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Effect of the Supply-Side factors on inflation in South Asia: An analysis of oil price, technology, and labor market dynamics

Maaz Ahmad [a,b,*], Zebo Kuldasheva [a], Nilufar Ismailova [a], Muhammad Eid Balbaa [a], Nazokat Akramova [c], Noor Ul Ain [d]

[a] World Economy Department, Tashkent State University of Economics, Tashkent 100003, Uzbekistan
[b] University of Tashkent for Applied Sciences, Str. Gavhar 1, Tashkent 100149, Uzbekistan
[c] Department of Business Administration, Tashkent State University of Economics, Tashkent 100003, Uzbekistan
[d] School of Economics, Quaid-i-Azam University, Islamabad, Pakistan

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ABSTRACT

As a long-lasting and ongoing economic problem, inflation significantly affects how society views socioeconomic concerns and how people go about living their daily lives. For South Asian economies, inflation is not only a hypothetical economic concept; it is a brutal reality that affects their capacity to pay for necessities. Therefore, this study examines the effects of oil prices, technological advances, and labor market dynamics on inflation using the Panel ARDL on a subset of South Asian countries over the years 1995 to 2022. The Hausman test recommends PMG estimates while the cointegration test verifies the presence of long-run correlations between variables. According to the findings of this study, oil prices contribute to inflation in South Asian economies. Moreover, technological advancements have the ability to lower inflationary pressures. The overall condition of the labor market particularly is reflected in factors like employment rates, which have a signaficant impact on inflation. Tight labor markets can result in short-term demand-pull inflation when workers demand higher wages. On the other hand, cost-push inflation may occur if wages continue to rise steadily over time.

1. Introduction

As a persistent and ongoing economic phenomenon, inflation has a significant influence on how society perceives socioeconomic issues and on how people carry out their daily lives. South Asia, a region with a population of more than 2 billion, is undoubtedly not exempt from the effects of inflation. Inflation is not only a theoretical economic idea for South Asian economies; it is a harsh reality that has an impact on their ability to pay for essentials. It is defined as the steady rise in the average price of commodities and amenities over time. The average person's purchasing power decreases as prices rise, making it more difficult to successfully make ends meet while maintaining the same level of living. Its impacts spread to every area of the economy, affecting every dimension. The effects of inflation have an impact on the overall financial health of the country and cause changes in household saving, investment, and spending habits. Savings can lose value due to inflation, which makes it difficult for people and families to budget for present and future costs and investments like retirement, housing, and education. Because it can change pricing policies, production costs, and profitability, inflation is a problem for businesses as well. This can therefore cause workers to experience job instability and economic uncertainty.

The past trajectory of inflation within South Asia has been characterized by cyclical swings and an ongoing increasing tendency, resulting in a dynamic business environment. Inflation in South Asia is marked by alternate periods of gradual price growth followed by sudden spikes in prices. The region has gone through periods of hyperinflation, particularly in the 1970s and early 1980s when inflation rates soared to unmanageable heights. In an effort to combat these inflationary pressures, authorities have responded to previous crises by enacting a number of economic and policy measures, frequently in coordination with international financial institutions. Nevertheless, despite these initiatives, the pandemic-induced considerable rise in worldwide inflation exacerbated Pakistan's inflation problems. Political uncertainty, rising energy prices, and the catastrophic floods in the region brought additional layers of complication to the inflationary scenario in the nation and exacerbated this rebound.

* Corresponding author at: World Economy Department, Tashkent State University of Economics, Tashkent 100003, Uzbekistan; University of Tashkent for Applied Sciences, Str. Gavhar 1, Tashkent 100149, Uzbekistan.
E-mail address: maazahmad@tsue.uz (M. Ahmad).

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With a growing population and vibrant economic sectors, countries of South Asia constantly struggle to keep prices stable. The persistence of inflation in the region and its wide-ranging effects are the driving forces behind this study. Inflation erodes consumers' purchasing power, particularly among vulnerable groups who spend a large portion of their income on necessities like food and fuel. It also makes it difficult for businesses to plan long-term strategies. Therefore, inflation has a disproportionately negative effect on people who are low on money. The interaction of supply and demand is an essential aspect of the analysis of pricing mechanisms of economics. The countries in South Asia have witnessed swings in inflation rates over the years and variables that affect the demand side such as economic variables or consumer spending, and fiscal policy has played a great role in impacting them. However, the supply-chain operation of the economy which usually comes with production-and distribution-related bottlenecks and structural incapacity problems, has become a key indicator of the inflation dynamics of the economy. In this regard, the phrase "supply-side factors" needs to be seen in a broad perspective including the production and availability of products and services and also any structural issues that have an impact on the health of the economy itself.

