TÜRKİYE CUMHURİYET MERKEZ BANKASI

RESEARCH NOTES IN ECONOMICS

Inflation Dynamics in Turkey: A Historical Accounting

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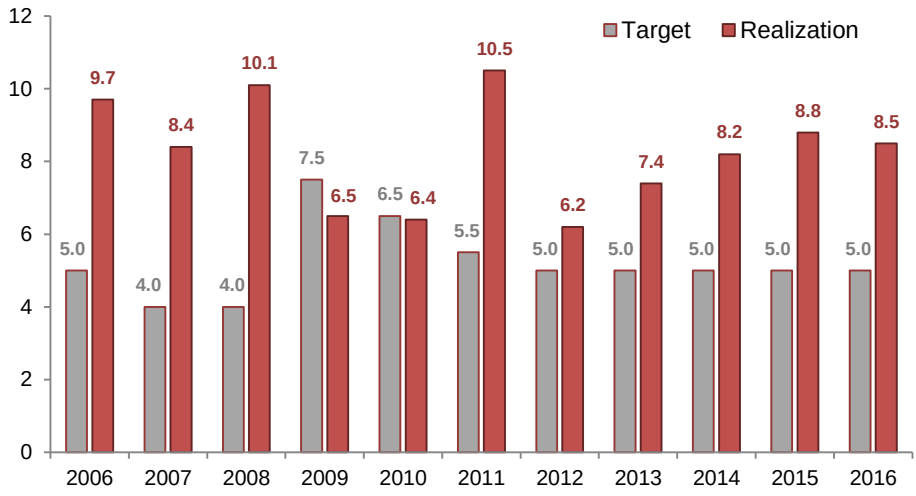
Özet: Bu çalışmada Türkiye'de uygulanmakta olan enflasyon hedeflemesi rejiminin 2006-2016 yıllarını kapsayan dönemi için enflasyonun temel makro belirleyicileri incelenmektedir. Parametreleri zamana göre değişen bir Phillips eğrisi tahmin edilerek elde edilen bulgular, ithalat fiyat geçişkenliğinin son yıllarda azaldığına, döviz kuru geçişkenliğinin ise göreli olarak daha istikrarlı seyrettiğine işaret etmektedir. Bu yaklaşım kullanılarak, döviz kuru, ithalat fiyatları, çıktı açığı ve reel birim ücret gibi makro değişkenlerin enflasyona katkısı hesaplanmaktadır. Çalışmada aynı zamanda enflasyon hedeflemesinin iki farklı alt dönemi ele alınarak değişen enflasyon dinamikleri irdelenmekte ve politika çıkarımları yapılmaktadır. Bulgularımız, fiyat istikrarına ulaşmak için konjonktürel ve yapısal politikaların bir arada ele alındığı bütüncül bir yaklaşımın önemine işaret etmektedir.

Abstract: This study investigates the key drivers of consumer inflation in Turkey during the inflation targeting period covering 2006-2016. We estimate a reduced-form time-varying parameter (TVP) Phillips curve for core inflation, defined as CPI excluding unprocessed food, alcoholic beverages and tobacco. TVP estimates suggest that there is a clear decline in import price pass-through in recent years whereas pass-through from exchange rates to domestic inflation is relatively stable. Using this setup, we compute the contribution of macro variables such as exchange rate, import prices, output gap and real unit wages to inflation. We document the changes in inflation dynamics over the past decade, particularly focusing on the two distinct episodes of inflation targeting in terms of monetary policy implementation and discuss implications for price stability. Overall, our results suggest that achieving price stability requires a holistic approach embedding both cyclical and structural policies.

1. Introduction

During the inflation targeting period from 2006 to 2016, annual consumer inflation in Turkey remained high with an average rate of 8.2 percent, significantly exceeding the targets (Chart 1). The first five years of inflation targeting period can be characterized as conventional inflation targeting, while the period after 2011 was marked by a more flexible regime integrating financial stability objective into the inflation targeting framework (Kara, 2013). Despite different policy approaches adopted in two subsamples, average inflation did not show any significant discrepancy, with inflation reverting to a mean of around 8.2 percent. The persistent nature of the inflation process has called for a deeper analysis throughout the targeting period.

Chart 1. Consumer Inflation and Targets
(Year-end, Percent)



Source: TURKSTAT, CBRT.

