflation differentials can either be benign or unkind depending upon whether such differentials arise from productivity differentials or structural rigidities (Alberola, 2000). According to Beck *et al.,* (2009), a regional inflation differential can be harmful when it manifests itself in economic distortions through nominal price rigidities or other structural inefficiencies, which in turn will have adverse implications for policy effectiveness at the aggregate level. Regions having excess aggregate demand will experience (due to capacity constraints and the price-setting power of the producers) higher inflation and *vice-versa.* Thus, non-synchronisation of regional business cycles may lead to inflation differentials (*ibid.*). In the real world, however, every nation can be characterised by diverse regions with some degree of integration but differential response to aggregate economic policy. Thus, Carlino and DeFina (1998, a and b) argue that regional inflation studies can provide a richer perspective on the sources of differential responses. Cavallo and Ribba (2014) emphasise the need for stability of regional inflation as an important condition for price stability at the aggregate level and effective functioning of a common monetary union. They argue that the regional inflation differential from the aggregate inflation should be transitory in nature so that the former can be predicted by the latter. In this context, Honohan and Lane (2003) offer two arguments: (i) the fear of sustained inflation, and (ii) a weaker adjustment mechanism in relative prices leading to boom-bust cycles for which the regional inflation differential should be studied for policy purposes.

The persistence in regional inflation and its implications for monetary policy is another aspect covered in the literature (Cecchetti *et al.,* 2002; Gali *et al.,* 2001). A central bank will be effective in achieving the inflation target when inflation is less persistent. Moreover, the sacrifice ratio (output cost) will be low with low inflation persistence (Ascari and Vaona, 2010).

In this context, some studies have focused on the welfare implications of regional inflation divergences (Andrés *et al.,* 2008; Benigno and López-Salido, 2002). Drawing from the important works of Romer and Romer (1999), Easterly and Fisher (2000) and Fielding (2004), studies on regional inflation differential and persistence emphasise the welfare implications of asymmetric monetary policy transmission in regions with relatively higher poverty levels. Thus, policy formulation which undermines regional heterogeneity in inflation can be welfare depreciating (Coleman, 2012; De Grauwe, 2000; Fielding, 2004).

From an applied perspective, the literature recognises a variety of factors or sources underlying the regional inflation dynamics (ECB, 2003, 2005). Most studies recognise inflation persistence or inertia as an integral part of regional inflation dynamics. In this context, it has been argued that empirical measures of persistence can be biased in the absence of critical regional factors. Accordingly, non-synchronous business cycles and regional supply and demand conditions as reflected in per capita income, output gap and agriculture output growth are considered for analysing the regional inflation dynamics (Angeloni and Ehrmann, 2007; Beck *et al.,* 2009; Carlino and DeFina, 1995; Cavallero, 2011; De Grauwe, 2000; Honohan and Lane, 2003; Mehrotra *et al.,* 2007; Ridhwan, 2016; Rogers, 2007). Prices are also affected by nominal variables for which interest rate, credit, monetary aggregate and financial system structure are considered as possible factors to explain inflation behaviour (Honohan and Lane, 2003; Mehrotra *et al.*, 2007; Nagayasu, 2010, 2011; Woodford and Walsh, 2005). The role of decentralised fiscal policy, through regional taxes, revenue, expenditure and budget deficits, is exemplified by Canova and Pappa (2003), Duarte and Wolman (2008), Honohan and Lane (2003) and Tirtosuharto and Adiwilaga (2013).

Structural economic characteristics of regions in terms of share of tradable goods and non-tradable goods, labour market conditions such as productivity and cost push induced wages are emphasised in studies on different countries (Andrés *et al.,* 2008; Arize *et al.,* 2005; Beck et al., 2009; Beck and Weber, 2005; Bowdler and Nunziata, 2007; Campolmi and Faia, 2006; Carlino and DeFina, 1998a, 1998b; Christopoulos and Tsionas, 2005; De Grauwe and Skudenly, 2000; Duarte and Wolman, 2008; Honohan and Lane, 2003; Jaumotte and Morsy, 2012; Mehrotra *et al.,* 2007; Nagayasu,