Many factors can affect inflation level directly or indirectly but focusing on the dynamics of the labor market, technological developments, and oil prices as supply-side variables affecting inflation enables a focused investigation of important drivers in the economic supply chain. These particular factors have a direct impact on the costs of production, the use of resources, and the effectiveness of the supply chain. As a result, they have a major impact on the levels of total prices. By affecting the prices of goods and services, these supply-side variables not only have a direct impact on inflation but also have an impact on larger economic dynamics.

The study aims to critically assess the complex relationship between supply-side factors and price stability to have an apprehension about the ways through which these variables impact price stability. The need for this study arose with the understanding that in fact, supply-side factors are a dynamic phenomenon, which can either exacerbate or mitigate the pricing pressures but they are not simply the passive contributors to inflation. Understanding their role is very important since these variables have several components that can affect the price and the availability of vital goods and services. Their complex role is vital since these variables include a wide range of components that might affect the availability and cost of necessary goods and services. Supply-side issues have the ability to cause price variations, which in turn could affect people's purchasing power and well-being. These factors range from the volatile nature of global oil prices to local natural resources, from technology breakthroughs to regulatory reforms. Therefore, for policymakers, economists, and stakeholders looking to map out a course for achieving long-term economic growth and prosperity, a thorough examination of supply-side issues and their impact on inflation becomes not just pertinent but also crucial.

By concentrating on the impact of supply-side variables, this study aims to improve our knowledge of the dynamics of inflation in South Asia. The research attempts to add to the body of knowledge already available concerning inflation in the region by conducting an empirical analysis of these aspects. It explores the key factors originating from the supply side of the economy, including technical improvements and energy resource availability. This study evaluates how these elements will manage price stability. Finally, via learning more about the supply-side dynamics driving inflation, the research provides suggestions and perspectives that might help decision-makers develop policies that guarantee price stability.

The structure of the paper is as follows: section 2 reviews past studies, section 3 discusses the methodology and econometrics techniques, section 4 discusses results and section 5 concludes the findings of the study and suggests policies.

2. Literature review

Significant scholarly discussion and policy disagreement have surrounded the connection between supply and demand side issues and inflation. Natural resources including oil and forests are a significant supply-side factor that affects the economic progress of a nation (Ahmad, Kuldasheva, Nasriddinov, Balbaa, & Fahlevi, 2023). Demand as well as supply variables can impact a country's overall price level, and these two forces frequently interact to determine inflation's course (Barth & Bennett, 1975; Dramais, 1977; Schwarzer, 2018). Many researchers have argued that the economic pressures that lead to inflation are mostly caused by supply-side factors (Zhang, 2012; Filis & Chatziantoniou, 2014; Masanori, 2020), while others have argued that demand-side factors are primarily responsible for the inflationary pressures that lead to inflation (Monfort & Peña, 2009; Hussain & Obaid, 2013). Utilizing a variety of theoretical paradigms and empirical research, this section of the literature review discusses the numerous supply-side determinants that have been deemed to be inflation drivers. The variables mentioned play a role, in determining manufacturing costs, resource availability, and overall economic productivity and urbanization. These factors have an impact on the dynamics of inflation. However, Pan, Ashraf, Raza, Nasriddinov, and Ahmad (2023) and Ahmad et al. (2023) found that urbanization affects the environment and economic growth asymmetrically.

Economic researchers and industry professionals have long recognized that cost-push inflation and supply fluctuations are contributors to inflationary pressures (Carrin & Barten, 1974; Javed, Farooq, & Akram, 2010; Takami, 2015; Machlup, 2020). Cost-push inflation occurs when rising manufacturing costs, such as labor expenses or raw material prices lead to an increase in prices (Sihotang & Nopeline, 2020; Jain, Sharma, & Kumar, 2022). The classic cost push model is often associated with the writings of Milton Friedman and Edmund Phelps from the 1960s (Friedman, 1968; Phelps, 1968; Laidler, 2007; Dimand, 2008; Schwarzer, 2018). According to these economists' theories when unemployment is low or moderate employees have bargaining power during negotiations. This results, in wage increases that businesses pass on to customers through prices (Tobin, 1972; Lindbeck & Snower, 2001; Hassel, 2014). This concept was backed by research conducted by Lipsey (1960) and Solow (1969), who emphasized the role of labor market dynamics, in driving cost-push inflation.