This study aims to contribute to a better understanding of the inflation process since the adoption of the formal inflation targeting in Turkey. To this end, we investigate the key drivers of consumer inflation over the last decade from a quantitative historical accounting perspective and document the changes in inflation dynamics in a reduced-form time-varying parameter Phillips curve framework. Using this background, we provide some insight into the policy options for achieving price stability.

2. Methodology: Time-varying Parameters

In this section we present the motivation for our methodological choice. The model used in decomposing the drivers of inflation is based on a two-equation model in the spirit of Yellen (2015). The first equation is an identity linking the CPI inflation into four categories as unprocessed food, alcohol-tobacco, taxes and other prices i.e. CPIX (CPI excluding unprocessed food, alcohol-tobacco and taxes) by taking into account the weights of these items in total consumption basket. In the second equation, we use a quarterly reduced-form Phillips curve to model CPIX inflation. To explain the CPIX inflation, we use cyclical variables such as output gap and real unit wages, as well as exchange rates and import prices to capture the small open economy characteristic of Turkey:

$$\pi_t = c + \alpha\pi_{t-1} + \delta(\sum_{i=0}^{1} gap_{t-i})/2 + \sum_{i=0}^{2} \gamma_i \Delta e_{t-i} + \varphi\pi_t^m + \theta(\sum_{i=3}^{4} \Delta ruw_{t-i})/2 + \varepsilon_t \qquad (1)$$

Here π_t is quarterly CPIX inflation; gap_t is output gap; e_t is USD/TL exchange rate; π_t^m is USD-denominated import price inflation; ruw_t is real unit wages and finally ε_t refers to error term. Lag structure is determined by using a general-to-specific model selection approach based on SIC. We include both output gap and real unit wages in the same equation since each may have different information content for real marginal costs.[1]

In this context, Table 1 displays the estimation results of this baseline model with constant parameters for the whole sample in column (1), which explains significant portion of the variation in inflation. In columns (2)-(4) we estimate the same model under shorter sample periods. The results imply that some parameters of the model may have changed over time. For example, there seems to be a decline in the coefficient of lagged inflation in recent years whereas the constant term appears to be increasing over time. Existence of time variation can also be supported by the estimation results in column (5), which interacts the import prices with a dummy variable taking the value of one after the period 2011 and zero beforehand.[2] Estimation results in column (5) suggest that there is a significant decline in import price pass-through in recent years.

[1] There is a component of wages which is determined by the public behavior (minimum wages) regardless of the output gap dynamics. Aldan and Gürcihan-Yüncüler (2016) empirically show that workers who earn around the minimum wage have acyclical wages. Binding minimum wage suppresses wage cyclicality in Turkey. These observations suggest that output gap and real unit wages might have different information content for short-term inflation dynamics.

[2] Such treatment specific to import price variable is based on our prior assessment driven by judgmental observations on the response of domestic energy prices to international commodity price developments.

Table 1. Constant Parameter Estimates of the Baseline Model for Different Sample Periods
(Dependent variable: CPIX Inflation[(a),(b)])

Sample:	(1) 06:Q2-16:Q4	(2) 06:Q2-14:Q4	(3) 06:Q2-12:Q4	(4) 06:Q2-10:Q4	(5) 06:Q2-16:Q4
c	**0.90*** **	**0.86*** **	**0.85*** **	**0.81*** **	0.88***
π_{t-1}	**0.28*** **	**0.30*** **	**0.34*** **	**0.34*** **	0.27***
$[gap_t + gap_{t-1}]/2$	0.09***	0.09***	0.10***	0.09***	0.08***
Δe_t	0.08***	0.09***	0.08***	0.10***	0.08***
Δe_{t-1}	0.02**	0.02**	0.02	0.02	0.03***
Δe_{t-2}	0.03***	0.03***	0.02**	0.03**	0.04***
π_t^m	0.11***	0.11***	0.10***	0.11***	0.13***
$[\Delta ruw_{t-3} + \Delta ruw_{t-4}]/2$	0.11***	0.11**	0.14***	0.14**	
$D_{07:04}$	1.99***	2.00***	2.10***	2.19***	1.91***
Δruw_{t-3}					0.06**
$\pi_t^m * Dum11$					**-0.05****
R^2	0.88	0.89	0.94	0.97	0.90
R^2 (Adj.)	0.85	0.85	0.91	0.94	0.86
LM(4)	0.36	0.37	0.74	0.20	0.36
BPG Heter.	0.94	0.99	0.71	0.56	0.96

Notes: (a) Dependent variable is quarterly logarithmic difference of seasonally adjusted CPI excluding unprocessed food, alcoholic beverages and tobacco (CPIX). Inflation series utilized in the model is also adjusted for tax changes.
(b) (***), (**) and (*) represent statistical significance at 1 percent, 5 percent and 10 percent respectively. HAC standard errors and covariances are used. P-values are reported for serial correlation LM and Breusch-Pagan-Godfrey heteroskedasticity tests.

