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Dissecting Turkish inflation: theory, fact, and illusion

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Abstract
The policy debate in Turkey over the impact of interest rate on inflation concerns the question of what policymakers should do when faced with volatile and high inflation. Motivated by this discussion, we provide an empirical analysis by connecting the cost channel to the Phillips relation. Our findings prove the existence of the cost channel. However, other determinants of inflation —labor share of income, prices of imported inputs, and consumption goods —dominate the cost channel in Turkey.

Keywords Inflation dynamics · Cost channel · Monetary transmission · Open economy New Keynesian Phillips curve · Generalized method of moments

JEL Classification C22 · E31 · E58

1 Introduction

Turkey is an exemplary laboratory for studying inflation dynamics. Unlike advanced countries, the inflation rate in Turkey is quite volatile and got through several phases: chronic and acute inflation, implicit and explicit inflation-targeting regimes. In the 1990s, Turkey experienced very high inflation rates, as shown in Fig. 1. After uncontrollable inflation, thanks to successful policies and determined policymakers, Turkey entered a low and stable inflation period in the early 2000s. Since the adoption of explicit inflation targeting, while inflation was still high and notably volatile by international standards, it was not as wild as before. However, in 2017, this relatively favorable outlook has changed dramatically, and inflation has turned into well above the double-digit figure, which warrants policymakers once again.

The conventional wisdom of monetary policy suggests the tightening of the policy rate in response to a rise in inflation. Opposing the mainstream theory, the

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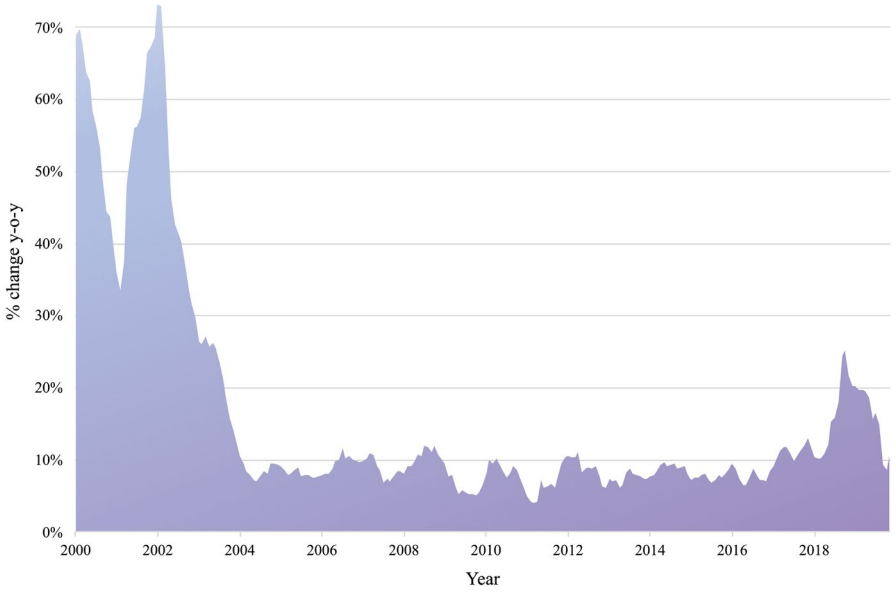

Fig. 1 Consumer price index - all items *Source*: Organization for Economic Co-operation and Development

President of Turkey stated that "...low interest rates deliver low inflation" in an investors meeting in London in May 2018. Accordingly, the Turkish government overestimates the *cost channel* component of inflation, and since then, they have been bashing the monetary policymakers for interest rate hikes. In this paper, we aim to enlighten the ongoing conflict between policymakers and the political authority on the conduct of monetary policy. To do so, we derive an augmented Phillips equation that includes the cost channel of monetary transmission, economic activity, and open economy elements by synthesizing the narrative background of Turkey with macroeconomic theory.

Among others, Ravenna and Walsh (2006); Chowdhury et al. (2006); Tillman (2009) study the structural dynamics of inflation in a context in which firms face cash-in-advance constraints, and the cost of working capital is a function of the policy rate. Therefore, the interest rate enters the firm's effective marginal cost function, which leads to an increase in inflation as a direct impact of an interest rate hike, which is called the *cost channel*.