2010; Ridhwan, 2016; Rienzo, 2017; Rudd and Whelan, 2005; Sbordone, 2002; Willis, 2003). Furthermore, while recognising the role of asset prices and wealth channel of policy transmission mechanism, some studies have considered housing prices as a source of regional inflation differential (Arnold and Kool, 2003; Honohan and Lane, 2003; Ridhwan, 2016). Oil prices, reflecting supply shocks, are considered by Wilkinson (2011), Atems and Lam (2013), Tirtosuharto and Adiwilaga (2013) and Honohan and Lane (2003). External sector conditions reflecting changes in exchange rate are considered by Nagayasu (2010), Ridhwan (2016), Angeloni and Ehrmann (2007), Honohan and Lane (2003) and Rogers (2007).

In the Indian context, regional inflation dynamics have been examined with a focus on the cross-sectional dependence and convergence argument (Das and Bhattacharya, 2008; Kundu *et al.,* 2018; Pillai *et al.,* 2012) and the existence of the Phillips curve at the state level (Behera *et al.,* 2017). The objective of this paper is to provide a generalised perspective on regional inflation dynamics.

Section III
Methodology and Data

For the empirical methodology, we follow the studies focused on sources of regional inflation and use a dynamic panel data model (Holmes, 2002; Honohan and Lane 2003; Licheron, 2007; Rogers 2007). Since the dynamic panel data model is widely popular, we skip its technical details and confine to a synoptic presentation of non-technical aspects of the empirical strategy. The dynamic panel data (DPD) model is suitable when an economic model involves a lagged dependent variable. Illustratively, a model of inflation can involve inflation persistence, usually captured through lagged inflation as the explanatory variable. In this case, ordinary least square (OLS) estimation will produce biased and inconsistent parameter estimates. Thus, Arellano and Bond (1991), Arellano and Bover (1995) and Blundell and Bond (1998) suggested DPD model based on Generalized Method of Moments (GMM). They suggested one-step and two-step GMM estimation procedures for implementing DPD model. Although the two-step estimator is asymptotically more efficient than the one-step estimator and relaxes the assumption of homoscedasticity, the efficiency gains are not that important even in the case of heteroscedastic errors (Arellano and Bond, 1991; Blundell and Bond

1998; Blundell *et al.,* 2000). This result is supported by Judson and Owen (1999). Moreover, the two-step estimator imposes a downward (upward) bias in standard errors (t-statistics) due to its dependence on estimated values as it uses the estimated residuals from the one-step estimator, which may lead to unreliable asymptotic statistical inference (Bond, 2002; Bond and Windmeijer, 2005). This issue should be taken into account, especially in the case of data samples with a relatively small cross-section dimension (Arellano and Bond, 1991; Blundell and Bond, 1998).

From an empirical perspective, a dynamic panel model parameter estimates are valid when the estimated model is free from (i) residual serial autocorrelation; and (ii) model misspecification problems. The first aspect can be solved with the inclusion of additional instruments or higher lags of the dependent variables, which may further lead to an over-parameterized model. The validity of the instruments used in the moment conditions as well as the assumption of serial independence of the residuals is crucial for the consistency of the GMM estimates. Here, a practical issue is that the system GMM can generate moment conditions prolifically (Roodman, 2009). Too many instruments in the system GMM may overfit an endogenous variable even as it weakens the Hansen test for joint validity of the instruments. In order to deal with the instruments' proliferation, studies rely on alternative techniques for limiting the number of instruments such as using only certain length of lags instead of all available lags for instruments (Roodman, 2009b). We overcome this aspect by including some select period specific dummy variables to account for notable adverse economic and structural developments. Illustratively, the year 2008-09 was marked by the global financial crisis. At the same time, there was a poor monsoon in India in 2009. Again, in recent years, 2013-14 witnessed a global economic slowdown alongside domestic development such as monsoon failure, which may not be fully captured in agriculture production (since the sector growth accounts for kharif as well as rabi crops). With regard to the model specification condition, studies rely on the Sargan specification test proposed by Arellano and Bond (1991), Arellano and Bover (1995) and Blundell and Bond (1998). Under the null hypothesis of valid moment conditions, the Sargan test statistic is asymptotically distributed as chi-square distribution. Arellano and Bond (1991) find a tendency for the Sargan test to under-reject and over-reject the null hypothesis in the presence of heteroscedasticity in the case of the two-

step estimator and one-step estimator, respectively. As an alternative, they suggested estimating the dynamic panel model using the robust estimator approach in the case of one-step estimation. Because asymptotic distribution is not known under the assumptions of robust estimator, the Sargan test is not computed. Thus, we have estimated the dynamic panel model with one-step estimation and robust standard error approach.

