Received 17 August 2022
Revised 24 September 2022
Accepted 24 October 2022

Assessing non-linear effects of government size on inflation in India: recent evidence from smooth transition autoregression model

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Abstract

Purpose – Standard economic theory predicts that any increase in public spending is accompanied by a rise in inflation in an economy. This paper presents empirical proof that prices do not always rise with an increase in public expenditure but only up to a certain threshold level. The primary aim of this paper is to unearth the government size-inflation nexus in India for the period from 1971 to 2019.

Design/methodology/approach – The logistic STAR (smooth transition autoregression) model is employed to unravel the government size-inflation nexus for the Indian economy from a non-linear perspective.

Findings – The finding of our study confirm the non-linear relationship between the size of the government and inflation in India. The estimated threshold level for government size is precisely found to be 9.27%. The size of the government exerts a negative influence on inflation until it reaches the optimal or threshold level. Any further increase in the size of government beyond this threshold level would result in a rise in inflation.

Research limitations/implications – The findings have implications for the conduct of fiscal policy. Policymakers can increase government spending in a regime of small government size without having any inflationary impacts by generating revenues from taxes and other sources instead of relying much on the central bank. In the regime of a large-sized government, adhering strictly to the discipline in the conduct of fiscal and monetary policies would help curb inflation and enhance growth synchronously, hence alleviating any loss of welfare.

Originality/value – To the best of the authors' knowledge, this study is an attempt to revisit the government size-inflation nexus in India from a non-linear perspective using the Smooth Transition Autoregression (STAR) model for the first time.

Keywords Government size, Inflation rate, Threshold level, Smooth transition autoregression, Non-linear analysis, Indian economy

Paper type Research paper

1. Introduction

The effects of government size on macroeconomic variables such as economic growth, consumption interest rates and investment have received widespread attention in the literature, particularly since the onset of the subprime mortgage crisis of 2007. In public and academic discussions, it is conventionally professed that inflation and government size are interconnected (Han and Mulligan, 2008). Nevertheless, how inflation responds to changes or shocks in government size has conventionally obtained meager attention in the literature. How government size impacts inflation can significantly affect fiscal and other macroeconomic policy management decisions. Conventionally speaking, any increase in government spending is followed by a rise in inflation (Dumitrescu *et al.*, 2022). As per the Keynesian view, governments must incur expenditures to bring stability to the economy and augment productivity or investment (Mehrara *et al.*, 2016). However, apart from its impacts on production, government size also affects the inflation rate in any economy (Georgantopoulas and Tsamis, 2010). It is also widely acknowledged that "high and volatile" inflation impedes economic growth and inflicts high welfare costs (Baharumshah *et al.*, 2016). Economies quite often face this tradeoff of controlling inflation and increasing government expenditure to ward off any recessionary tendencies. Restraining the inflation

Journal of Economic and Administrative Sciences
Vol. 41 No. 2, 2025
pp. 540-555

2054-6238
DOI 10.1108/JEAS-08-2022-0190

rate within manageable limits can enhance the economy's growth potential. At the same time, a low inflation rate might pose counter-productive effects (Vinayagathasan, 2013). Despite everything, a few questions arise and remain unanswered. First, whether the size of government really matters for inflation? Second, what should be the target level of the size of government or, in other words, what is the threshold or optimal level of government size?

Since India sustains to be a poverty-ridden and unequal country, inflation appears to be a social and political concern. Nevertheless, in India, political economy concerns often overpower fiscal policy decisions. The loss of political power that results from failing to account for substantial adverse shocks in expenditure decisions could result in a loss of well-being (Goyal and Sharma, 2018). Moreover, one of the principal problems that might damage the optimistic growth expectations of the Indian economy is undoubtedly inflation. Besides, it is also inimical to social justice and inflicts severe welfare costs. Consequently, making prices stable becomes a key objective of macroeconomic policy. Historically, inflation has been a problem in the Indian economy, although low to moderate inflation levels can be documented from the literature. During the 1970s and 1980s, India, like other economies, witnessed a rise in inflation owing to the amalgam of accommodative monetary policy, expansionary fiscal policy and supply shocks (Pattnaik and Samantaraya, 2006). The average inflation rate stood at 7.54% from 1970 to 1980, and between 1980 and 1990, it turned out to be 9.21%. During the early 1990s, inflation still rose but was contained in the mid-nineties due to the government's reform initiatives and other liberalisation policies. From 1990 to 1993 average inflation rate was 11.54, which gradually declined to 4.67% in 1999. The average inflation rate from 1990 to 2000 was quoted at 9.55%. It was 5.53% for the period spanning from 2000 to 2010. Again, the inflation rate peaked from 2010 to 2019 and stood at 6.87%.

Contrarily the size of the government has swelled substantially since the inception of planning in India till the nineties due to the ever-increasing role and responsibilities of government in the nation's economic activities (Seshaiah *et al.*, 2018). The share of public expenditure in GDP during 1970–71 was 17.2%, 25.6% in 1980–81 and 28.5% of GDP during 1990–91. However, due to the reform initiatives and neo-liberal policies that influenced the economic scene in India post-1990s, the size of the government has somewhat tended to diminish and has followed a kind of erratic pattern. The public expenditure's share in GDP was 24.7% in 1996–97 and 25% in 1997–98. In 2011–12, this downward trend in the ratio of government expenditure as a proportion of GDP was reversed and was 28.1%. Regardless of these improvements in the share of public spending in GDP or the enhancements in the size of the government over time, the slack growth momentum, mounting fiscal deficits and volatile prices raise concerns about the threshold government size that might contain the rising prices and put the economy on the path of sustainable and high economic growth without inflicting any severe welfare costs in the guise of the inflation tax.