Many empirical studies estimate the effect of the interest rate on marginal costs in developed countries and conclude that the cost channel is quantitatively important, and the strength varies across countries and over time.[1] Yet the studies on emerging economies, especially for Turkey, are very limited. Kara et al. (2017) estimate

[1] Ravenna and Walsh (2006) is the first to introduce the cost channel in the New Keynesian framework for a closed economy. See Chowdhury et al. (2006); Ravenna and Walsh (2006); Henzel et al. (2009); Tillman (2009); DeFiore and Tristani (2013) for further studies.

a reduced-form time-varying parameter backward-looking Phillips relation for Turkey with exchange rate dynamics, import prices, output gap, and real unit wages for the period 2006–2016. The findings of the paper emphasize the significance of the exchange rate pass-through during the analyzed period for Turkey without considering the cost channel. With a similar specification for the Phillips relation, Ozmen and Sarıkaya (2014) studies the sensitivity of consumer inflation to credit by estimating a Phillips curve for subgroups of consumer prices in Turkey.

We contribute to the literature investigating the empirical relevance of the cost channel in inflation dynamics for a small open economy in the context of a New Keynesian Phillips curve (NKPC). To the extent of our knowledge, this is the first paper exploring the empirical relevance of the cost channel on inflation dynamics in Turkey. We first derive an open economy NKPC with unit labor cost, interest rate, and import price dynamics. Next, we estimate the augmented Phillips equation by the generalized method of moments. We find that the cost channel-augmented Phillips equation is a pertinent description of short-run inflation dynamics in Turkey. The main result is robust under different inflation measures: GDP deflator, producer price inflation (PPI), and consumer price inflation (CPI).

The rest of the paper is organized as follows. Section 2 presents the theory. In Sect. 3, we provide facts about inflation and drivers of inflation. In Sect. 4, we analyze our findings and discuss the perspective of the illusion it generates. Section 5 concludes.

2 Theory

To provide some reduced-form empirical evidence on inflation dynamics in Turkey, we present a structural relation between current inflation and expected and past inflation, and real marginal cost.

2.1 Model

In this section, we derive an open economy NKPC in the spirit of Gali and Monacelli (2005). Following Lagoa (2014), we assume that the production takes place by using labor and imports, and these inputs are financed by loans taken from the financial intermediaries. Therefore, costs of labor and imported inputs are considered as financial costs of the firms. On the demand side of the model, we assume two countries, home and foreign, with the same technologies and preferences. The foreign country consumes only domestically produced goods. On the other hand, the home country uses imported goods for both consumption and production in addition to domestically produced goods.

2.1.1 Price developments

We use the hybrid pricing structure of Gali and Gertler (1999) and Gali et al. (2001) which allows a fraction of firms to use a backward-looking rule of thumb. Following

the standard Calvo type price setting for the hybrid model and we assume that firms reset their prices with a probability of $1-\theta$. However, only a fraction of $1-\omega$ of them chooses their price optimally, as in the baseline Calvo (1983). The rest of them adopts the following backward-looking rule of thumb:

$$p_t^b = p_{t-1}^* + \pi_{t-1} \tag{1}$$

where $p_{t-1}^* = (1-\omega)p_{t-1}^f + \omega p_{t-1}^b$ is the average price chosen in $t-1$. The hybrid version of the marginal cost-based Phillips curve is:

$$\pi_t = \gamma_f \pi_{t+1} + \gamma_b \pi_{t-1} + \lambda \widehat{mc}_t \tag{2}$$

where $\gamma_f = \frac{\beta\theta}{\theta+\omega(1-\theta(1-\beta))}$ represents the importance of the expected inflation, $\gamma_b = \frac{\omega}{\theta+\omega(1-\theta(1-\beta))}$ is the backward-looking component, and $\lambda = \frac{(1-\omega)(1-\theta)(1-\theta\beta)}{\theta+\omega(1-\theta(1-\beta))}$ is the trade-off between inflation and marginal cost.