The data set comprises of annual indicators for major states for which CPI data are available for the period 1999-2000 to 2015-16. We experiment with two inflation indicators: CPI inflation for agricultural labourers (CPI-AL) and industrial workers (CPI-IW). These two indicators, in some ways, represent rural and urban inflation conditions. For the CPI-IW inflation, we work out the CPI-IW for various states, for which data are available for select centres, as the weighted index and then the annual variation in the combined index for each state. For the sake of consistency, we define the variables in annual growth form and ratio form as applicable. For explanatory variables, apart from inflation persistence, we consider four sets of factors comprising demand, supply, structural, and policy variables. First, the demand effect is captured through states' real per capita income growth and fiscal policy induced government expenditure growth. For government expenditure, the impact is shown alternatively through the growth of states' overall spending and social sector spending. Credit conditions are measured in terms of growth of bank credit and credit-to-deposit ratio based on credit utilisation data for the states. Generally, increases in demand variables are expected to increase the inflation. Second, among the supply side factors, we have taken growth rate of output under agriculture and allied activities. High real growth of the agriculture output is expected to induce lower inflation. On the other hand, common oil price shock measured in terms of one period lag of fuel price inflation is considered as a supply shock – higher oil price leading to increase in overall inflation. Third, structural characteristics of a region are captured through growth of utilities (electricity, gas and water supply) – crucial inputs for producing sectors including agriculture, industry and services. Also, we consider real growth of transport and communications services. Fourth, from a policy perspective, the monetary policy effect is measured through a common variable, the call money interest rate. From the fiscal policy perspective, apart from the government spending, we consider the tax rate measured by states' own tax revenue.

Section IV
Empirical Findings

Some stylised facts on the heterogeneity of regional inflation and economic conditions are provided in Tables A1, A2, A3 in the Appendix. Table A1 presents year-wise cross-section mean, median and standard deviation of CPI-AL inflation and the number of states above and below cross-sectional mean inflation for the sample of 19 states. It is evident that the states did not witness similar inflation conditions during any particular year; for all the years we find as many states below and above cross-sectional mean inflation. Similar findings emerge for CPI-IW inflation for 26 states and union territories (UTs) for which data were available (Table A2). Regional differences were also discernible for the explanatory variables. As an illustration, Table A3 provides summary statistics for the growth rate of real per capita state domestic product.

We begin with the empirical analysis of regional inflation dynamics based on CPI-AL inflation (Table 1). We estimated 11 models with alternative combination of variables, beginning with a basic model (M1) of inflation and growth relationship along with inflation persistence (lagged dependent variable) and then extending the model to include other variables pertaining to the supply side (states' agricultural output growth and fuel price inflation), monetary policy (call money rate), fiscal policy (alternatively characterised by government's overall spending and social sector spending, and states' own indirect tax revenue), structural conditions in terms of real growth of power, gas and water supply sectors (crucial inputs for production), and, finally, the transaction cost (inflation in the prices of transport and communications sectors).

In the basic model (M1), the income growth showed a positive influence on inflation, though the coefficient was significant at 10 per cent level of significance. The persistence effect was highly significant. We derive insights relating to the role of supply side factors – agriculture sector growth and fuel price inflation in models M2 and M3. When supply side variables are included in the regression equation, the income effect strengthens considerably,