Against this backdrop, the study endeavours to unravel the threshold effects of government size on inflation in India. More specifically, we examine whether any optimal or threshold level of government size exists in India and how differently inflation responds to that threshold level of government size. The present study drifts from the already existing ones in several ways. First, to the best of our knowledge, the paper focuses on the inflation-government size nexus in the Indian economy, for which the topic has not received much deliberation from the researchers and other concerned quarters before. The prevailing literature demonstrates that a considerable number of studies exist on government size-economic growth and inflation-growth nexus. However, the topic of the present paper has been largely neglected in practice and theory. Therefore, to the best of our knowledge, this study is the first attempt to investigate the effects of the size of the government on inflation in India from a non-linear perspective. Second, we scrutinise the likelihood that the inflation-government size nexus can be depicted aptly by a non-linear model with remarkably different dynamics in periods following a shift in the size of government from a phase of small to large

government and vice-versa. Third, we can estimate the threshold level of government size and capture the response of inflation to the shocks in government size for the Indian economy. The findings of the present paper can aid policymakers in framing policies more precisely, keeping in view the relationship dynamics and the possible tradeoff involved. Put differently, our empirical findings have ramifications for the comprehensive fiscal policy debate. To chase our goal, we employ the non-linear Smooth Transition Autoregressive (STAR) model developed by Terasvirta and Anderson (1992) and Terasvirta (1994) to verify the non-linearities involved in the inflation-government size nexus. Using STAR methodology gives us several advantages: the data can be separated into two distinct phases. Besides, the smoothness of the switch between regimes or phases can be estimated; regime-switching takes place gradually when an observed variable crosses the unobservable threshold level. Furthermore, we contribute to the ongoing debate about the impacts of shocks or modifications in government size on inflation by confining ourselves to the Indian economy. More specifically, in the present study, we want to add to the literature, although very little, about whether bigger governments really tend to inflate or what correlation exists between the size of the government and inflation.

The remainder of this paper is structured as follows. Section 2 outlines the review of the literature. In section 3, we describe the data and the econometric methods employed for analysing the data. Section 4 offers the interpretation of the results of the econometric model used. Finally, we conclude and offer some policy implications in section 5.

2. Review of literature

It would not be prejudiced to state that the empirical literature on the inflation-government size nexus is indeterminate. Researchers and policymakers have a common consensus that a rise in the general price level due to an increase in government size has deleterious impacts on output growth due to the associated welfare costs. However, the possible reasons for inflation are still being discussed. Different schools of thought have described the relationship dynamics between inflation and government size nexus differently.

2.1 Theoretical underpinnings

The Keynesian aggregate demand and aggregate supply framework explain how government expenditure can influence inflation in an economy. As per Keynesians, a fiscal stimulus in terms of increasing government expenditure can increase aggregate demand due to a rise in private consumption and investment (Afonso *et al.*, 2020). Given that aggregate supply remains fixed or inelastic in the short run, an increase in aggregate demand can raise the general price level. Therefore Keynesians believed that there is a positive relationship between government size and inflation, and the direction of causation runs from government size to inflation.

Another line of thought regarding the nexus between government size and inflation is offered by Clark's (1945) critical limit hypothesis. According to this hypothesis, inflation would be a natural outcome if countries let go of the share of public expenditure beyond 25% of the threshold level. It would mean that even if countries operate under a balanced budget, inflation would still be an outcome if the share of government expenditure reaches this critical limit of 25% (Magazzino, 2011). The reasons discussed in Clark's analysis are that owing to higher taxes through which government expenditures are being financed, there would be a reduction of incentives to work of taxpayers that would jeopardize their productivity levels. The fall in the productivity levels of workers would bring a fall in supply. On the other hand, aggregate demand would rise due to an increase in government expenditure. As a result, the mismatch between demand and supply would lead to inflationary tendencies as a net result in

an economy (Ezirim and Muoghalu, 2006). The upshot of Clark's analysis is that a positive relationship exists between the two; increase in government size would increase the general price level.

The fiscal theory of price level (FTPL) provides yet another explanation of the nexus between government size and inflation in an economy. The FTPL is a disagreement that objects to the celebrated proposition of Milton Friedman, which states that "inflation is always and everywhere a monetary phenomenon." Thus instead of monetary policy as proposed by Friedman, the price levels are determined and maintained by fiscal policies as per the proponents of FTPL (Afonso *et al.*, 2020). As per FTPL, fiscal policy in general and government expenditure, in particular, will signify the price levels in an economy. They believed that if the fiscal authority raises revenues to finance the rising government expenditure without depending on the monetary authority, the disparity between taxes and government expenditures which is government savings, will decline. This decline in government savings leads to an increase in the general price level. Table 1 given below depicts some theoretical underpinnings concerning the inflation-government size nexus [1].

3. The data and econometric methodology

3.1 The data

We used annual time series data for the Indian economy from 1971 to 2019. Table 2 below defines the variables used, the sources they are extracted from and the descriptive statistics of these variables for investigative purposes. In addition, Figure 1 given below represents how the size of the government and inflation has moved over time.