Supply-side shocks refer to events or changes that disrupt production and impact the availability of goods and services, in the economy (Koks & Thissen, 2016). These disruptions can arise from factors, including fluctuations in resource prices, natural disasters, or geopolitical events. A prime example of supply-side shocks occurred in the 1970s when oil prices experienced fluctuations due, to tensions (Wakeford, 2006; Filippidis, Filis, & Kizys, 2020). Research conducted by Hamilton (1996) Barsky and Kilian (2002) and Aharon, Aziz, and Kallir (2023) indicates that such disturbances can lead to cost-push inflation by increasing production and transportation costs. Numerous empirical studies have analyzed the connection between cost-push inflation and supply-side shocks. Galı and Gertler (1999) and Blanchard and Quah (1989) have explored the role of supply-side shocks in explaining changes in inflation over time and across different countries. Their findings indicate that supply-side shocks, including changes in commodity and oil prices, significantly contribute to fluctuations in inflation. Lei, Yang, Alharthi, Rasul, and Raza (2022) and Gu et al. (2023) argued that dependence on natural resources also creates environmental problems.

The connection, between inflation and advancements in technology has captured the interest of researchers (Shone, 1981; Danninger & Mincer, 2000; McAdam & Willman, 2013). Technological progress is characterized by improvements in production methods and the introduction of products and services. These advancements can have consequences, on inflation. The growth of technology has been consistently associated with productivity, which in turn affects price levels. Solow (1956) proposed the idea of technological advancement as a catalyst for long-term economic growth. The growth model developed by Solow made clear how productivity gains brought on by technological developments might result in increased output without raising prices. The relationship between rising productivity, technological development, and inflation has been studied empirically. According to Gordon (2012), the "Great Stagnation" in productivity growth over the past few decades has lowered inflation. On the other hand, Brynjolfsson and McAfee (2014), Corrado, Haskel, and Jona-Lasinio (2017), and Lv, Liu, and Xu (2019) place a strong emphasis on the contribution of information technology to rising productivity and possible inflation.

An economy's inflationary pressures are greatly influenced by labor market dynamics. There are several ways in which issues associated with the labor market might affect the level of prices generally, making the relationship between inflation and labor markets complicated. The Phillips Curve describes a negative correlation between inflation and unemployment. This link suggests that when unemployment decreases, wage growth quickens, raising the cost of manufacturing. Demand-pull inflation occurs when rising costs are passed on to buyers in the form of increased prices (Phillips, 1958). Expectations of inflation can be influenced by labor market conditions, which in turn can have an impact on how people negotiate pay and establish prices. Businesses and employees may demand greater wages and raise prices if they expect future inflation to be higher (Mankiw, 2001; Rudd, 2022; Yuldashev et al., 2023). Wage pressures can be affected by the extent of labor market rigidity, which is frequently determined by the ratio of open positions to people looking for work. Workers have more negotiating power and can bargain for higher compensation when labor markets are constrained and job openings are abundant. Businesses raising prices to offset rising labor expenses can result in cost-push inflation (Blanchard & Galí, 2007; Demary & Hüther, 2022(Balbaa et al., 2021).

3. Methodology and data

This study uses a linear econometric model to examine how oil prices, technological innovation, and labor market dynamics affect inflation, and the model's specification is as follows:

$$IF_{it} = \pi_0 + \pi_0 \cdot OP_{it} + \pi_0 TECH_{it} + \pi_0 LMD_{it} + \varepsilon_{it} \tag{1}$$

Where i indicates country and t denotes time. IF is inflation, OP is the oil price, TECH is technological innovation and LMD is the labor market dynamics. However, to check long-run and short-run effects, Panel ARDL is used. Before moving to ARDL, it is necessary to test cross-sectional dependence.