Table 1: Regional Inflation Dynamics (Based on CPI-AL) *(Contd...)*

Variables	Alternate Dynamic Panel Data Models: Dependent Variable – Inflation: CPI-AL										
	M1	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**	**M09**	**M10**	**M11**
Persistence (1-Lag) CPINF.L1	0.5606 (0.00)	0.5546 (0.00)	0.3108 (0.00)	0.3803 (0.00)	0.3674 (0.00)	0.3403 (0.00)	0.3424 (0.00)	0.3641 (0.00)	0.3579 (0.00)	0.3803 (0.00)	0.4209 (0.00)
Per capita Income Growth: PYG	0.1541 (0.09)	0.3493 (0.00)	0.4324 (0.00)	0.2728 (0.00)	0.2448 (0.00)	0.2018 (0.00)	0.2110 (0.00)	0.1836 (0.01)	0.1642 (0.01)	0.1758 (0.00)	0.1495 (0.00)
Supply Shock (Agriculture Growth): GAG		-0.1105 (0.01)	-0.1259 (0.00)	-0.1078 (0.00)	-0.1014 (0.00)	-0.0856 (0.01)	-0.0856 (0.01)	-0.0801 (0.01)	-0.0844 (0.01)	-0.0877 (0.00)	-0.0846 (0.00)
Oil Price Inflation (INFCPALPOL)			0.3742 (0.00)	0.3795 (0.00)	0.3773 (0.00)	0.3909 (0.00)	0.3916 (0.00)	0.3926 (0.00)	0.3869 (0.00)	0.3363 (0.00)	0.2747 (0.00)
Monetary Policy (CMR)				-0.7748 (0.00)	-0.7904 (0.00)	-0.8096 (0.00)	-0.7976 (0.00)	-0.7923 (0.00)	-0.8268 (0.00)	-0.8570 (0.00)	-0.8252 (0.00)
State Fiscal Policy: Growth of Total Expenditure (GBE)					0.0393 (0.01)						
State Fiscal Policy: State Social Expenditure Growth (GSE)						0.0489 (0.00)	0.0498 (0.00)	0.0517 (0.03)	0.0531 (0.00)	0.0562 (0.00)	0.0476 (0.00)

Table 1: Regional Inflation Dynamics (Based on CPI-AL) *(Concld...)*

Variables	Alternate Dynamic Panel Data Models: Dependent Variable – Inflation: CPI-AL										
	M1	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**	**M09**	**M10**	**M11**
Structural Development (GEW1)							-0.0228 (0.05)	-0.0241 (0.05)	-0.0210 (0.05)	-0.0238 (0.03)	-0.0372 (0.00)
Financial Access (GBC)								0.0405 (0.01)	0.0368 (0.01)	0.0299 (0.07)	0.0414 (0.00)
State Fiscal Policy: Growth of Own Tax Revenue (GOTX)									0.0635 (0.03)	0.0668 (0.00)	0.0532 (0.01)
Transaction Cost											0.0721 (0.00)
Intercept	1.3340 (0.02)	0.7260 (0.00)	-0.9780 (0.04)	4.4549 (0.00)	4.2609 (0.00)	4.4257 (0.00)	4.4256 (0.00)	3.5577 (0.00)	0.1532 (0.93)	3.4841 (0.00)	3.8899 (0.00)
Wald Chi-sq (P value)	543 (0.00)	415 (0.00)	540 (0.00)	678 (0.00)	711 (0.00)	1133 (0.00)	1125 (0.00)	1216 (0.00)	2498 (0.00)	1789 (0.00)	2531 (0.00)
AB Test: AR(2) test: Z (probability)	-1.27 (0.21)	-0.46 (0.64)	-0.85 (0.40)	-0.70 (0.48)	-0.66 (0.51)	-0.81 (0.42)	-0.82 (0.42)	-0.74 (0.46)	-0.93 (0.35)	-1.04 (0.30)	-1.69 (0.09)

Note: Figures in parantheses indicate the significance/probability 'z' statistic associated with the coefficient of explanatory variables.

while the persistence effect reduces, especially in the presence of fuel price inflation (M3).