3.2 Choice of variables

The inflation rate in an economy gets determined by various monetary and non-monetary factors such as money supply, fiscal deficit, exchange rate, government spending, openness, real GDP per capita, output gap, etc. We have included only a few relevant variables in our model to unearth the government size-inflation nexus in India. Conventionally economic theory has been used to describe the behaviour of economic agents, including consumers, firms and various policies of the government. Now there is an ever-increasing perception that economic analysis can also explain the government's behaviour (Han and Mulligan, 2008). Most economists believe that an increase in the money supply leads inflation to persist in time, implying that inflation is a monetary phenomenon (Burton and Fischer, 1997). Disparities in the money supply growth rate can aptly describe the variations in the inflation rate over time and across countries.

Nevertheless, this is not very intriguing. The question that interests us is why governments allow the money supply to grow and thus inflate. The possible reasons governments tend to inflate might be the perceived real benefits in return. To unravel this nexus between the size of government and inflation in the Indian economy, we include the size of the government measured as the annual growth rate of general government expenditure and is our primary variable of interest. Besides, we also plug in our model, the growth rate of money supply mimicked by the broad money (M3) growth to capture the influence of money supply on the

Theories	Relationship	Direction	Reasons
Keynesian	+ ve	$G_{exp} \rightarrow INF$	A rise in private consumption and investment
Clark's CLH	+ ve	$G_{exp} \rightarrow INF$	A mismatch between demand and supply
FTPL	+ve	$G_{exp} \rightarrow INF$	A decline in Govt. savings

Table 1.
Nexus between inflation and size of government

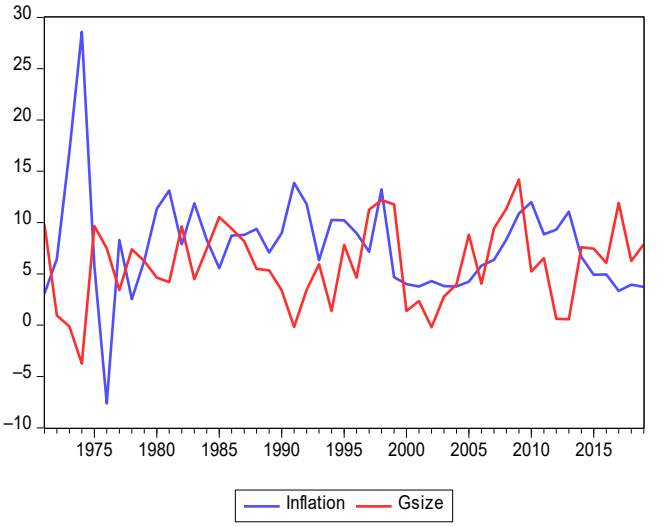

Figure 1.
Inflation rate and government size over time

Variables	Definition, description and source	Years	Mean	Max	Min	Std.Dev
Inflation rate (P_t)	annual percentage change of Consumer Price Index (CPI), from WDI	49	7.79	28.59	−7.63	4.98
Government size (Gsize)	annual percentage growth of general government final consumption expenditure, from WDI	49	5.93	14.19	−3.74	3.93
Broad money growth rate (*MS*)	the annual percentage growth rate of broad money, from WDI	49	16.22	24.49	6.80	3.53
Fiscal deficit (*FD*)	gross fiscal deficit of central government as a percentage of GDP, from RBI	49	5.05	8.13	2.53	1.40
Official exchange rate (*ER*)	annual average based on monthly averages, from WDI	49	31.87	70.42	7.49	20.61

Table 2.
Definitions and descriptive statistics of variables

inflation rate. Another essential potential determinant of inflation is undoubtedly fiscal deficit, which we have incorporated in our model because inflation tax can often be used as a primary means to yield seigniorage or diminish government debt liabilities in real terms (Han and Mulligan, 2008). Based on this, we included fiscal deficit as a percentage of GDP in our model. Finally, the exchange rate, which implies the price of domestic currency in foreign currencies, fluctuates based on the dynamics of global markets. These exchange rate fluctuations can affect any economy's domestic inflation rate. Particularly in a country where a substantial portion of its foreign trade is denominated in other countries' currencies, its inflation rate might get strongly affected by the exchange rate fluctuations. For the reasons mentioned above, we have included the official exchange rate as a determining variable in our analytical model to assess its possible impact on the inflation rate.

3.3 Modeling framework

To capture the relationship between inflation and the size of the government, the present paper exploits the standard Cobb–Douglas type function. The general form of the Cobb–Douglas type function is as follows:

$$P_t = A_t GS_t^{\beta} MS_t^{\alpha} e^{\mu_t} \quad (1)$$

where P_t is the inflation rate, GS_t is the size of the government, MS_t is the broad money (M3) growth rate. A_t is the deterministic term, measured as $A_t = C_o$, where C_o is the constant. β and α are the elasticity coefficients with respect to the size of the government and the money supply. μ_t is the white noise error term, and t = 1, . . ., T is the time frame of our sample.

In the log-linear form, the above model given in equation (1) can be written as

$$log(P_t) = log(C_o) + \beta\, log(GSize_t) + \alpha\, log(MS_t) + \mu_t \quad (2)$$

We slightly modified the above model given in equation (2). We included a few more variables (control variables) that are potential players which can determine the inflation rate to avoid misspecification bias.

The econometric representation after the modification of equation (2) becomes

$$log(P_t) = log(C_o) + \beta\, log(GSize_t) + \alpha\, log(MS_t) + \delta\, log\,(X_t) + \mu_t \quad (3)$$

where X_t is a vector of control variables, and δ is a vector of parameters associated with the control variables.