In light of this empirical evidence, we estimate CPIX inflation with a time-varying model in order to capture the changing dynamics. To this end, we treat each parameter of equation (1) to adjust smoothly over time, and evolve as a random walk, that is $\beta_t = \beta_{t-1} + e_t$, where $\beta_t = [c_t \ \alpha_t \ \delta_t \ \gamma_{0,t} \ \gamma_{1,t} \ \gamma_{2,t} \ \varphi_t \ \theta_t]'$. Hence β_t is the unknown state variable here. Unless there is a large shock to e_t, the parameter will fluctuate around its previous estimate. Equation (1) with each parameter taking a time script is the measurement equation. Assuming independent and identically distributed normal error terms, and zero correlation between e_t and ε_t, we estimate the model with the Kalman filter.[3]

3. TVP Findings: How the Parameters Evolve over Time

Estimations of the baseline model shown in Chart 2 indicate that there is some variation in parameters. Particularly, the coefficient of lagged inflation appears to be decreasing over time. Filtered estimates point out that the shift in inertia occurs notably in 2013.[4] Time-varying

[3] For further details, see Harvey (1990).
[4] We can estimate the unobserved state variable β_t depending on different information sets (Y_t). Filtered estimate at time t uses observations available at time t, that is $E(\beta_t|Y_t)$, whereas the smoothed estimate takes into account the information made

parameter estimates for output gap and real unit wages are found to be relatively stable. When inflation inertia is taken into account, the coefficient of output gap in the longer run is estimated to be around 0.13, implying roughly 0.5 percentage point increase (decrease) in inflation when output gap is one percentage point higher (lower) throughout the year. The coefficient of the real unit wages suggests that 1 percentage point temporary shock to real unit wages in a given quarter leads to 0.16 percentage point increase in inflation in the longer run.

Short-run exchange rate pass-through, the sum of exchange rate coefficients in the baseline model, is estimated to be steady around 13 percent, whereas it is 18 percent in the longer run when taking into account the dynamic effects through lagged inflation (Chart 2). This finding is consistent with results of previous studies.[5] Moreover, short term exchange rate pass-through coefficient is broadly stable over time.

As expected from the results presented in Table 1, there is a notable variation in import price pass-through to inflation. Estimates point out that short-run pass-through for USD-denominated import prices, which is measured by the coefficient of the contemporaneous quarter has come down from 12 percent in 2006 to 9 percent at the end of the sample. The decline in import price pass-through might be partly reflecting the limited response of domestic electricity and natural gas prices to the fall in international oil prices following the global financial crisis, possibly due to the discontinuance of the automatic pricing mechanism.[6]

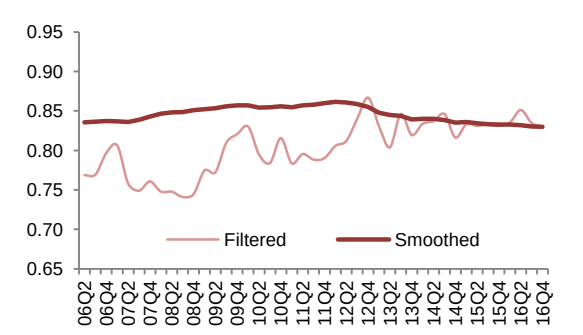
available after time t, $E(\beta_t|Y_T)$ hence it is conditional on all the sample. Since the smoothed estimate is based on more information than the filtered, it fluctuates less compared to the filtered one. Note also that at the end of the sample period T, due to the lack of future data, the filtered and smoothed estimates are exactly the same.

[5] Findings of Kara and Öğünç (2012) indicate that the pass-through for the exchange rate under different models for the period 2002-2011 is 15 percent on average in one-year period and 17 percent on average in two-year period. Estimates based on the Bayesian VAR approach presented in the CBRT (2016) point out 18 percent pass-through for the exchange rate basket after two years. Özmen and Topaloğlu (2017) adopt a disaggregated approach examining pass-through for CPI sub-groups and document that pass-through for exchange rate is about 17 percent for the aggregate CPI with a bottom-up approach.

