



Inflation persistence in Turkey: A TVP-estimation approach

Berk Bilici^a, Semih Emre Çekin^{b,*}

^a Development Investment Bank of Turkey, Turkey

^b Department of Economics, Turkish-German University, Istanbul, Turkey

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ABSTRACT

We analyze inflation dynamics in Turkey by estimating inflation persistence for the period 1990–2018. Inflation persistence is defined as the speed with which inflation returns to its equilibrium level (long-term mean) after a shock and we apply a time-varying parameter estimation method based on the Kalman filter. We find that inflation persistence increases and exhibits high volatility in periods of high inflation in which inflation expectations and pricing behaviors are negatively affected. We further find that with institutional changes in the conduct of monetary policy, inflation started to decline after 2003 and inflation became less persistent. Monetary policy appears to be effective at maintaining price stability until 2016. Empirical results show that there is a significant rise in inflation persistence starting in 2016 accompanied by an upward trend in inflation.

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1. Introduction

Inflation dynamics in Turkey have been analyzed for several decades, offering an interesting case study. It is well known that the monetary policy regime underwent several important changes during this period, most notably in 2001, after which the central bank was given legal independence and adopted implicit inflation targeting. While inflation rates decreased considerably after this change, there has been a new surge after 2018, with rates surpassing 20%. Amid these developments, a crucial question pertains to inflation persistence.

This concept, which we define as the speed with which inflation converges to the equilibrium after a shock, as in Willis (2002) has been analyzed extensively in the monetary economics literature. Earlier authors such as Taylor (1980) and Fuhrer and Moore (1995) presented the problem in the context of wage contract models whereas more recent contributions such as Davig and Doh (2014) used more structural models in which parameters are subject to changes over time. Utilizing both classical and Bayesian methods within a univariate autoregressive model and defining inflation persistence as the relation of inflation with its past values, Levin and Piger (2004) study inflation dynamics in 12 industrialized countries. In their work, they attribute the structural breaks that many of the sample countries' data exhibit to changes in the long-term

mean of inflation, i.e. adjustments to the inflation targets of corresponding central banks. Amid the structural breaks, their estimates exhibit low levels of inflation persistence, implying that high levels of inflation persistence are not inherent to inflation dynamics in industrialized economies. In yet another analysis, Pivetta and Reis (2007) implement non-linear Bayesian methods to estimate persistence in GDP deflator inflation in the US for 1965–2001, where three different definitions of inflation persistence are used. Their findings indicate that inflation persistence remains high and unchanged for the estimation period while Stock and Watson (2007) find that there has been some decrease in inflation persistence.

Finally, in his analysis of inflation persistence in the US, Marques (2005) uses the definition of inflation persistence as in Willis (2002) and indicates that there is an inverse relation between inflation persistence and the speed, with which inflation returns to its equilibrium level.

Inflation persistence in Turkey has also received attention in the literature. Earlier analyses on inflation persistence in Turkey include Alper and Üçer (1998) who estimate a lagged inflation coefficient recursively in a VAR setup and find that persistence has been high during the 1980 decade and most of the 1990 decade, and Erlat (2002) who uses an autoregressive fractionally integrated moving average (ARFIMA) model and finds that inflation in Turkey is mostly stationary but exhibits long memory. More recent analyses such as Çiçek and Akar (2013) use quantile autoregression method and find that inflation persistence has relatively decreased after inflation targeting was adopted by the Central Bank.

* Corresponding author.

E-mail address: emre.cek@gmail.com (S.E. Çekin).