2.1.2 Marginal cost

The characterization of marginal cost follows Ravenna and Walsh (2006) which includes the cost channel of interest rate. The cost channel effect appears in the marginal cost, hence in inflation, since firms have to borrow from banks to finance their factors of production. Unlike Ravenna and Walsh (2006), we assume that firms utilize imported goods —in addition to labor —to produce output. In this framework, all firms are assumed to have the same technology given by the following production function:

$$Y_t = [\alpha_N (Z_t N_t)^{(\epsilon-1)/\epsilon} + \alpha_M (M_t)^{(\epsilon-1)/\epsilon}]^{\epsilon/(\epsilon-1)} \tag{3}$$

where $\alpha_N = 1-\alpha_M$, ϵ is the elasticity of substitution between labor and imported inputs. Y_t denotes output produced in the home country, Z_t is technology level, N_t refers to labor input, and M_t is the imported goods used in the production process. M_t is an aggregated index of imported goods: $M_t = (\int_0^1 m_t(i)^{(\theta-1)/\theta} di)^{\theta/(\theta-1)}$. To pay labor cost W_t and cost of imported inputs M_t in advance, firms borrow loans from banks at interest rate I_t.

The marginal cost equation is derived from the cost minimization problem:

$$MC_t = \frac{I_t \frac{W_t}{P_t^h} \frac{N_t}{Y_t}}{\alpha_N \left(\frac{Z_t N_t}{Y_t}\right)^{1-\frac{1}{\epsilon}}} = \frac{I_t S_t}{\gamma_t} \tag{4}$$

where γ_t is the elasticity of output with respect to labor: $\gamma_t = (\partial Y_t/\partial N_t)(Y_t/N_t)$, and S_t is the labor income share $N_t W_t / P_t^h Y_t$.

$$\frac{N_t}{M_t} = \left(\frac{\alpha_N P_t^f I_t}{\alpha_M W_t I_t}\right)^{\epsilon} = \left(\frac{\alpha_N P_t^f}{\alpha_M W_t}\right)^{\epsilon} \tag{5}$$

Log-linearizing and substituting the above condition into Eq. (4), we obtain:

$$\widehat{mc}_t = \hat{s}_t + \hat{i}_t + \phi(\hat{p}_t^f - \hat{\omega}_t) \tag{6}$$

where $\phi = \frac{1-s\Phi}{s\Phi}(\epsilon - 1)$. s is the steady-state value of labor income share, and Φ is the steady-state mark-up. ϵ is the elasticity of substitution between inputs. ϵ being higher than one implies a reduction in marginal cost as the relative price of imports decreases because firms prefer to substitute cheaper input labor with imported inputs.

Plugging the marginal cost equation into Eq. (2) gives us the hybrid NKPC which stands for domestic inflation (domestic producer price index).

$$\pi_t^h = \gamma_f E_t \pi_{t+1}^h + \gamma_b \pi_{t-1}^h + \gamma_s \hat{s}_t + \gamma_i \hat{i}_t + \gamma_{p\omega}(\hat{p}_t^f - \hat{\omega}_t) \tag{7}$$

where π_t^h is the inflation rate of domestic goods.

We also focus on the impact of price developments in imported consumption goods on CPI inflation. It can be written as the weighted average of domestic inflation and imported inflation as follows:

$$\pi_t^c = (1 - \gamma_m)\pi_t^h + \gamma_m \pi_t^m \tag{8}$$

where γ_m is the share of imported goods in total consumption, and π_t^m is the imported consumption goods inflation. Plugging Eq. (7) into Eq. (8), we get

$$\begin{aligned}\pi_t^c =& \gamma_f E_t \pi_{t+1}^c + \gamma_b \pi_{t-1}^c + \gamma_c(\pi_t^m - \gamma_f E_t \pi_{t+1}^m - \gamma_b \pi_{t-1}^m) + \gamma_s' \hat{s}_t + \gamma_i' \hat{i}_t \\ &+ \gamma_{p\omega}'(\hat{p}_t^f - \hat{\omega}_t)\end{aligned} \tag{9}$$

where $\gamma_s' < \gamma_s$, $\gamma_{p\omega}' < \gamma_{p\omega}$, $\gamma_i' < \gamma_i$, implying that the coefficients of the labor share, cost channel, and imported input are expected to be smaller in CPI-based Phillips curve specification.

3 Fact

In this section, we substantiate empirical facts by estimating GDP-deflator, PPI, and CPI.