In the fourth specification given in M4, the monetary policy variable (call money rate) is included as an explanatory variable. It has a highly statistically significant impact on inflation with the expected negative sign. It suggests that the monetary policy could have a strong potential to stabilise regional inflationary pressures. An interesting finding is that the coefficient of income growth moderated significantly when monetary policy variable was included in the regression. In terms of the direction and magnitude of the monetary policy impact, the results are comparable to the literature in the Indian context. Illustratively, Mohanty and John (2015), using the SVAR model and impulse response analysis, showed that a one percentage point increase in call money rate is associated with a 120 basis points reduction in inflation over a six-month period. Mohanty (2012), Khundrakpam (2012), and Kapur and Behera (2012) show the effectiveness of the interest rate channel but do not provide accumulated impulse response analysis for which a comparison could be possible.

Next, we include the fiscal policy measured in terms of growth rate of states' overall government spending in model 5 and developmental social expenditure in model 6. Though government expenditure growth has statistically significant positive effect on inflation, the impact (coefficient size) is quite low when compared to the impact of other variables like income, supply side factors and monetary policy. An interesting point is that the social sector spending could be more conducive to effective demand than overall spending. Given the low inflationary impact, social spending induced effective demand could be desirable from the growth perspective. This is evident when we compare M5 and M6 with M4; the inflationary impact of per capita income is reduced to the extent of fiscal impact.

The growth of utilities (power, water and gas), reflecting upon the structural development, is introduced in model 7 (M7). The coefficient of this variable, though smaller in size, is statistically significant with negative sign. It implies that substantial real improvement in structural conditions can have a negative impact on inflation.

In model 8 (M8), we included bank credit growth. As expected, credit growth has statistically significant positive impact on inflation. Higher credit growth and better access to credit can contribute to demand and thus spur inflation. However, the coefficient of credit growth was much smaller than the coefficient of interest rate. This finding is in line with RBI (1998) and Dhal (2000), exemplifying the role of the interest rate channel compared with the credit channel of monetary transmission mechanism in the Indian context during the reform period.

In the models M9 and M10, we explore the impact of states' tax policy in the model using the ratio of own tax revenue to GSDP and growth rate of own tax revenue, respectively. Here we find M10 (with growth of own tax revenue) a plausible model rather than M9, as the intercept term is more or less similar to other models (M4-M8). In the model M10, the coefficient of growth rate of own tax revenue is positive and statistically significant. Similar to government expenditure, the coefficient size is low. Finally, we consider the role of transaction cost, which turned out to be statistically significant with a positive sign. As compared with Model 10, the presence of transaction cost leads to some moderation in the impact of oil price inflation, income growth and tax revenue growth but a strengthening of persistence, and financial access (credit growth).

Overall, we derive a couple of generalized perspectives. First, across the models, M4 to M11, the coefficient of interest rate does not change much. Thus, monetary policy through interest rate channel has the potential to stabilize inflation condition across the states. Second, similar to the interest rate effect, oil shock effect does not change much across the models. Thus, it is a significant source of supply shock to inflationary pressure. Third, the income effect can be exaggerated unless we consider other important demand, supply and policy variables. This is crucial finding as quantum of growth and inflation relationship is critically important for policy purposes.

Table 2 provides estimates for the inflation based on CPI-IW. Here, we have introduced additional variables like industrial wage inflation and house price inflation. Results show some similarities as well as striking differences with the estimates for CPI-AL given in Table 1. Models M1 to

M3 with fewer variables, like income growth and supply shocks, cannot be robust in terms of intercept terms when compared with the models with more explanatory variables. Moreover, models M1 to M3 are likely to suffer from serial autocorrelation problem. On the other hand, as we estimate the models with several variables, M4 to M11, we get plausible and robust results.

A couple of important insights must be mentioned here. Similar to CPI-AL, inflation persistence emerges as a significant source of CPI-IW inflation; a finding similar to other studies on inflation in India including Kapur and Behera (2012). Monetary policy induced interest rate variable has a significant inverse relationship with CPI-IW inflation also. Again, government social expenditure has a statistically significant effect compared with insignificant effect of overall spending. Agricultural production and structural conditions (real growth of power and utility sectors) – supply side factors – share inverse relationship with both types of inflation. Wage inflation and house price inflation have statistically significant positive effect on CPI-IW inflation. In the presence of these two additional variables, transaction cost showed lower effect on CPI-IW than CPI-AL. A major difference pertains to insignificant effect of credit growth on CPI-IW inflation. This result needs further analysis. Furthermore, the role of taxes can be subdued when we consider transaction cost, house prices and wage inflation.