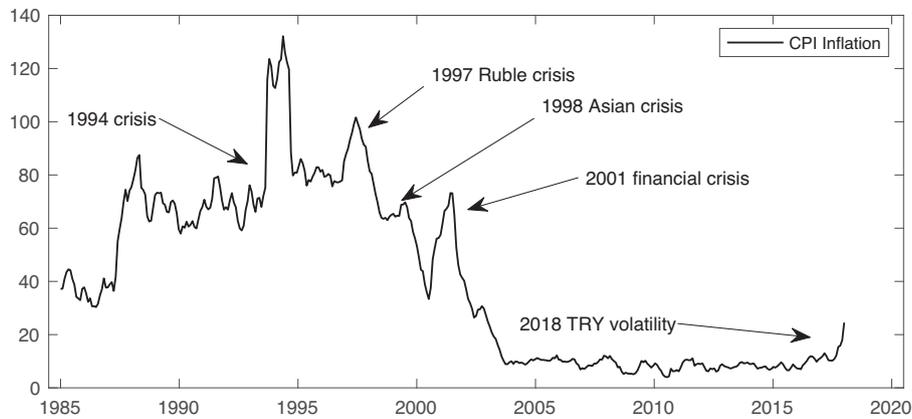


Fig. 1. 1983M1–2018M9 CPI inflation in Turkey (YoY-change, monthly data).

However, one shortcoming of these papers is that inflation persistence is not modeled in a time-varying setup and its dynamics over time cannot be discerned. To this end, we provide an empirical assessment of inflation persistence in Turkey for the period after 1985 by adopting a time-varying estimation method based on a state-space representation. Our approach is different from these models as we model inflation persistence directly as in Willis (2002) and investigate the topic in a time-varying context. The case of Turkey is particularly interesting in the context of inflation dynamics since it is a country that went through several periods of high inflation until the first part of the 2000 decade but did not experience a hyperinflation like many other emerging economies. While inflation rates decreased significantly after this period, inflation rates spiked once more after 2018, surpassing rates in most other emerging economies. These developments also increased the effect of dollarization in the decision-making stage of economic actors. Our findings indicate that inflation persistence is very high as indicated by other authors such as Çiçek and Akar (2013). But we also find that after institutional changes were implemented in 2001 both the level and variability of persistence significantly decreased and remained relatively low until 2016. One implication of these results is that Turkey's recent experience with high inflation deteriorated inflation dynamics significantly and may pose difficulties for the monetary authority to implement efficient policies.

The structure of the paper is as follows. In the next section, we give a brief account of inflation dynamics in Turkey, starting from the aftermath of the oil crisis in 1979–1980 and local political crisis in early 1980s. In Section 3, we give a detailed definition for inflation persistence and the analytical framework including the model for measuring the persistence. Section 4 presents the empirical strategy and the estimation methods and we give the results of our empirical analysis for inflation persistence in Turkey. Concluding remarks are presented in Section 5.

2. Inflation dynamics in Turkey after 1980

The concept of headline inflation is often used while assessing inflation and price changes in Turkey. The headline inflation best reflects the increases in the comprehensive price index which represents the general level of prices. In Turkey, headline inflation refers to actual changes in the Consumer Price Index (CPI) and CPI is an index created to measure the prices and changes in the sales phase of goods and services.

In Fig. 1, the year-on-year percentage change of monthly CPI is given for the period January 1983–September 2018 in Turkey. In this period, CPI inflation has several stages where it follows different characteristics.

The 1980s and 1990s are known as periods of high inflation. In the first half of the 1980 decade, liberal economic measures were pursued as part of the stabilization program that was adopted in 1980. As an extension of this program that was helpful in bringing inflation rates to lower levels, various reforms were implemented in the second half of the decade. These included the establishment of foreign exchange and overnight interbank money markets, the implementation of open market operations by the central bank and measures to liberalize bank borrowing and lending rates. However, given fragile fiscal fundamentals, use of monetization to cover public debts and a general lack of fiscal discipline, inflation rates remained at around 50% in the second half of the decade.

The 1990 decade was similarly plagued by fiscal and political fragility and resulting high inflation rates. Especially amid the economic crisis in 1994, the Turkish Lira has devalued against the US dollar which has led to sudden increases in inflation. Nevertheless, starting from 1995, the inflation rates decreased somewhat and declined to two digits from three digits. However, this disinflationary period lasted until the 1997 Asian financial crisis, which caused excessive depreciation in currencies of emerging economies and has led to sharp rises in headline inflation in Turkey until the end of 1997. This worsening in the course of headline inflation stops at the beginning of 1998 and there is a significant decrease in inflation until 2001. However, it can be seen that with the impact of the economic crisis in 2001 the inflation rate soared again. For a more detailed account of Turkish inflation dynamics for this period, we refer Rittenberg, Selçuk, and Kibritçiöğlü (2002) to the reader.