3.4 Econometric specification of smooth transition autoregression (STAR) model

From recent empirical studies that have used linear models, it has been figured out that plenty can be achieved by assenting to non-linear specifications. One of the crucial reasons for allowing a non-linear specification is that economic variables are often subject to regime-switching. The probability of structural breaks may trigger variables to switch regimes and thus their non-linear behaviour. Besides, the concept of regime-switching presupposes a sudden change of variables from one economic phase to another. Despite that, most economic variables switch from one regime to another in a gradual manner, with the shift from one extreme economic phase to another phase taking a while. In addition, when the size of the government is above or below the threshold level or when it increases or decreases, it affects the inflation rate in a non-linear manner.

Consequently, overlooking the possibility of non-linearity in our model might yield biased results. To handle this possibility of non-linearity between the size of the government and inflation in our model, we propose a two-regime non-linear STAR (smooth transition autoregression) model. The STAR model is quite prevalent for non-linear time series analysis. Unlike the discrete switching model, for example, Hansen (1999), the transition in STAR models imitates the transition as a continuous and smooth process conditional upon the transition variable. Using the STAR model allows for embracing regime-switching behaviour evenly when the precise time of the regime shift is unknown and when the period of transition from one regime to another is short. Therefore, these models furnish supplemental information on the dynamics of variables that display their value even during the shift period.

Using equation (3), a standard STAR model can be introduced like

$$P_t = \alpha_0 + \delta_1 GSize_t + \delta_2 MS_t + (\alpha_1 + \omega_1 Gsize_t + \omega_2 MS_t).\, h[(Gsize_t);\, \gamma, c] + \beta_i X_t + \mu_t \quad (4)$$

Here, α_0 and α_1 are constant terms associated with the linear and non-linear part; δ_1, δ_2 and ω_1, ω_2 are the parameters associated with the size of the government and money supply (linear and non-linear part), which vary across the regimes; $h[(Gsize_t);\, \gamma, c]$ represents the continuous transition function of the observable transition variable $Gsize_t$ which is by construction bounded between zero and one. The parameter γ is the slope of the transition function, which shows the speed of transition from one extreme economic regime to another, and c is the estimated threshold value of the transition variable $Gsize_t$. Also β_i denotes the (2×1) vector of

regime unvarying parameters associated with X_t control variables plugged into our model to control for the omitted variable bias and $\mu_{t\sim}$ n.i.d $(0, \sigma^2)$.

To capture any non-linearities between the size of the government and the inflation rate, this study utilizes the logistic transition function. The transition function's form can be either logistic or exponential (Terasvirta and Anderson, 1992) since no theoretical guide traced from literature can aid us in choosing between the logistic and exponential functional forms that our observable transition variable can take. Therefore, the choice of the functional form becomes empirically data-driven.

We define the logistic function for the transition function as

$$h[(Gsize_t); \gamma, c] = \{1 + \exp[-\gamma((Gsize_t) - c)]\}^{-1}, \gamma > 0 \quad (5)$$

The representation in equation (5) of the transition function is the Logistic STAR (LSTAR) model, which demonstrates the existence of two distinct economic phases regarding the impact of the size of the government on inflation. The smoothness and the switch between the regimes are determined by the level of the size of the government. In a broader framework, an asymmetric S-shaped cycle in the economy can be portrayed by the LSTAR model. The LSTAR function is monotonically increasing in the transition variable $Gsize_t$ whereby the two distinct economic phases represent high and low values of the threshold variables. Also, the parameter γ defines the slope of the transition function and the provision $\gamma > 0$ judges the smoothness of the transition function. As $\gamma \to \infty$, $h[(Gsize_t); \gamma, c] = 0$ for $Gsize_t \leq c$, presupposes that P_t follows a linear specification; $h[(Gsize_t); \gamma, c] = 1$ for $Gsize_t > c$, implying that P_t moves in compliance with a non-linear adjustment process, and our LSTAR model becomes a two-regime threshold model. However, if $\gamma \to 0$, the STAR model approximates a linear VAR model.

3.5 Testing for non-linearity in STAR type models

One step in estimating the STAR model is to test the null hypothesis of linearity against the non-linear variant of STAR type models. To verify the existence of non-linearities, we may test the null hypothesis using either $\omega = 0$ or $\gamma = 0$, suggesting that the model is not non-linear. Testing the linearity with the Lagrange Multiplier (LM) linearity test would be invalid because the STAR models can only be known under the alternative hypothesis. To resolve this issue, Luukkonen *et al.* (1988) designed a method that substitutes h with a Taylor series expansion which is estimable under the null. We follow Luukkonen *et al.*'s (1988) method, which is predicated on the third-order Taylor approximation about $\gamma = 0$. This testing procedure involves picking the linear part of the model and adding terms depicting the synergy between the linear regressors and the polynomial terms in the Taylor approximation. After the interaction of the linear regressors with the polynomial terms in the Taylor expansion, we estimate the following auxiliary regression

$$P_t = \rho_0 + \rho_1'\phi_t + \rho_2'\phi_t(Gsize_t) + \rho_3'\phi_t(Gsize_t)^2 + \rho_4'\phi_t(Gsize_t)^3 + \rho_5'\phi_t(Gsize_t)^4 + \varepsilon_t \quad (6)$$

where ε_t combines the original residual error (μ_t) from equation (4) and the approximation error $\varepsilon_t \sim$ n.i.d $(0, \sigma^2)$ resulting from Taylor series approximation, ρ_0 is the intercept term, ρ_z' is a (4×1) vector, $z = 1, 2, 3, 4$. The Luukkonen *et al.* (1988) linearity tests are equivalent to examining the common hypothesis that all non-linear terms or the elements of the above Taylor expansion are zero, as in the following null hypothesis