Finally, a comparison of results in Tables 1 and 2 suggests that the impact of interest rate on CPI-AL inflation is more than that on CPI-IW inflation. As a general perspective, this finding is in line with asymmetric monetary transmission mechanism discussed in the literature; greater the financial constraints, greater the monetary policy effect. De (2017) provided a consumption channel explanation. Using household survey data for rural and urban areas, De (2017) showed that the expenditure of a poor household with higher share of food expenditure will have more sensitivity to fluctuations in relative food prices and monetary policy shocks. The sutdy also reported that in response to expansionary monetary policy, real consumption expenditure declined to a lower bound of 1.4 per cent in rural areas and 1.2 per cent in urban areas in India. Furthermore, in response to expansionary monetary policy, food consumption inequality rose by 3.2 per cent in rural areas and 2.9 per cent in urban areas.

Table 2: Regional Inflation Dynamics (Based on CPI-IW) *(Contd...)*

Variables	Alternate Dynamic Panel Data Models: Dependent Variable – Inflation: CPI-IW										
	M1	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**	**M09**	**M10**	**M11**
Persistence (1-Lag) CPINF.L1	0.4981 (0.00)	0.4776 (0.00)	0.4448 (0.00)	0.5469 (0.00)	0.5356 (0.00)	0.5249 (0.00)	0.5448 (0.00)	0.5476 (0.00)	0.5186 (0.00)	0.5303 (0.00)	0.4879 (0.00)
Per Capita Income Growth: PYG1	0.2096 (0.00)	0.3458 (0.00)	0.4445 (0.00)	0.3973 (0.00)	0.4048 (0.00)	0.3716 (0.00)	0.3713 (0.00)	0.3675 (0.00)	0.2506 (0.00)	0.3605 (0.00)	0.2256 (0.00)
Agriculture Output Growth: GAG1		-0.0741 (0.00)	-0.1031 (0.00)	-0.0884 (0.00)	-0.0897 (0.00)	-0.0845 (0.00)	-0.0836 (0.00)	-0.0829 (0.00)	-0.0515 (0.00)	-0.0848 (0.00)	-0.0612 (0.00)
Oil Price Inflation			0.0680 (0.01)	0.1015 (0.00)	0.1040 (0.00)	0.1153 (0.00)	0.0975 (0.00)	0.0976 (0.00)	0.0647 (0.00)	0.1086 (0.00)	0.0747 (0.00)
Monetary Policy (Call Money Rate)				-0.6523 (0.00)	-0.6528 (0.00)	-0.6708 (0.00)	-0.6180 (0.00)	-0.6173 (0.00)	-0.7016 (0.00)	-6099 (0.00)	-0.5650 (0.00)
Fiscal Policy (GBE)					0.0254 (0.04)						
Fiscal Policy (GSE)						0.0421 (0.00)	0.0398 (0.00)	0.0399 (0.00)	0.0491 (0.00)	0.0388 (0.00)	0.0434 (0.00)
Structural Development (GEW1)							-0.0360 (0.00)	-0.0357 (0.00)	-0.0327 (0.00)	-0.0370 (0.00)	-0.0298 (0.00)
Financial Access (GBC)								0.0047 (0.79)	0.0057 (0.77)	-0.0032 (0.87)	0.0131 (0.53)
Fiscal Policy (ZTXR1 / GOTX1)									0.1014 (0.00)	0.0509 (0.10)	0.0443 (0.16)