Following the crisis in 2001, institutional changes were implemented to monetary policy, most importantly the Law of the Central Bank of the Republic of Turkey (CBRT) in 2001. The law gave the CBRT its formal independence and further prevented state-owned enterprises from borrowing directly. And most importantly, the CBRT has implemented implicit inflation targeting and price stability became the primary objective. Following these major changes in monetary policy, inflation rates fell to single digits in 2004. Tight monetary policy implemented by the CBRT after 2001 to decrease inflation has been supported by strict and fundamental regulations in the banking sector and by a tight fiscal policy that was implemented consistently to reduce public deficit.

With implementation of the required reserve system by the CBRT as an alternative monetary policy instrument in 2005, and explicit inflation targeting since 2006, inflation has remained relatively close to single-digit levels. With the explicit inflation targeting regime, the CBRT set its inflation targets as the 12-month year-end inflation rate of CPI and inflation targets are set as point targets with the government.

After the global financial crisis in 2008, extreme expansionary monetary policies, led by the Federal Reserve (Fed), have provided abundant liquidity which has caused excessive volatility in financial markets and capital flows. In this period, capital flows to emerging markets have increased significantly due to the slow-down of the economic activity in developed countries. From the end of 2010, unconventional monetary policy tools such as reserve option mechanism and interest rate corridor have been implemented by the CBRT to limit volatility in foreign exchange rates, prevent overheating in credit markets and maintain price – and financial stability.¹

In May 2018, the CBRT announced that it will return to a conventional policy regime in which the inflation targeting regime will mainly operate through open market operations and the interest rate channel.² Inflation targets for 2018 and 2019 are set as $5 \pm 2\%$ rates for the 12-month year-end inflation of CPI.

3. Inflation persistence and its measurement

In the literature several different definitions are used for inflation persistence. [Batini and Nelson \(2001\)](#) give three different definitions: (1) positive serial correlation in inflation (2) lags between systematic monetary policy actions and their (peak) effect on inflation (3) lagged responses of inflation to non-systematic policy actions (i.e. policy shocks). In the first definition, inflation persistence is expressed as the interaction of inflation with its past values and thus, it is basically defined as inflation inertia. According to this definition, inflation persistence can be shown with the coefficients estimated by an AR(p) model. The other given definitions are related to the speed of the response of inflation to systemic and non-systemic shocks. According to these two definitions inflation persistence is high (low) if the speed of response is low (high).

[Willis \(2002\)](#) used a similar definition where inflation persistence is expressed as the speed of convergence of inflation to its long-term trend. [Marques \(2005\)](#) interprets this definition in a different way and expresses inflation persistence as the speed of convergence of inflation to its equilibrium level (mean inflation) after a shock. Given these two definitions, it is crucial to determine clearly and correctly the equilibrium level of inflation for measuring inflation persistence. In other words, as stated by [Marques \(2005\)](#), the speed at which inflation converges to its equilibrium level (long-term mean) after a shock depends on the equilibrium level of inflation before the impact of the shock.

In the majority of empirical studies using univariate time series analysis, it is assumed that mean inflation is constant when inflation persistence is measured. As in the analysis of [Marques \(2005\)](#), keeping the equilibrium level constant can lead to overestimation of inflation persistence. For this reason, it is a more accurate assumption that the equilibrium level of inflation varies over time.

The other most commonly used method is the half-life method. However while the sum of autoregressive coefficients allows the mean reversion coefficient to be used for a measure of inflation persistence, the half-life method, as indicated by [Pivetta and Reis \(2007\)](#), does not provide a good measure for inflation persistence if the impulse response function of the process fluctuates significantly over time and for cases of high persistence in a process the half-life is close to infinity, which makes it difficult to distinguish changes in persistence over time.