$$H_0 : \rho_2' = \rho_3' = \rho_4' = \rho_5' = 0 \quad (7)$$

More specifically, this test uses the following hypothesis

$$H_{04} : \rho_2' = \rho_3' = \rho_4' = \rho_5' = 0 \quad (8)$$

$$H_{03} : \rho_2' = \rho_3' = \rho_4' = 0 \quad (9)$$

$$H_{02} : \rho_2' = \rho_3' = 0 \quad (10)$$

$$H_{01} : \rho_2' = 0 \quad (11)$$

In addition to the Luukkonen *et al.* (1988) linearity tests, the Teräsvirta tests of non-linearity are utilised, which are a set of sequential tests for elements of Taylor approximation. The test procedure proposed by Teräsvirta authorises the selection of the transition function. The Teräsvirta sequential test of non-linearity executes the three tests in the following sequence:

$$H_3 : \rho_4' = 0 \quad (12)$$

$$H_2 : \rho_3' = 0 \big| \rho_4' = 0 \quad (13)$$

$$H_1 : \rho_2' = 0 \big| \rho_3' = \rho_4' = 0 \big| \quad (14)$$

If the null hypothesis of linearity is rejected, the results of the Teräsvirta (1994) tests of non-linearity can also be utilized to choose between the alternative functional forms for h, that is, the transition function. If the p-value for H_2 is not the smallest, the LSTAR model is to be chosen; on the contrary, if the p-value for H_2 is the smallest ESTAR model is to be selected.

Finally, another workable approach in deciding an appropriate model that chooses between LSTAR and ESTAR functions is to use Escribano-Jorda tests. The test suggested by Escribano-Jorda uses distinct peculiarities of the Taylor expansion to test the non-linearity and make a distinction between the LSTAR and ESTAR models. The Escribano-Jorda tests are premised on fourth-order Taylor approximation and use the following null hypothesis

$$H_{OL} : \rho_3' = \rho_5' = 0 \quad (15)$$

$$H_{OE} : \rho_3' = \rho_5' = 0 \quad (16)$$

The H_{OL} test examines the linearity opposed to the logistic function alternative, while the H_{OE} test assesses the linearity against an exponential function alternative.

4. Results and discussion

4.1 Integration properties (Unit root test)

In the first instance, we proceeded with the ADF and PP test to examine the integration properties of the series under consideration. However, an essential characteristic of the unit root estimation procedure in the existence of a structural break is to "over reject" the unit root null due to the size distortions they can exhibit. Besides, owing to the likelihood of structural breaks of the variables, the usage of these tests can generate biased and fallacious results. To overcome this problem and have robust and reliable results, in the present paper, to examine the integration properties of the variables with endogenous breaks, Lee and Strazicich's (2004) unit root estimation procedure is adopted that concedes for no more than two structural breaks. Table 3 shows the test results of PP and ADF test results, and Table 4 presents the results of Lee and Strazicich's unit root estimation.

It can be seen from Table 4 that the null of unit root with one endogenous structural break can be rejected for the size of the government at 1%, inflation rate at 1%, money supply at 5%, and exchange rate at 10% level of significance respectively. Thus, these series are stationary at the level form or integrated of order zero $I(0)$. In addition, the null of unit root for fiscal deficit can only be rejected by taking its first difference form, implying that the series is integrated of order one $I(1)$.

Variables	PP		ADF	
	Intercept	Intercept and trend	Intercept	Intercept and trend
Government size (Gsize)	−4.9588 (0.0002)***	−5.1018 (0.0007)***	−4.1805 (0.0021)***	−4.3038 (0.0076)***
Inflation rate (P_t)	−4.8863 (0.0002)***	−5.0663 (0.0008)***	−3.3235 (0.0197)**	−3.4555 (0.0571)*
Broad Money Growth (Ms)	−3.9350 (0.0037)***	−4.6025 (0.0030)***	−2.0528 (0.2642)	−2.8012 (0.2041)
Δ Broad Money Growth (Ms)	–	–	−11.5691 (0.0000)***	11.5329 (0.0000)***
Exchange Rate (Er_t)	0.7624 (0.9923)	−2.1550 (0.5029)	1.1810 (0.9976)	−3.0516 (0.1303)
Δ Exchange Rate (Er_t)	−5.5545 (0.0000)***	−5.7237 (0.0000)***	5.4087 (0.0000)	−5.6004 (0.0002)***
Fiscal Deficit (Fd_t)	−2.5152 (0.1183)	−2.6655 (0.2550)	−6.7172 (0.0000)***	−2.6868 (0.2465)
Δ Fiscal Deficit (Fd_t)	−7.7680 (0.0000)***	−7.7753 (0.0000)***	–	−6.8984 (0.0000)***

Table 3.
ADF and PP unit root estimation results

Note(s): ***,** and * denote statistical significance at 1%,5 and 10% levels of significance

Variables	$I[d]$	t-statistics	Break year
Government size (Gsize)	[0]	−5.158062***	2008
Inflation rate (P_t)	[0]	−6.094061***	1982
Broad Money Growth (MS)	[0]	−3.810715**	2013
Exchange Rate (Er_t)	[0]	−3.205275*	2008
Fiscal Deficit(Fd_t)	[1]	−2.665466	1993

Table 4.
Lee and Strazicich's (2004) unit root estimation with one endogenous structural break

Note(s): The critical values for Lee and Strazicich's test are −4.084,−3.487, and −3.185 at 1%, 5 and 10% levels of significance.***,** and * denote statistical significance at 1%,5 and 10% levels of significance

4.2 Linearity tests and model selection

To verify the existence of non-linearities in our model, the Taylor expansion given in equation (6) has been utilized using *Gsize* as the transition variable. The results of the threshold linearity tests proposed by Luukkonen *et al.* (1988), Teräsvirta (1994) sequential tests and Escribano and Jordá (2001) test are presented in Table 5 given below.