Table 2: Regional Inflation Dynamics (Based on CPI-IW) *(Concld.)*

Variables	Alternate Dynamic Panel Data Models: Dependent Variable – Inflation: CPI-IW										
	M1	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**	**M09**	**M10**	**M11**
Transaction Cost (TCOST)											0.0379 (0.01)
HPINF											0.0722 (0.06)
WGINF											0.0967 (0.00)
Intercept	1.6486 (0.00)	1.3595 (0.00)	0.5637 (0.18)	4.0937 (0.00)	3.7780 (0.00)	3.7291 (0.00)	3.7364 (0.00)	3.6342 (0.00)	3.6355 (0.00)	3.0229 (0.00)	2.4556 (0.00)
Wald Chi-sq (P value)	391.7 (0.00)	557.2 (0.00)	494.1 (0.00)	712.5 (0.00)	629.6 (0.00)	668.1 (0.00)	779.8 (0.00)	1033.7 (0.00)	1485.1 (0.00)	892.3 (0.00)	1846.2 (0.00)
AB Test AR(2) test: Z (probability)	-2.3 (0.02)	-2.0 (0.05)	-1.8 (0.08)	-0.92 (0.36)	-0.93 (0.35)	-0.66 (0.51)	-0.79 (0.42)	-0.85 (0.40)	-0.42 (.67)	-0.80 (0.42)	-1.41 (0.16)

Note: Figures in parentheses indicate the significance/probability 'z' statistic associated with the coefficient of explanatory variables.

GBE: Growth in Government Expenditure; GSE: Growth in Government Social Expenditure; GEW: Growth of Electricity and Water Supply Output; GBC: Growth of Bank Credit; ZTXR: States Own Tax revenue to GSDP ratio; GOTX: Growth of States own Tax revenue; WGINF: Growth rate of wages; HPINF: Housing Price Inflation.

Section V
Conclusion

This study has attempted an empirical analysis of regional inflation dynamics in the Indian context, using demand, supply, structural and policy variables in a dynamic panel data framework. The study has analysed two consumer price inflation series pertaining to agriculture labourers and industrial workers, which, to some extent, relate to rural and urban inflation conditions. The results of the study confirmed some standard economic premises. Monetary policy through interest rate can have a significant common influence in stabilising inflation conditions across states. Inflation could be positively affected by variables such as real per capita income growth, government expenditure growth and bank credit growth, but negatively by supply side factors such as real agriculture sector growth. Among the structural factors, inflation could decline with growth of utilities such as power, water supply and gas. On the other hand, States' own tax revenue rate can have positive but low impact on inflation. Thus, the study provides an applied perspective that the information available from national accounts on states' GSDP and states' budget documents could be exploited to evaluate the policy transmission mechanism at a disaggregated level. Going forward, the empirical approach can be extended as longer time series data become available for CPI rural and urban areas, which is used for policy purposes.

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Appendix

Table A1: Cross-sectional Summary Statistics of Inflation (CPI-AL)

Year	Mean	Median	Standard deviation	Maximum	Minimum	Count 1	Count 2	Average of deviation from mean (Count 1)	Average of deviation from mean (Count 2)
1999	11.1	10.8	3.3	19.0	5.2	7	12	3.1	-1.6
2000	5.1	4.7	2.4	10.8	1.2	8	11	2.5	-1.5
2001	0.7	1.0	2.6	4.4	-5.8	12	7	1.7	-2.2
2002	0.6	0.7	2.0	4.2	-3.5	11	8	1.5	-1.6
2003	2.4	2.6	2.6	8.7	-3.0	12	7	1.6	-2.1
2004	3.2	3.3	1.9	5.8	-2.0	11	8	1.4	-1.5
2005	2.7	2.6	1.7	5.4	-1.7	9	10	1.5	-1.1
2006	3.9	4.0	2.2	9.2	-1.2	11	8	1.5	-1.7
2007	7.6	7.8	2.0	10.6	3.6	11	8	1.5	-1.7
2008	7.3	7.2	1.5	10.8	3.4	10	9	1.0	-0.9
2009	9.7	10.0	2.2	13.2	5.7	13	6	1.4	-2.2
2010	13.7	13.9	2.5	17.2	8.0	11	8	1.9	-2.1
2011	10.0	10.0	2.3	14.7	6.3	10	9	1.9	-1.7
2012	8.2	8.0	2.7	13.8	4.1	8	11	2.7	-1.7
2013	10.0	10.0	1.3	11.8	7.1	12	7	0.8	-1.1
2014	11.1	11.0	2.6	17.2	6.6	10	9	2.1	-1.9
2015	7.3	6.9	2.1	12.1	2.2	8	11	2.0	-1.2
2016	4.0	4.4	2.4	8.5	-2.1	11	8	1.6	-1.8

Note: Count 1: No. of states above or equal to the cross sectional mean.
Count 2: No of states below the cross-sectional mean.