¹ See [Aysan, Fendoğlu, and Kılınc \(2014\)](#) for an overview of the implementation of unconventional monetary policies.

² Press Release on the Operational Framework of the Monetary Policy, CBRT, 28 May 2018.

These two issues make the half-life method inadequate for our analysis where we estimate inflation persistence in Turkey over time while it exhibits high volatility.

In addition to above mentioned difficulties associated with the half-life method, the suitability of the cumulative impulse response function (CIRF) for good scalar measure of persistence and the monotonic relation between CIRF and the sum of autoregressive coefficients (ρ) makes ρ a more proper measure of inflation persistence.

In our study, inflation persistence is defined as the speed of convergence of inflation to the equilibrium level after a shock, and it is assumed that inflation persistence is given by the sum of autocorrelation coefficients.

4. Estimation method of inflation persistence for the Turkish economy

4.1. Empirical model

Time-invariant models assume constant values for parameters of interest throughout the estimation period and do not allow to see the effects of policy changes that occurred during the estimation period.

Time-varying parameter estimation models however allow to take into consideration the critique by [Lucas \(1976\)](#) which indicates that behaviors and expectations of economic agents will change if there is a change in policy regime and the assumption of fixed historical relations between economic variables are not reliable in cases of significant policy changes. In the time-varying parameter estimation method, time and frequency of structural changes are determined by the data and individual effects of structural changes on coefficient estimates can be observed. From the perspective of inflation persistence, it can be seen how the level of inflation persistence responds to changes in the monetary policy regime or important policy changes.

The starting point for our model of inflation persistence is given as:

$$(\pi_t - \mu_t) = MD_t = \sum_{j=1}^p \beta_j MD_{t-j} + \epsilon_t \quad (1)$$

where MD_t is the deviation of inflation π_t from its mean μ_t . In previous work such as [Bleaney \(2000\)](#), [Levin and Piger \(2004\)](#) or [O'Reilly and Whelan \(2005\)](#) that deal with inflation persistence, mean inflation enters the deviation term as a constant parameter μ , such that $MD_t = \pi_t - \mu$. This assumption may be more reasonable for advanced economies with relatively low and stable inflation rates, but for economies with high inflation such as Turkey, a variable mean inflation μ_t may be more reasonable, such that $MD_t = \pi_t - \mu_t$. For the purpose of obtaining a variable mean inflation measure, we used a centered rolling window method with a 61-term window. It is also worth mentioning that the inflation target is not an appropriate measure of long-term inflation mean in Turkey because it remained constant for much of the period of our analysis while inflation rates soared and because Turkey's central bank started implementing explicit inflation targeting only since 2006.

Utilizing these definitions, we get:

$$MD_t = \sum_{j=1}^{p-1} \delta_j \Delta MD_{t-j} + \rho MD_{t-1} + \epsilon_t \quad (2)$$

Here, ρ is the coefficient for inflation persistence (sum of autocorrelation coefficients), and ϵ_t represents the stochastic shocks that affect mean deviations of inflation. It is assumed that ϵ_t is nor-

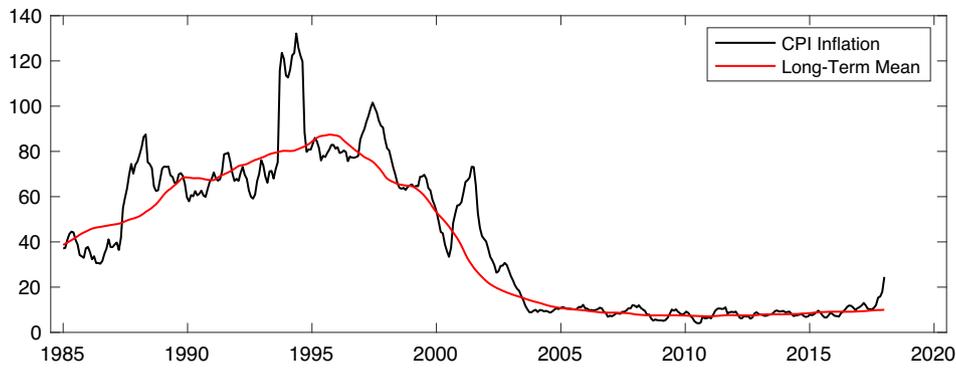


Fig. 2. 1985M7–2018M9 CPI inflation and its equilibrium level (long-term mean) (YoY-change, monthly data).

mally distributed with zero mean and a constant variance, and there is no serial correlation between its values at different points in time.