3.1. Cross-Sectional dependence test

The assessment of cross-sectional dependence is of paramount significance in empirical research employing panel data, particularly when the sample units consist of developing and transitional countries that share analogous economic characteristics. The escalation in spatial interdependence within panel data is primarily attributed to factors such as globalization, heightened economic integration, and reduced trade barriers (Tufail, Song, Umut, Ismailova, & Kuldasheva, 2022). Thus, we are employing a CD test introduced by Pesaran (2015) that is recommended for both balanced and unbalanced panel datasets and aims to rectify potential biases and inconsistencies that may arise with the ignorance of cross-sectional test. The Pesaran test statistic is characterized by the following expression:

$$CD = \sqrt{\frac{2T}{m(m-1)}} \left(\sum_{i=1}^{m-1} \sum_{j=i+1}^{m} \widehat{l}_{ij} \right) \ m(0,1) \tag{2}$$

Here, 'm' represents the sample size, 'T' denotes the time, $\widehat{l}_{ij}$ signifies the ordered pairwise correlation corresponding to each cross-section within each time. This rigorous assessment allows us to mitigate the potential adverse effects of cross-sectional dependence, ensuring the reliability and integrity of our empirical results.

3.2. Slope homogeneity test

It is imperative to assess the homogeneity of slopes because unit root, cointegration, and long-run estimation techniques, which hinge upon the assumption of homogeneity of slopes, may yield unreliable outcomes when confronted with slope heterogeneity. To address this concern, we have employed the well-regarded slope homogeneity method developed by Pesaran and Yamagata (2008).

$$\widetilde{S} = \sum_{i=1}^{N} \left(\widehat{\beta}_i - \widetilde{\beta}_{WFE} \right) \frac{XiM_\tau X_i}{\sigma_i^2} \left(\widehat{\beta}_i - \widetilde{\beta}_{WFE} \right) \tag{3}$$

$$\widetilde{\Delta} = \sqrt{N} \left(\frac{N^{-1}\ \widetilde{S} - k}{\sqrt{2k}} \right)$$

$$\widetilde{\Delta} = \sqrt{N} \left(\frac{N^{-1}\ \widetilde{S} - E(\widetilde{z}_{it})}{\sqrt{var(\widetilde{z}_{it})}} \right)$$

Where $E(\widetilde{z}_{it}) = k$, $var(\widetilde{z}_{it}) = 2k(T - k - 1)/(T + 1)$.

3.3. Panel unit root test

It is pre-requisite to ascertain the stationarity of the variables incorporated into the model before advancing to cointegration, long-run, and short-run tests. In this regard, we have opted for the utilization of second-generation tests by Pesaran (2007), specifically the CADF and CIPS tests, which take into consideration the presence of cross-sectional dependence and heterogeneity. The rationale behind favoring these second-generation tests over their first-generation counterparts lies in their capacity to address the intricate interplay of cross-sectional dependence and heterogeneity, thereby mitigating the risk of null hypothesis over-rejection, as delineated by (Choi, 2001(Kuldasheva et al., 2023).

$$\Delta x_{it} = \rho_i + \gamma_i x_{i,t-1} + \beta_i \bar{x}_{t-1} + \sum_{j=0}^{k} \delta_{ij} \Delta \widehat{x}_{i,t-j} + \sum_{j=1}^{k} \theta_{ij} \Delta x_{i,t-j} + \varepsilon_{it} \tag{4}$$

Where ΔY_{it} and ρ_i denote a analyzed variable and intercept, respectively. Further, $\bar{x}$ refers to the average for observations at time t, respectively.

Whereas, by averaging the CADF we obtain CIPs.

$$CIPS = \frac{1}{N} \sum_{i=1}^{N} CADF \tag{5}$$

3.4. Panel cointegration test

To examine the long-term link between the variables in this study, the Durbin-Hausman panel cointegration test has applied. This test can only be applied if the endogenous variable is stationary at level I(1), while the independent variable could be stationary at level I(0) or first difference I(1) (Westerlund, 2008). Consequently, the Durbin-Hausman test's mathematical equation is expressed as

$$DH_p = \widehat{S}_n (\widetilde{\varnothing} - \widehat{\varnothing})^2 \sum_{i=1}^{n} \sum_{t=2}^{T} e_{it-1}^2 \tag{6}$$

$$DH_g = \sum_{i=1}^{n} \widehat{S}_i (\widetilde{\varnothing} - \widehat{\varnothing})^2 \left(\sum_{t=2}^{T} e_{it-1}^2 \right) \tag{7}$$