The null hypothesis of linearity ($H_0 : \rho_2' = \rho_3' = \rho_4' = \rho_5' = 0$) presented in Table 5 can be rejected at 1% significance level. The rejection of null of linearity based on the Luukkonen *et al.* (1988) test indicates that the non-linear specification of the STAR type model is appropriate. The results of Teräsvirta sequential tests also provide evidence against the linear model, which is rejected at the 5% level using $H_{03} : \rho_2' = \rho_3' = \rho_4' = 0$. In addition, the results of Teräsvirta sequential tests suggest the selection of the first-order logistic model. Furthermore, the results of the Escribano-Jorda test are used to select feasible functional form concerning the transition function or to choose between LSTAR and ESTAR models. By closely observing these test results, we conclude that the non-linear model is accepted at 5% level using $H_{04} : \rho_2' = \rho_3' = \rho_4' = \rho_5' = 0$. Also, the first-order logistic model with a non-zero threshold is the recommended model using $H_{OL} : \rho_3' = \rho_5' = 0$.

Null-hypothesis	*F*-Statistic	*p*-value
Luukkonen et al., test		
$H_{04}: \rho_2' = \rho_3' = \rho_4' = \rho_5' = 0$	5.809559	0.0001
$H_{03}: \rho_2' = \rho_3' = \rho_4' = 0$	5.809559	0.0001
$H_{02}: \rho_2' = \rho_3' = 0$	3.585073	0.0034
$H_{01}: \rho_2' = 0$	4.771043	0.0021
Teräsvirta sequential tests		
$H_1: \rho_2' = 0 \mid \rho_3' = \rho_4' = 0 \mid$	4.771043	0.0021
Escribano-Jorda test		
$H_{OL}: \rho_3' = \rho_5' = 0$	4.803802	0.0055
$H_{OE}: \rho_3' = \rho_5' = 0$	5.014361	0.0010

Note(s): Luukkonen *et al.*, test i.e. H_{0i} are based on i-th order Taylor expansion ($\rho_j' = 0$ for all $j > i$); for Teräsvirta sequential tests, all tests are based on the third-order Taylor expansion ($\rho_4' = 0$); for the Escribano-Jorda test, all tests are based on the fourth-order Taylor expansion

Table 5. Results of linearity tests

4.3 Empirical results of the STAR (LSTAR) model

In the next step of the estimation procedure, to unearth the non-linearities between the size of the government and the inflation rate, we applied the Logistic Smooth Transition Autoregression (LSTAR) model. The estimation results reveal that the inflation rate follows a non-linear pattern. The appropriate transition variable is the size of the government within the logistic smooth transition function. Using the size of the government as a transition variable, the Logistic STAR model with two extreme regimes shift-an unmodulated switch in the coefficients from linear to non-linear- is considered for modelling the response of inflation rate to changes/shocks in the size of the government in India. The LSTAR (logistic smooth transition autoregressive) results are presented in Table 6 below. The results presented in Table 6 demonstrate a negative association between the size of the government and the inflation rate in the first regime. The estimated coefficient is −0.96 with $p = 0.00$, implying statistical significance at 1% level. After reaching the threshold or optimum level, the impact of government size on the inflation rate becomes positive. The estimated coefficient of the size of the government in the second regime or non-linear part is 2.33 with $p = 0.08$, thus significant statistically at the 10% level. The coefficient of the government size increases significantly from −0.96 in the first regime to 2.33 in the second regime during the regime-switching transition. This finding would imply that up to the threshold level, the impact of government size on inflation decreases gradually, and thus no severe costs in terms of loss of welfare due to high inflation are inflicted. However, above the threshold level, any growth in government size is associated with an increase in inflation and thus results in a severe welfare loss due to inflation tax. The possible reason for the negative association might be mainly because in the first regime when the size of the government is small, an increase in the government size does not necessarily imply an increase in the budget deficit. Because of the small size of the government, public spending can be financed through tax revenues raised from the private sector.

Besides, Armey (1995) postulated that an economy with a small size of government would have more efficient and productive expenditures on the part of the government than economies with large-sized governments. This efficiency stemming from the size of the government can enhance aggregate supply through the provision of public goods for the private sector, resulting in a decreasing effect on the price level. One possible justification for the positive association between the size of the government and inflation is that increasing government size (expenditure) might drive up the cost of production. In turn, higher production costs would drive up inflation, so long as the monetary authority does not

Variables	Coefficient	*t*-statistic	*p*-value
Model LSTAR Regime I (Linear part)			
Constant	25.83436	5.640916	0.0000
Inflation (−1)	0.675620***	4.921502	0.0000
Inflation(−2)	−0.275338**	−2.548169	0.0160
Gsize	−0.964009***	−5.020505	0.0000
Gsize(−1)	0.313592*	1.892564	0.0678
MS	−0.589632***	−3.086951	0.0042
Regime II (Non-linear part)			
Constant	−31.75891	−1.747325	0.0905
Inflation (−1)	−1.103388**	−2.301339	0.0283
Inflation(−2)	0.355288	0.532013	0.5985
Gsize	2.339821*	1.757572	0.0887
Gsize(−1)	−0.190054	−0.376226	0.7093
MS	1.176089**	2.410755	0.0220
Regime-invariant variables (Control Variables)			
Fiscal Deficit	−0.809944*	−1.904519	0.0662
Exchange Rate	−0.140964***	−4.265694	0.0002
γ	2.785919	0.568580	0.5737
c	9.278195***	14.88429	0.0000
χ^2 *Serial (B-G LM)*	2.357[0.112]		
χ^2 *BPG*	1.570[0.173]		
χ^2 *Normal (JB)*	5.735[0.056]		