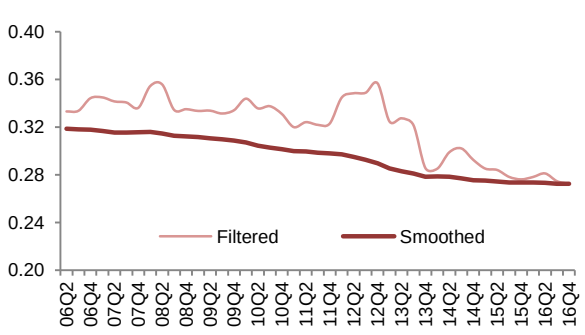
[6] This mechanism is also known as “Cost Based Pricing Mechanism” introduced in May 2008, which aims to set electricity and natural gas prices according to the “cost” factors (exchange rates and oil prices) prevailing in the market.

Chart 2. Time-varying Parameters for Baseline Model

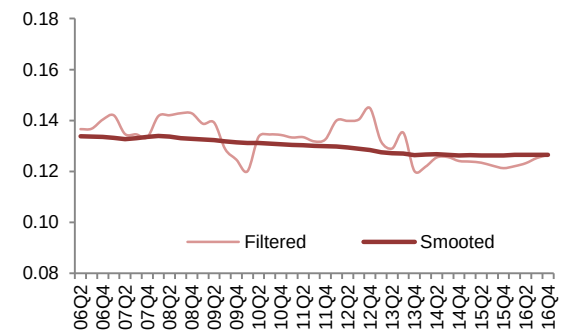
Constant term (c)



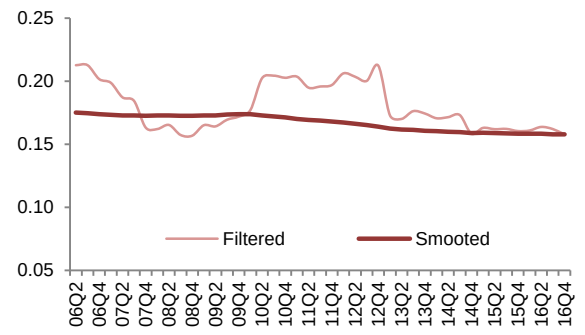
Backward-looking term (π_{t-1})



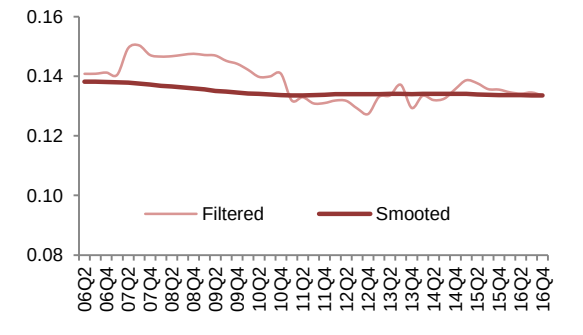
Output gap ($[gap_t + gap_{t-1}]/2$, Long-run)



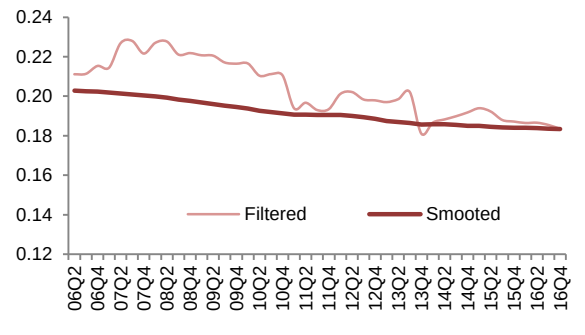
Real unit wages ($[\Delta ruw_{t-3} + \Delta ruw_{t-4}]/2$, Long-run)



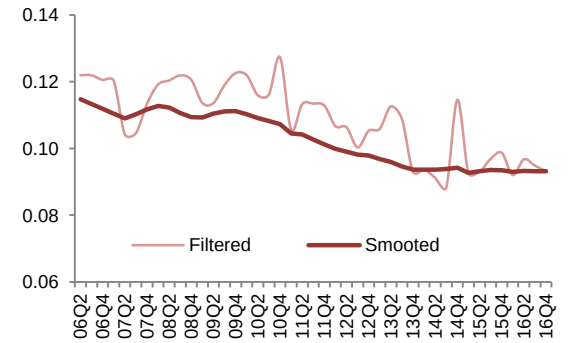
Exchange rate pass-through (Short-Run)