The optimal lag in the AR(p) model is two as specified by using Hannan–Quinn information criteria (HQIC), and the AR(2) model is given as:

$$MD_t = \delta_{1,t} \Delta MD_{t-1} + \rho_{1,t} MD_{t-1} + \epsilon_t \quad (3)$$

and the state-space model of Eq. (3) used in the estimation is given as:

$$MD_t = \begin{pmatrix} \Delta MD_{t-1} & MD_{t-1} \end{pmatrix} \begin{pmatrix} \delta_{1,t} \\ \rho_{1,t} \end{pmatrix} + \epsilon_t, \quad \epsilon_t \sim N(0, \sigma_\epsilon^2) \quad (4)$$

$$\begin{pmatrix} \delta_{1,t} \\ \rho_{1,t} \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \begin{pmatrix} \delta_{1,t-1} \\ \rho_{1,t-1} \end{pmatrix} + \begin{pmatrix} \vartheta_t \\ \omega_t \end{pmatrix}, \quad \begin{pmatrix} \vartheta_t \sim N(0, \sigma_\vartheta^2) \\ \omega_t \sim N(0, \sigma_\omega^2) \end{pmatrix} \quad (5)$$

In the model, Eqs. (4) and (5) are measurement and state equations, respectively and coefficients $\delta_{1,t}$ and $\rho_{1,t}$ represent time-varying coefficients our estimation model. The state equation shows how the time-varying parameters evolve over time and it is assumed that the parameters follow a random-walk process with normally distributed errors. The time-varying nature of the coefficients are determined by values of σ_ϵ^2 , σ_ϑ^2 , σ_ω^2 . If these variance parameters are zero, then estimated coefficients will remain constant over time. However these parameters are unknown and they are estimated via the maximum likelihood estimation method.

4.2. Data sets

We use monthly CPI inflation for the empirical analysis as compiled by the Turkish Statistical Institute. Due to data availability, we examine the period 1990–2018.³

In Fig. 2, CPI inflation and its equilibrium level are given. In calculation of the equilibrium level of CPI inflation with the centered rolling window method, a 61-term window for 5-year average is used so that our estimate starts in 1990. Then, mean deviations for inflation are calculated by subtracting the equilibrium level from the original inflation series which are shown in Fig. 3. As seen in both these figures, the equilibrium level and mean deviations of the CPI inflation have changed over time, drastically since 2002, with

³ While the inflation series originally starts in 1983, we use the centered rolling window method with a 61-term window for the calculation of the mean inflation series. As a robustness check we also implemented our estimation using different window lengths but these did not lead to significant qualitative differences.

Table 1

ML estimation results of parameters of variances.

	Point estimates
σ_ϑ	1.6879
σ_ω	0.1634
σ_ϵ	0.8163

structural changes taking place in monetary policy implementations.

4.3. Estimation results

The maximum likelihood estimates of parameters of variances in the model are reported in Table 1. With these estimated parameter values, unobserved coefficients $\rho_{1,t}$ and $\delta_{1,t}$ are computed by using the Kalman Filter. The estimated values of the coefficient $\rho_{1,t}$ for 1990–2018, which represents inflation persistence, are given in Fig. 4.⁴

As is visible from the figure, $\rho_{1,t}$ exhibits great variability and exhibits values greater than one for some periods. As explained in Cecchetti and Debelle (2006), $\rho_{1,t} \geq 1$ is typically found for periods when inflation is on a sharp upward trend and pricing behavior is severely distorted.⁵