3.1 Data and empirical methodology

We estimate the model using the generalized method of moments (GMM). Under rational expectations, actual future inflation is expressed as a summation of expected inflation and an expectational error, ξ_t, as follows: $\pi_{t+1} = E\pi_{t+1} + \xi_t$. We use Eq. (2) and replace expected inflation with its realization to obtain

$$\pi_t^h = \gamma_f \pi_{t+1}^h + \gamma_b \pi_{t-1}^h + \lambda \widehat{mc}_t + \epsilon_t.$$

Here, ϵ_t represents a linear combination of a forecast error, $\gamma_f[\pi_{t+1}^h - E_t\pi_{t+1}^h] = \gamma_f \xi_t$, and a measurement error, u_t.

Since the prediction error ξ_t at time t is orthogonal to the information available at time $t-1$, we use the following conditions to estimate the Phillips equation by GMM:

$$E_t\{(\pi_t - \gamma_f \pi_{t+1} - \gamma_b \pi_{t-1}^h - \lambda \widehat{mc}_t) Z_{t-1}\} = 0$$

where Z_{t-1} is a vector of instruments that are dated from period $t-1$ or earlier. We use a parsimonious set of instruments in the estimation. Our choices of instrument sets are guided by first-stage F tests. The instrument choices yield p-values for the regression diagnostic statistics, namely Hansen J-statistics and Kleibergen–Paap LM statistics, above the 5% threshold.

We use the continuously-updated (CU) GMM estimator of Hansen et al. (1996), where the weighting matrix and the vector of coefficients are estimated simultaneously. Compared to the two-step GMM, a widely utilized alternative in the literature, the CU-GMM estimator works better with weak instruments, and it has better finite-sample properties. We rely on Newey–West correction with automatic plug-in lag length to obtain heteroscedasticity and autocorrelation consistent standard errors and obviate possible correlation in moment conditions.

We use quarterly data for the period 2006–2019 to estimate the Phillips curve for Turkey. By choosing this interval, we focus on the explicit inflation targeting period of the Central Bank of the Republic of Turkey, and exclude the post-COVID data.[2] Data sources and variable transformation are presented in Table 1.

3.2 Interpreting the results

Table 2 reports the cost-channel-augmented Phillips curve estimates as specified in Eq. (7). We find that all coefficients are positive in sign and statistically significant at the 5% level. Lagged and expected future inflation rates are significant determinants of observed inflation. The estimates for coefficients on expected future inflation versus backward inflation are 0.55 (γ_f) and 0.48 (γ_b), respectively. Also, the forward component of inflation dominates inflation dynamics. Real unit labor cost exhibits the largest significant coefficient among the components of the marginal cost. We further report direct interest-rate effects. We observe that one percent increase (decline) in the interest rate, keeping all the other factors constant, is associated with a 0.02 percent increase (decline) in deflator inflation. Moreover, the relative import price estimate is positive and significant, as is consistent with the prior theory,

[2] The variation in macroeconomic data originating from the COVID-19 pandemic leads to a challenge for the estimation and analysis of macroeconometric models. See Lenza and Primiceri (2020), Schorfheide and Song (2020), and Bobeica and Hartwig (2021) for detailed discussion. We treat the COVID-19 data as outliers generated by large shocks as suggested by the recent literature and exclude them from our estimation.

Table 1 Variable definitions and data sources

Variable	Definition	Source
Producer inflation (π^p)	GDP-Deflator inflation rate SA, quarterly, y-o-y	CBRT
	PPI-Domestic inflation rate, quarterly, y-o-y	CBRT
Consumer inflation (π^c)	CPI-D inflation rate, quarterly, y-o-y	CBRT
Import inflation (π^m)	Import unit price index, TL, quarterly, y-o-y	TurkStat
Real wage ($\hat{\omega}$)	Wages in manufacturing deflated by CPI	OECD
Labor share of income ($\hat{s}$)	Unit labor cost index, log, SA, HP-filtered	TurkStat
Lending rate ($\hat{i}_t$)	Commercial credit lending rate, log, HP-filtered	CBRT
Relative import price ($\hat{p}^f - \hat{\omega}$)	Import unit value index minus log of SA manufacturing wage, log, HP-filtered	TurkStat
Output gap	Real GDP, SA, log, HP-filtered	TurkStat
Commodity price	Commodity price index, log, HP-filtered	IMF IFS
Commodity price inflation	Commodity price inflation, quarterly, y-o-y	Authors' Calculations