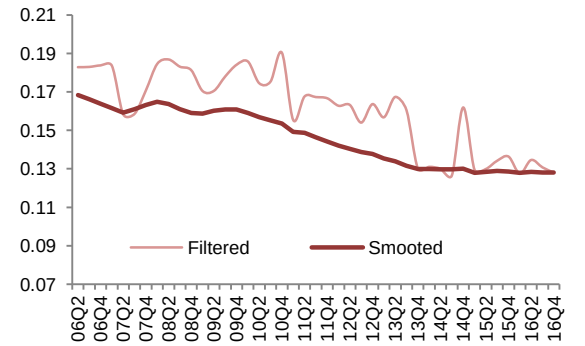
Exchange rate pass-through (Long-Run)



Import price pass-through (Short-Run)



Import price pass-through (Long-Run)



A final point to highlight is the constant term in the Phillips curve. It is not trivial to interpret this parameter as it could possibly reflect some sort of "trend inflation" as well as the effect of other factors not accounted in the model. Derivation of conventional version of the new Keynesian Phillips curve (NKPC) assumes log-linearization around a zero-inflation steady state. However, as pointed out by Cogley and Sbordone (2008), it is possible to allow for nonzero steady state inflation, which in turn introduces the "trend inflation" concept. Their derivation assumes that nonresetting firms' prices are a mixture of past inflation and current trend inflation and they define an NKPC relation in terms of inflation gap, $\hat{\pi}_t = \pi_t - \bar{\pi}_t$, under certain assumptions.[7] Here trend inflation ($\bar{\pi}_t$) corresponds to long-run inflation expectations and it is time-varying.[8] They argue that much of the persistence observed in inflation is due to shifts in this trend inflation.

Our setup involves a reduced form model rather than a structural NKPC, therefore we acknowledge that time-varying constant term in the TVP model may not represent a fundamental measure of trend inflation. Yet, this term may implicitly be related to inflation persistence embedded in the pricing behavior, possibly hinting the role of expectations. It is interesting to note that filtered estimates presented in Chart 2 signal a steady increase in the intercept term over time, similar to the findings of the constant parameter model. Smoothed parameters, on the other hand, are more stable around 0.85 percentage points. As it will be discussed in the next section, average contribution of this component to annual consumer inflation is around 4 percentage points. This sizeable contribution from "unaccounted component" hints that more detailed work regarding the structural interpretation of long-term expectations on inflation is needed to have a better understanding of inflation dynamics.

4. Historical Accounting: Decomposition of Consumer Inflation

In this section, we provide a historical accounting of inflation. The quarterly contributions of variables to consumer inflation are calculated by multiplying them by their corresponding time-varying filtered coefficients, as well as adding up the contributions from excluded components of CPI, which are unprocessed food, alcohol-tobacco and taxes. Next, contributions to quarterly inflation are accumulated to obtain annual figures. Table 2 presents the estimated contributions to consumer inflation in annual terms for the entire inflation targeting period. During this episode, unprocessed food prices and exchange rates ($/TL) provide the highest contribution to inflation, both averaging 1.3 percentage points per year.

[7] In the formulation of sticky price models, each period, only a fraction of firms (1-θ) are able to reset their prices to an optimal reset price; for all other non-resetting firms (θ), there can be alternative assumptions such as simply keeping their prices unchanged or some form of indexation to past inflation and so on.

[8] Yun (1996) shows that if trend inflation is constant ($\bar{\pi}$) and non-reset prices are fully indexed to current trend inflation, then it is possible to obtain an NKPC in terms of π_t with an intercept that depend on trend inflation.

Contribution of food prices displays large fluctuations from one year to another, suggesting that unprocessed food group has been one of the major drivers of inflation volatility. For instance, the contribution was 2.4 points in 2009, while it moved down sharply to -0.3 point in 2012.