Both the level and volatility of inflation persistence seem to be very high from 1990 to 2003, especially when compared to the results in industrialized economies as in Levin and Piger (2004) or Cecchetti and Debelle (2006). This is not surprising as the period was marked by some of the most volatile developments in the Turkish economy that included high inflation and interest rates and frequent financial crises. The behavior of inflation persistence in the earlier part of our observation period is mostly likely related to the fact that after the oil price crisis in 1979, government authorities attempted to abandon the fixed exchange regime amid the current account liberalization, and this has led to devaluations in Turkish lira against other major currencies and thus, to sharp increases in inflation and deterioration in pricing behavior after 1980.⁶

The economic crisis of 1994 in Turkey stems from macroeconomic imbalances based on the twin deficit, where Turkey had both high current account deficit and fiscal deficit, and the lack of taking macroprudential measures, that are specified with requirements of the international capital market. At the end of 1993, the political

⁴ To ensure that our assumption that residuals don't exhibit serial correlation holds, we examined the autocorrelation function (ACF) and applied the Ljung-Box Q-test. Both tests imply that there is no residual autocorrelation. These results are available upon request.

⁵ A technical explanation of this issue is available upon request.

⁶ We refer the reader to Ertuğrul and Selçuk (2001) for a description of events in the Turkish economy during the 1980 decade.

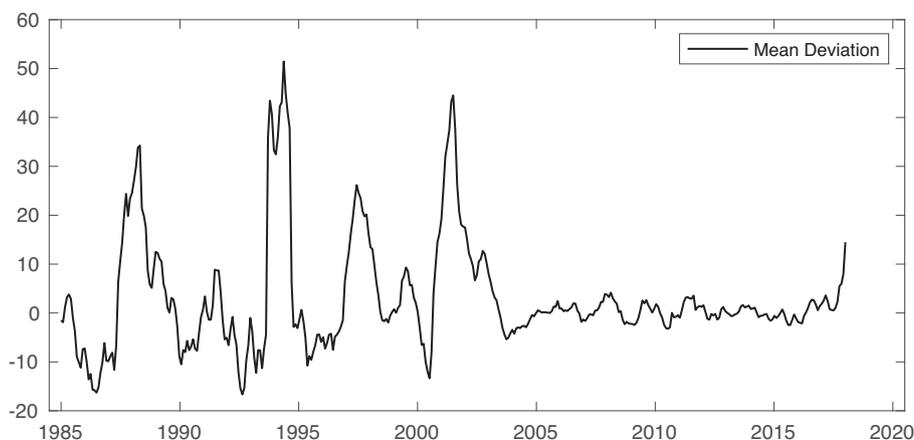


Fig. 3. Mean deviations of CPI inflation (YoY-change, monthly data).

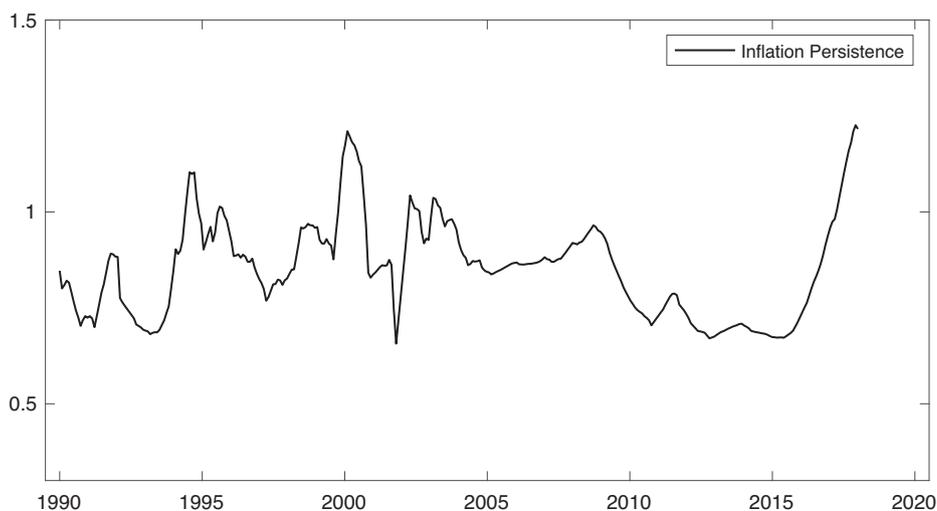


Fig. 4. Inflation persistence ($\rho_{1,t}$) estimated with TVP model.