CBRT stands for Electronic Data Delivery System of the Central Bank of the Republic of Turkey, and TurkStat is Turkish Statistical Institute. We detrend the variables using the Hodrick–Prescott filter with $\lambda = 1600$

Table 2 CU-GMM estimates of the Turkey NKPC for deflator inflation

Reduced form parameters					Test			
γ_f	γ_b	γ_s	γ_i	γ_{pw}	J-Stat	KP-Stat	CD-Stat	F-Stat (1^{st} stage)
0.55^a	0.48^a	0.24^a	0.02^a	0.06^a	2.865	2.781	4.705	30.87
(0.06)	(0.07)	(0.04)	(0.01)	(0.01)	[0.721]	[0.836]		

The set of instruments incorporates three lags of inflation and lending rate; first lag of unit labor cost, and import inflation. Parenthesis contains Newey-West-corrected HAC standard errors (with automatic plug-in lag length). Brackets contain p-values. J-Stat reports Hansen's test of the validity of overidentifying restrictions. KP-Stat shows Kleibergen–Paap rk LM statistic for the under-identification test. F-Stat and CD-Stat report Kleibergen–Paap rk Wald F statistic and Cragg–Donald Wald F statistic for weak identification tests, respectively. Stock–Yogo weak ID test critical values are used to evaluate Cragg–Donald F statistic.

[a] indicates significance at the 1% levels.

[b] indicates significance at the 5% levels.

[c] indicates significance at the 10% levels

which reflects the open economy characteristics of Turkish inflation. The positive sign of the impact of the relative import price implies that the elasticity of substitution between inputs is positive, and an increase (a decrease) in γ_{pw} rises (decreases) the marginal cost as labor is substituted by imported inputs.

We further carry out the Phillips curve estimations using PPI and CPI to test whether our results are sensitive regarding the choice of the price index. According to the results, shown in Tables 2 and 3, forward-looking components remain

Table 3 CU-GMM estimates of the Turkey NKPC for PPI inflation

Reduced form parameters					Test			
γ_f	γ_b	γ_s	γ_i	γ_{pw}	J-Stat	KP-Stat	CD-Stat	F-Stat (1^{st} stage)
0.59[a]	0.37[a]	0.19[b]	0.08[a]	0.09[a]	7.676	10.49	5.704	12.69
(0.05)	(0.04)	(0.07)	(0.02)	(0.02)	[0.660]	[0.487]		

The set of instruments incorporates two lags of inflation; three lags of lending rate; first lag of output gap, import price, and manufacturing wage. Parenthesis contains Newey-West-corrected HAC standard errors (with automatic plug-in lag length). Brackets contain p-values. J-Stat reports Hansen's test of the validity of overidentifying restrictions. KP-Stat shows Kleibergen–Paap rk LM statistic for the under-identification test. F-Stat and CD-Stat report Kleibergen–Paap rk Wald F statistic and Cragg–Donald Wald F statistic for weak identification tests respectively. Stock–Yogo weak ID test critical values are used to evaluate Cragg–Donald F statistic.

[a] indicates significance at the 1% levels.

[b] indicates significance at the 5% levels.

[c] indicates significance at the 10% levels

predominant—ranging between 0.56 and 0.59. The effect of the forward-looking element is found to be more prominent in domestic-PPI inflation dynamics. Similarly, unit labor cost persists to be the most substantial determinant of inflation in marginal cost. Moreover, the results confirm our earlier findings on the presence of cost channel and the relative input price. The interest rate has a significant impact on inflation regardless of the type of price index. When producer inflation is measured by PPI rather than the GDP deflator, the impact of the interest rate is more substantial, reflecting the comovement between PPI-inflation and the lending rate in recent periods.

Although imports are considered only intermediates in domestic inflation, we allow the presence of the imported final goods to determine consumer inflation. Our findings point out that the backward-looking and forward-looking components of inflation remain similar when imported consumption goods are considered.