Note(s): ***,** and * represent statistical significance at 1%,5 and 10% level respectively. The figures in parentheses are probability values

Table 6.
The STAR model estimates and diagnostic checks

counteract this increase in price level with tight monetary policy. Besides, this finding is consistent with the result of Nademi and Winker (2022).

Moreover, a negative relationship exists between money supply and inflation rate in the model's first regime or linear part. The estimated coefficient of the money supply is −0.58 with $p = 0.0042$, thus statistically significant at 1% level. The estimated coefficient of the money supply growth in the second regime or non-linear part is 1.17 with $p = 0.020$, therefore significant statistically at the 5% level. This finding indicates that the coefficient of money supply also increases significantly from −0.58 to 1.17 during the transition from the phase of small government size to the phase of bigger government. This positive association is established between the money supply and inflation mainly because, in the phase of bigger government, money supply growth outpaces the economy's capacity to produce goods and services, which in turn would raise the price level in the economy. This finding is in line with the monetary theory of inflation.

Furthermore, the estimations based on the LSTAR model reveal that the slope coefficient of the transition function γ equals 2.78, implying that the transition from one extreme regime to another is smooth. In other words, the low slope parameter value would mean that the size of the government gradually affects inflation in the Indian context. The results also reveal that with the size of the government as a transition variable, its shape exhibits an asymmetric S-shaped pattern with the threshold value of 9.27% ($c = 9.27$) with $p = 0.00$, which is statistically significant at 1% level. Thus, if the growth of size of the government is restricted below this threshold value, it would negatively impact inflation. Letting the size of the government go beyond the threshold value will positively affect inflation and hence the loss of welfare. The estimated transition function related to the transition variable *Gsize* is presented in Figure 2 for better understanding. The figure indicates a smooth transition from one economic regime to another.

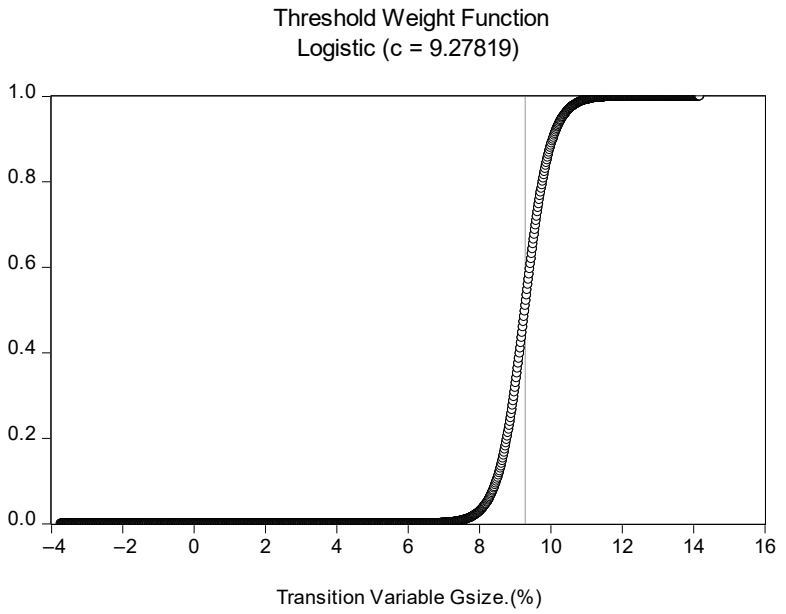

Figure 2.
Estimated transition function

The exchange rate and fiscal deficit are the regime invariant control variables. They have been plugged into the model to dodge the error due to omitting other relevant variables that might otherwise produce spurious results. The findings of our estimation suggest a negative association between the fiscal deficit and inflation which refutes the fiscal theory of price level on empirical grounds in the Indian scenario. The coefficient for fiscal deficit equals −0.80 with $p = 0.062$ implying statistical significance at the 10% level. One possible justification for this finding might be that we are assuming a one-to-one type that is a linear relationship between fiscal deficit and inflation while ignoring the possibility of a non-linear relationship that might actually exist between the two. It would mean that only large and persistent budget deficits are inflationary in nature. There might exist a threshold level for budget deficit beyond which it might positively affect inflation. Also, due to the deficit, which is not significant in size, there would be a spur in economic activity due to the provision of public goods. The provision of public goods might result in promoting aggregate supply to match the increasing aggregate demand, leaving prices unaffected or might have, in fact, a dwindling impact on the price level in the economy. Besides, this finding conforms to the result of Abu and Karim (2015).

On similar lines, they have found a negative relationship between fiscal deficit and inflation due to the non-linear relationship between inflation and fiscal deficit in 15 African countries. The estimation results also reveal that the exchange rate and inflation are also associated negatively with each other. The estimated coefficient for the exchange rate is −0.14 with $p = 0.0002$ implying that the relationship is statistically significant at 1% level. As in Mohant and Klau's (2005) paper, a higher rate represents appreciation and thus the negative sign of the coefficients associated with the exchange rate. In a similar vein, the negative coefficient of the exchange rate in the present paper would mean appreciation of the domestic currency, which affects the domestic price levels directly or indirectly depending upon the pass-through. Appreciation of currency would result in declining domestic production costs as imported inputs become cheaper. Moreover, due to the direct influence of

appreciation on prices of finished imported goods and import substitutes, a spiral of declining domestic prices will be witnessed in the economy (Dornbusch, 1976).