authority injected TL liquidity to the money market for reducing high interest rates on government bonds; but high liquidity of TL has increased demand of foreign currency, especially US dollar, further. Therefore, the political authority began to sell foreign currency to meet and limit the demand for foreign currency. However, this has made the financial market expects further weakening in TL and the confidence in TL has decreased considerably. As these measures were not effective, in April 1994 a 50% devaluation was realized in TL and the effects of this depreciation in TL have led to considerable increases in inflation and significant deterioration in pricing behavior which can be seen as excessive volatility and levels in inflation persistence (see Özatay, 2000 for an anatomy of the 1994 crisis).

From May 2003 on, a modest decline in inflation persistence begins and with the announcement by the CBRT in 2005 that the transition to explicit inflation targeting will be realized in 2006 this downward trend in inflation persistence continues until June 2013, while there is a significant increase in inflation persistence amid the recession in 2008. In the same period, headline inflation in Turkey also fell from two double-digit figures to single-digit values. A fall in inflation persistence while maintaining price stability is one indication of an effective monetary policy implementation.

Following the announcement by the Federal Reserve in May 2013 about lowering the amount of asset purchases and ending the quantitative easing policy in the upcoming years, the majority of emerging market currencies depreciated against the US dollar and the depreciation of TL against US dollar was sharp. In the

same period, the sharp increases in USD/TL parity and the excessive volatility in the exchange rate negatively affected inflation dynamics and pricing behaviors.

Furthermore, there is a more substantial increase in inflation persistence after the end of 2015. This also points out to the worsening of inflation dynamics and pricing behavior after the second half of 2017 where CPI inflation has reached two-digit levels again. In the first eight months of 2018 sharp and excessive depreciation of the TL against US dollar and high volatility in exchange rates lead to uncertainty in the financial market and in the real economy, which magnified the deterioration in pricing behavior because of the high pass-through effect of exchange rates on prices in Turkey. In this period, inflation persistence reached the same levels as in the crisis periods of 1998 and 2001.

4.3.1. Robustness

Given the TVP estimation based on the Kalman filter of the AR(2) model the results might suffer from small sample bias as indicated by Andrews and Chen (1994). For testing small sample bias in autoregressive coefficient estimates in our model, we used both median-unbiased estimation method proposed by Andrews and Chen (1994) and OLS estimation in our AR(2) model. Results of both methods of the AR(2) model in our study show that there are no significant differences between coefficient estimates of the two different estimation methods.

Table 2
OLS vs. median unbiased estimation.

	OLS coefficient estimates	Median-unbiased estimates
ρ	0.9316	0.9336
δ	0.3886	0.3876

These results indicate that the state-space estimates in our model based on maximum likelihood estimation do not suffer from small sample bias.

5. Conclusion

In has been established in the inflation literature that inflation persistence can render the conduct of monetary policy inefficient in advanced as well as in emerging economies. In this work, we analyzed the dynamics of inflation persistence in Turkey in a time-varying setup and showed that it is relatively high in comparison to industrial countries. At the same time, we find that persistence underwent significant changes corresponding to the changes in the monetary policy framework.

Specifically, we find that inflation persistence exhibits sharp increases and high volatility from 1990 to 2004 where high inflation, with an average of 69%, was experienced in the Turkish economy, and in the second half of 2015. In this period, the inflation rate reached again two-digit levels and started exhibiting an upward trend. These developments in inflation persistence reflect the negative effects of high inflation periods on the dynamics of inflation and pricing behaviors, and the increase in inflation persistence continues so long as inflation remains on two-digit levels.

Our results also serve as a warning that while necessary institutional changes can lead to better inflation dynamics and can lower inflation persistence, the gains can disappear within a short period of time, as is evident in the recent experience of Turkey.

Conflict of interest

None declared.

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