In Sect. 2, we theoretically conjecture that the elasticity of inflation for the unit labor cost, lending rate, and import price would be lower in CPI-based Phillips curve estimates. Table 4 confirms our earlier prediction. Furthermore, we find significant coefficient(s) for imported inflation (together with its lead and lag), which confirms the theoretical presumption of the presence of imported consumption goods. Since the backward-looking component, γ_{bc} is statistically significant, implying price-stickiness in import prices, targeting consumer price inflation is optimal for a small open economy like Turkey when all final goods are produced using a mixture of domestic and imported factors of production.

Table 4 CU-GMM estimates of the Turkey NKPC for CPI inflation

Reduced form parameters					Test			
γ_f	γ_b	γ'_s	γ'_i	γ'_{pw}	J-Stat	KP-Stat	CD-Stat	F-Stat (1^{st} stage)
0.56^a	0.47^a	0.10^a	0.02^a	0.01^c	3.016	3.354	6.271	92.09
(0.04)	(0.03)	(0.01)	(0.00)	(0.00)	[0.933]	[0.949]		
		γ_c	γ_{fc}	γ_{bc}				
		0.07^a	-0.03^a	-0.07^a				
		(0.01)	(0.01)	(0.01)				

The set of instruments incorporates four lags of inflation; three lags of lending rate, second lag of unit labor cost, import price and manufacturing wage, and commodity inflation. Parenthesis contains Newey-West-corrected HAC standard errors (with automatic plug-in lag length). Brackets contain p-values. J-Stat reports Hansen's test of the validity of overidentifying restrictions. KP-Stat shows Kleibergen–Paap rk LM statistic for the under-identification test. F-Stat and CD-Stat report Kleibergen–Paap rk Wald F statistic and Cragg–Donald Wald F statistic for weak identification tests respectively. Stock–Yogo weak ID test critical values are used to evaluate Cragg–Donald F statistic.

[a] indicates significance at the 1% levels.

[b] indicates significance at the 5% levels.

[c] indicates significance at the 10% levels

4 Illusion

Understanding the components and dynamics of inflation is crucial for policymakers. In the previous section, our decomposition of marginal cost suggests that the dynamics of the labor share of income, interest rate, prices of imported inputs, and consumption goods are significant determinants of inflation in Turkey. According to our findings, the weight of the economic activity and the price developments in imported consumption goods dominates the cost channel. In other words, the demand channel is stronger than the cost channel. Hence, even though the presence of the cost channel of interest rate seems to justify the political concerns discussed above, this is an *illusion*. Interest rate changes are unlikely to dominate the price developments, the cost channel is negligible for the assessment of monetary policy transmission in Turkey. Since the price of imported final goods significantly impacts inflation, monitoring exchange rate volatility is essential for inflation targeting. Thus, the exchange rate pass-through on inflation —which calls for monetary tightening—should be prioritized over the cost channel in the monetary policy design. Our results clearly show that expectations play a central role in the determination of inflation. When inflation is above the target, as in Turkey for many years, a tight monetary policy can help to guide expectations as well.

The assessment technique utilized in this analysis falls under the category of limited information models. It is worth emphasizing that intertemporal interaction between the determinants of inflation can be analyzed by full information methods. However, we exclude these interactions in our analysis and focus on the partial equilibrium of a single Phillips equation. By relying on limited information methods, our analysis is robust to model misspecification concerns. We leave the full information

analysis in the context of a dynamic stochastic general equilibrium model for future research.

5 Conclusions

We estimate the New Keynesian Phillips curve for Turkey using a GMM technique with quarterly data from 2006 to 2019 and substantiate the statistical relevance of the cost channel. The evidence suggests that the cost-channel-augmented Phillips curve is an appropriate description of short-run inflation dynamics in Turkey. We document that dynamics of the labor share of income, interest rate, prices of imported inputs, and consumption goods are significant determinants of inflation in Turkey. According to our findings, the weight of the economic activity and the price developments in imported consumption goods dominates the cost channel. The main result is robust under different measures of inflation: GDP deflator, PPI, and CPI. To sum up, the Central Bank of the Republic of Turkey should pay more attention to developments in exchange rates by putting aside cost channel concerns, and act on theoretically suggested policies for fighting inflation.

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Declarations

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