Table A2: Cross-sectional Summary Statistics of Inflation (CPI-IW)

Year	Mean	Median	Standard Deviation	Maximum	Minimum	Count 1	Count 2	Average of deviation from mean (Count 1)	Average of deviation from mean (Count 2)
1999	13.22	13.21	4.86	24.40	2.62	12	14	3.99	-3.42
2000	2.85	3.40	5.25	12.17	-18.74	16	10	2.32	-3.71
2001	3.91	3.45	2.39	9.90	0.10	9	17	2.62	-1.39
2002	3.62	3.90	2.42	9.60	-0.02	14	12	1.77	-2.07
2003	3.19	3.70	3.14	7.90	-7.10	16	10	1.62	-2.60
2004	4.40	4.00	1.32	7.57	1.70	11	15	1.26	-0.92
2005	4.97	4.10	3.19	15.83	0.50	10	16	2.65	-1.66
2006	5.15	5.00	2.34	12.39	1.64	10	16	2.16	-1.35
2007	6.99	6.20	3.26	19.42	2.80	8	18	3.49	-1.55
2008	6.28	6.20	1.42	9.70	3.76	12	14	1.20	-1.03
2009	9.51	8.65	5.26	31.89	1.43	9	17	4.06	-2.15
2010	9.62	12.15	7.12	16.20	-16.92	19	7	3.20	-8.69
2011	11.09	10.90	3.15	23.27	4.20	12	14	2.00	-1.71
2012	9.11	8.55	2.99	18.14	4.40	8	18	3.12	-1.38
2013	9.68	10.05	2.73	14.50	3.00	14	12	1.85	-2.16
2014	8.92	8.85	3.05	13.61	-1.08	13	13	2.16	-2.16
2015	5.03	5.75	4.27	10.10	-13.98	16	10	1.80	-2.88
2016	4.47	5.15	3.42	8.00	-7.97	19	7	1.41	-3.82

Note: Count 1: No. of states above or equal to the cross sectional mean.

Count 2: No of states below the cross-sectional mean.

Table A3: Cross-sectional Summary Statistics of Per capita Income Growth

Year	Mean	Median	Standard Deviation	Maximum	Minimum	Count 1	Count 2	Average of deviation from mean (Count 1)	Average of deviation from mean (Count 2)
1999	4.2	4.0	3.5	11.2	-1.6	10	10	2.7	-2.7
2000	4.2	4.4	2.9	9.7	-2.6	10	10	2.2	-2.2
2001	0.9	1.7	5.5	12.9	-8.8	12	8	3.6	-5.3
2002	3.2	3.9	4.3	13.9	-7.6	12	8	2.6	-3.9
2003	2.1	3.2	4.8	10.3	-11.4	12	8	2.8	-4.2
2004	6.8	5.4	6.2	26.2	-6.9	7	13	5.6	-3.0
2005	6.0	6.6	3.6	12.0	-3.7	11	9	2.4	-3.0
2006	5.9	4.6	3.9	13.2	-3.3	7	13	4.2	-2.3
2007	8.0	7.6	3.5	14.3	-0.2	9	11	2.9	-2.4
2008	6.5	6.5	2.9	12.1	2.0	10	10	2.3	-2.3
2009	5.9	5.2	2.9	12.8	1.1	9	11	2.3	-1.9
2010	6.2	6.6	2.7	10.1	0.2	11	9	2.1	-2.5
2011	6.8	6.2	3.6	13.4	-2.7	8	12	3.2	-2.2
2012	5.5	5.4	2.0	9.8	2.6	10	10	1.5	-1.5
2013	4.1	4.2	3.0	9.8	-1.6	10	10	2.4	-2.4
2014	5.2	6.0	2.1	8.4	-0.3	12	8	1.4	-2.2
2015	4.2	4.5	3.2	9.1	-4.8	12	8	1.8	-2.6
2016	7.0	6.4	2.4	13.0	2.8	8	12	2.2	-1.5

Note: Count 1: No. of states above or equal to the cross sectional mean.
Count 2: No of states below the cross-sectional mean.