Table 2. Average Contributions to CPI Inflation[(a)]
(Percentage point)

	Constant	Unpr. Food	Exc. Rate ($/TL)	Import Price ($)	Output Gap	Real Unit Wage	Taxes	Other[(b)]	CPI
2006	3.8	1.7	1.3	1.7	1.7	-0.4	0.0	-0.2	9.7
2007	4.0	1.5	-2.5	1.7	2.0	-0.7	0.7	1.9	8.4
2008	3.9	1.1	1.2	1.5	1.5	-0.3	0.1	1.1	10.1
2009	4.0	2.4	2.1	-2.0	-2.9	1.4	0.5	0.9	6.5
2010	4.1	1.1	-0.3	1.1	-2.0	0.5	1.8	0.1	6.4
2011	4.0	1.9	2.3	1.6	0.1	-0.1	1.1	-0.3	10.5
2012	4.3	-0.3	0.9	-0.4	0.1	-0.2	0.8	1.1	6.2
2013	4.3	1.4	1.3	-0.3	0.7	0.5	0.9	-1.3	7.4
2014	4.1	1.4	1.9	-0.7	0.6	0.0	0.9	0.0	8.2
2015	4.1	1.6	4.0	-2.2	0.6	0.6	0.3	-0.1	8.8
2016	4.0	0.5	1.6	-0.5	0.0	0.6	1.4	0.8	8.5
2006-16	**4.0**	**1.3**	**1.3**	**0.1**	**0.2**	**0.2**	**0.8**	**0.4**	**8.2**

(a) It should be noted that the estimated contributions may vary depending on model specification and sample size utilized.

(b) Includes the contribution of non-tax price changes in tobacco and alcoholic beverages as well as the residual term (model errors) and the dummy variable used for the last quarter of 2007.

Exchange rate turns out to be a major cost-push factor in driving consumer inflation. The highest pass-through effect was recorded in 2015 with 4 points, boosting up inflationary pressures, which was partly offset by the decline in international prices. Meanwhile, import prices provided a mere contribution of an average 0.1 points to inflation in the entire inflation targeting period (Table 2). Yet, the contribution of import prices changed dramatically in two distinct episodes, namely during 2006-2011 and afterwards (Table 2 and Chart 3).

Chart 3. Average Contribution to CPI Inflation
(Percentage point)

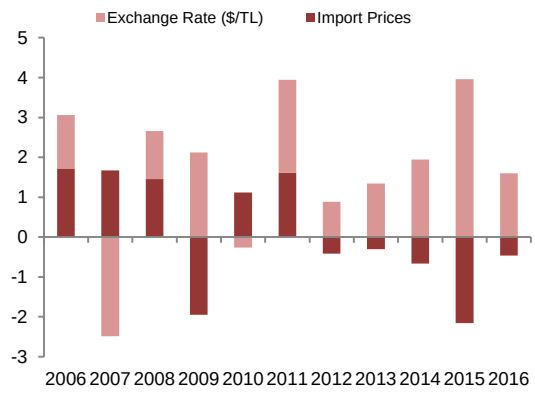
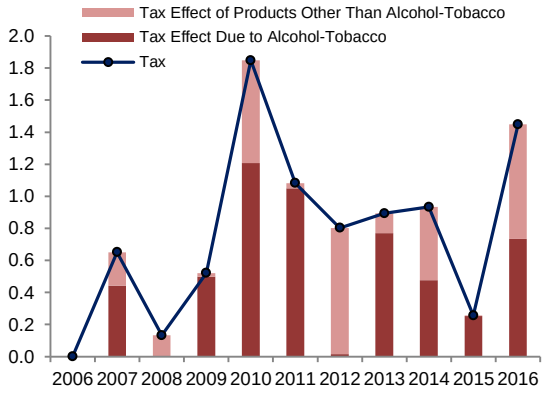


Chart 4. Average Contribution to CPI Inflation
(Percentage point)[(a)]



(a) Estimations for 2016 include tax adjustments in January 2016 as well as the electricity price adjustment of 0.16 points. Price changes in alcoholic beverages and tobacco are decomposed as tax and non-tax changes.

While the dampened global growth since 2013 affected inflation favorably through commodity prices and external demand channels, weaker capital flows during this period has exerted upside inflationary pressures through the exchange rate pass-through, especially after the Fed's tapering signal in May 2013. During 2011-2016, the contribution of exchange rate to annual inflation reached 2 points on average. As a result, exchange rate pass-through outweighed the favorable contribution of import prices in this period (Table 2).

Turning to the fiscal side, another major driver of inflation during this period was tax adjustments with 0.8 points contribution on average per year. This pattern can be attributed to the systematic behavior of fiscal policy, where fiscal adjustments to restore primary balances have mainly taken the form of tax hikes or other fiscal measures rather than expenditure cuts. The contribution of taxes on inflation has fluctuated substantially through years, which has been a significant factor adding to inflation forecast uncertainty. For instance, consumer inflation in 2008 had almost no push from the fiscal side, while two years later in 2010 the contribution of taxes became historically highest with 1.8 points (Table 2 and Chart 4). Tax adjustments were executed in various forms: For example, in 2016, tax hikes were implemented in tobacco and alcoholic beverages in January and December, in fuel oil in September, and in automobiles in the late November, which overall contributed to inflation by 1.4 points on an annual basis (Table 2 and Chart 4).