In addition, various diagnostic tests were used to verify the adequacy of the proposed model in this paper. These tests include normality, heteroskedasticity and serial correlation tests. The results of these diagnostic tests are also reported in Table 5. The BG-LM serial correlation test result suggests that no serial correlation exists in our model's residue. The BPG test findings confirm that our model does not suffer from the problem of heteroscedasticity, that is, no unevenness of variance in our model. Also, from the results of the J-B test, we confirm the normality requirements of the model.

5. Conclusion and policy implications

This paper endeavoured to revisit the government size-inflation nexus from a non-linear perspective in India using time-series data for the period from 1971 to 2019. For estimation purposes, this study utilizes an LSTAR model, which precisely estimates the threshold level of government size. Estimation results suggest that logistic STAR model is appropriate and depicts an asymmetric S-shaped pattern.

The stationary properties of the variables involved suggest that all variables are integrated of order zero *I(0),* except the fiscal deficit, which was stationary at its first difference *I(1).*

The non-linear STAR estimation indicates that the size of the government exerts a negative influence on the inflation in the Indian economy until the government size reaches the optimal or threshold level. The growth of size of the government beyond this threshold level starts affecting inflation positively. The estimated threshold level for government size growth is 9.275% which is statistically significant at 1% level. The slope parameter of the transition function suggests a smooth transition from one regime to another. Also, the liquidity growth during the phase of small government size is negatively related to inflation. In the phase of large-sized government, the relationship between liquidity growth and inflation becomes positive. This finding indicates that liquidity growth in the regime of small government would be beneficial to spur economic activity rather than being inflationary and vice-versa. Based on the estimation results, we conclude that when the size of government is small, that is, below the threshold level, increasing public spending or growth of size of the government would not necessarily result in rising inflation. Once the size of the government has reached or crossed the threshold level, further increments in the size of the government would be inflationary and thus result in a loss of welfare. Therefore, all things considered, we conclude that not all increases in government size are inflationary in nature, and bigger, not smaller, governments tend to inflate the economy more for prospective returns. These findings from our estimation have implications for the fiscal policy conduct in India. With the aim to contain inflation and prevent it from inflicting severe welfare costs, the fiscal authority should act accordingly to keep the size of government or public spending growth below the threshold level. Put differently, policymakers can set approximately 9.275% as the target value for the growth of size of the government. It signifies that up to this threshold level, the increasing public spending should be financed through taxes and other revenues and by not resorting to the country's central bank. Besides helping the monetary authority in containing the inflation within the permissible limits as targeted, it might also aid in mitigating the costs of welfare loss due to high inflation.

Moreover, sticking to this target or threshold value of government size (spending) growth, fiscal policy as a macroeconomic tool can be used more effectively to enhance economic growth and contain inflation simultaneously. In the first regime of small government, the government's dependence on the central bank in India to cover its increasing expenditures is low and, therefore an anti-inflationary impact. In the second regime of big government size, the appropriate policy decision to curb inflation is the discipline in the conduct of monetary and fiscal policies.

Note

1. List of empirical studies reviewed is given in Appendix.

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Appendix

Author	Sample data/ Countries	Time frame	Method used	Govt. Expenditure	Impact
Campillo and Miron (1997)	Panel data set of 62 countries	1973 to 1994	OLS	Debt to GDP as Proxy	Positive Impact
Han and Mulligan (2008)	Panel data of 80 countries	1973 to 1990	OLS and IV	Both aggregated and disaggregated	Weak positive peacetime correlation between government size and inflation and a negative cross-country correlation of inflation with defence spending
Ezirim *et al.* (2008)	Time series data for the USA	1970 to 2002	Cointegration and Causality analysis	Growth of public expenditure	Positive association
Muhammad *et al.* (2009)	Time-series data for Pakistan	1977 to 2007	Johansen Cointegration	Aggregated	Negative
Magazzino (2011)	Time series data set for 7 Mediterranean countries	1970 to 2009	Cointegration and Causality analysis	Aggregated	Long-run relationship and bi-directional causality in most countries
Attari and Javed (2013)	Time series data for Pakistan	1980 to 2010	ARDL Model	Aggregated and Disaggregated	Long run association
Mehrara *et al.* (2016)	Quarterly time series data for Iran	1990 to 2013	STR	Growth of Government Expenditure	Negative
Wang and Wen (2019)	Time-series and panel data for China	1978 to 2011	VAR and Panel regression	Aggregated	Positive impact on Inflation
Pandey and Shettigar (2018)	Monthly time-series data for the Indian economy	1997 to 2016	VECM and ARDL	Aggregated	Positive
Nguyen (2019)	Time series data for India, Indonesia and Vietnam	1970 to 2010	VECM and Cointegration analysis	Aggregated	Different short-run impacts for different economies
Oyerinde (2019)	Time series data for Nigeria	1980 to 2017	ECM and Causality	Aggregated	Positive and Bi-directional
Afonso *et al.* (2020)	Panel data set for eight large emerging market economies	1980 to 2015	Basic panel data techniques	Different Proxies	Positive long-run relationship

Table A1. List of reviewed empirical studies on government size and inflation nexus