Other macroeconomic drivers of inflation are the output gap and real unit wages. On average, the contribution of output gap was close to zero (0.2 points) since, by definition, the effects were cyclically offset by each other. In the first three years of inflation targeting preceding the global crisis, the economy was overheated and capacity pressures built up,

while productivity gains partly offset these pressures. The crisis years tell a different story with a deep slack in aggregate demand which dragged the output gap to disinflationary territory, but at the same time caused real unit wages to rise due to the cyclical loss in productivity. 2013 and onwards, inflationary pressures driven by output gap and real unit wages increased due to accelerated nominal wages and subdued productivity growth (Table 2).

Note that consumer inflation fell only to 6.5 percent despite the large slack in the economy in 2009, suggesting the existence of other persistent forces in driving inflation dynamics.[9] Our analysis does not allow us to make a structural assessment, but in our setup this is largely attributed to the constant term, whose contribution is estimated to be around 4 percentage points in annualized terms. Note that the constant term is the portion of inflation that cannot be explained by macroeconomic variables, which may be related to some form of more structural inflation persistence (see the discussion in the previous section). Constituting almost half of the average consumer inflation during 2006-2016, this term indicates that real cost of disinflation in Turkey may be remarkably high, suggesting the existence of significant policy trade-offs.

5. Changing Dynamics: A Before and After Analysis

Inflation targeting experience in Turkey can be split into two distinct episodes with respect to changing focus of monetary policy: (i) The period of conventional inflation targeting regime from 2006 to 2010, (ii) the unconventional policy framework from 2011 to 2016 with multiple objectives and multiple tools. Although, average consumer inflation was at similar levels during both periods, the drivers of inflation differ widely (Table 3).

Table 3. Average Contribution to CPI Inflation
(Percentage point)

	Constant	Unprocessed Food	Exchange Rate ($/TL)	Import Price	Output Gap	Real Unit Wage	Taxes	Other[(a)]	CPI
2006-16	**4.0**	**1.3**	**1.3**	**0.1**	**0.2**	**0.2**	**0.8**	**0.4**	**8.2**
2006-10	3.9	1.5	0.4	0.8	0.1	0.1	0.6	0.8	8.2
2011-16	4.1	1.1	2.0	-0.4	0.3	0.2	0.9	0.0	8.3

(a) Includes the contribution of non-tax price changes in tobacco and alcoholic beverages as well as the effect of the residual term and the dummy variable used for the last quarter of 2007.

[9] Atuk, Aysoy, Özmen and Sarıkaya (2014) and Özmen and Sarıkaya (2014) investigate cyclically dependent sub-items of the CPI and find that only one-third of the consumer basket in Turkey respond to output gap significantly. As the remaining part of the CPI is shown to be closely related with TL denominated import prices, hence their results imply a high sacrifice ratio (inflation-output trade-off).

In order to further contrast the drivers of inflation between the two episodes of inflation targeting, Chart 5 presents the contribution of "fundamental" macroeconomic factors to inflation as well as that of other factors in aggregated terms. We label fundamental factors as key determinants of core/underlying inflation in Turkey, which comprise exchange rate, import price, output gap and real unit wage. In the second part of the targeting period, the contribution of fundamental macroeconomic factors to inflation edged up by 0.8 points, whereas non-core drivers such as unprocessed food and tobacco made a smaller contribution. Besides, the constant term is slightly higher in the second period, possibly indicating a rise in trend inflation (Chart 5).

Chart 5. Average Contribution to CPI Inflation
(Percentage point)

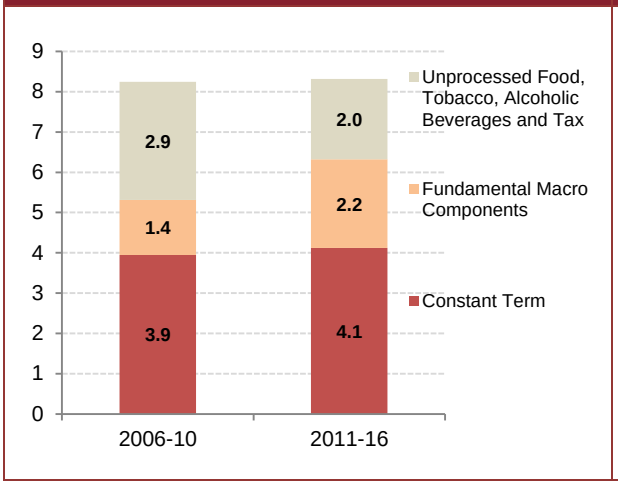


Chart 6. Decomposition of the Contribution of Fundamental Macroeconomic Components
(Percentage point)

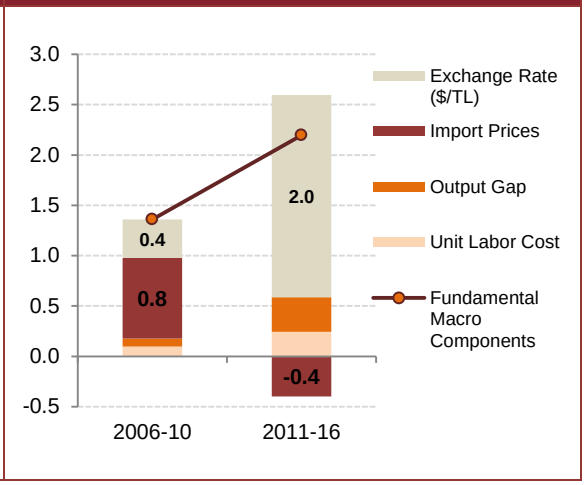


Chart 6 provides the breakdown of the contribution of fundamental variables in two episodes of inflation targeting. Accordingly, inflation dynamics were mostly driven by exchange rate in the second episode, which was marked by notable shifts in both external and domestic policy environments such as Fed tapering and the unconventional monetary-macroprudential policy mix. In addition to the exchange rate, output gap and real unit wages also exerted higher pressure on inflation in this period. On the contrary, the benign course of import prices in the second period partly mitigated the impact of other cost factors.

6. Conclusion and Final Remarks

This study investigates the main drivers of inflation in Turkey during the implementation of the formal inflation targeting period since 2006. We employ a time-varying Phillips curve to account for the historical movements in inflation. Our findings suggest that coefficients of the Phillips curve are broadly stable over time except for the import prices. The pass-through

from import prices to inflation seems to have weakened, possibly due to incomplete pass-through from the fall in oil prices to domestic energy prices in recent years.

The accounting of inflation across years reveals useful insights regarding inflation dynamics. Exchange rate and unprocessed food prices have been the main drivers of sharp changes in inflation from one year to another. Tax adjustments also create unpredictable movements. More interestingly, around 4 percentage points of inflation on average cannot be explained by standard macro variables in our sample period, suggesting the presence of more fundamental factors in explaining long term inflation process. This might be related to persistence in the pricing behavior due to expectation formation process as well as other structural factors which are not captured in our setup.

These results reveal the crucial role of managing expectations as well as the need for a comprehensive approach to achieve price stability in Turkey. Certainly, a price stability oriented monetary policy is the main prerequisite for implementing a successful disinflation. Yet, our results also suggest that joint effort by all relevant institutions is needed to ease the associated trade-offs and achieve ultimate price stability. For example, reducing the volatility of food inflation through structural policies is essential to bring down inflation uncertainty. In a similar context, mitigating the exchange rate pass-through by reducing dollarization and containing the external deficit are key to dampen inflation volatility and thus contribute to price stability in the longer term.

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Appendix:

Table A1. Data Description

Variable	Definition	Source
Unprocessed food prices	CPI sub-index (2003=100)	TurkStat
Alcoholic beverages and tobacco prices	CPI sub-index (2003=100)	TurkStat
CPIX	CPI excluding unprocessed food, alcoholic beverages and tobacco (Indicator D of TurkStat (2003=100), which is adjusted for taxes by authors)	TurkStat and authors' own calculations
Output gap	HP filtered GDP (λ=1600)	
Exchange rate	USD/TRY nominal exchange rate	CBRT
Import prices	USD denominated import price index (2010=100)	TurkStat
Real unit wages	RUW = (W/P)/(Y/L), W: Nominal wage, P: CPI, Y: Nonfarm GDP, L: Nonfarm employment, all series are seasonally adjusted.	CBRT, TurkStat and authors' own calculations

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