In panel testing, DHp is computed by summing individual terms and then multiplying, while DHg calculates by multiplying components and then summing. It's crucial to differentiate these statistics when forming alternative hypotheses. Panel mean null hypothesis is H_0: i = 1 for all individual-specific effects; Alternative hypothesis is H_1: i = 1 for all i. Group mean null hypothesis H_0: i = 1 while Alternative hypothesis is: H_1: i = 1 for at least some, indicating varying average individual-specific effects across dataset entities.

3.5. Panel autoregressive distributed lag (ARDL) model

In pursuit of estimating the long term and short-term effects of independent variables on inflation, we have adopted the panel ARDL (Autoregressive Distributed Lag) modeling approach. The rationale for selecting this method is grounded in its demonstrated efficiency, particularly when we are dealing with small sample sizes. Moreover, the panel ARDL model is well-suited for addressing potential issues related to serial correlation and endogeneity, based on proper lag selection and robust estimates. The equation of Panel ARDL is written as

$$IF_{it} = \omega_i + \sum_{j=1}^{r} \beta_{ij} IF_{i,t-j} + \sum_{j=0}^{q} \alpha_{1ij} OP_{i,t-j} + \sum_{j=0}^{q} \alpha_{2ij} TECH_{i,t-j} + \sum_{j=0}^{q} \alpha_{3ij} LMD_{i,t-j} + \varepsilon_{it} \tag{8}$$

To select optimal lag length Akaike Information Criterion is used. The error correction form of the above model is as follows;

$$\Delta IF_{it} = \vartheta_i + \sum_{j=1}^{r-1} \beta_{ij} \Delta IF_{i,t-j} + \sum_{j=0}^{q-1} \alpha_{1ij} \Delta OP_{i,t-j} + \sum_{j=0}^{q-1} \alpha_{2ij} \Delta TECH_{i,t-j} + \sum_{j=0}^{q-1} \alpha_{3ij} \Delta LMD_{i,t-j} + \varphi_i ECT_{i,t-1} + \varepsilon_{it} \tag{9}$$

Where $ECT_{i,t-1} = IF_{i,t-1} - \gamma_{1i} OP_{i,t-1} - \gamma_{2i} TECH_{i,t-1} - \gamma_{3i} LMD_{i,t-1}$ In this context, φ_i represents the speed of adjustment coefficient, and a noteworthy, negative value of this coefficient signifies the presence of integration between the dependent and independent variables. Additionally, π_{1i}, π_{2i}, π_{3i} denote the long-run coefficients. We have employed both the Mean Group (MG) and Pooled Mean Group (PMG) estimation techniques. In the panel ARDL models, the PMG approach, as proposed by Pesaran, Shin, and Smith (1999), assumes that the long-run coefficients (πi) are uniform across different cross-sections while allowing for heterogeneity in the short-run coefficients. In contrast, the MG approach, introduced by Pesaran and Smith (1995), is the least constricting approach, accommodating heterogeneity of all parameters. Thus, the choice of the appropriate approach is determined by conducting the Hausman test.

3.6. Data

This study uses panel data for the period of 1995 to 2022 for selected 5 South Asian countries Pakistan, Bhutan, Bangladesh, India, and Sri Lanka. South Asia is dealing with distinct developmental obstacles, such as disparities in infrastructure, poverty, and income disparities. Inflation dynamics directly impact these issues, thus it's critical to comprehend what factors can control inflation dynamics. Policymakers may support more equitable and sustainable development in South Asia by properly controlling inflation. The data on inflation is collected from the WDI database. The data on crude oil prices is gathered from the EIA database. For technological innovations, data on patents is used as a proxy and the data is collected from the WDI database. To assess the impact of labor market dynamics, we used ILO's data on the global employment rate. The labor market in South Asia is becoming more and more integrated with the world economy. South Asian industries and enterprises are directly impacted by changes in global employment trends and rates, particularly those in the manufacturing or service sectors that are focused on exports.

4. Results and discussion

Prior to performing the unit root analysis, a Cross-Sectional Dependence (CD) test is used in this study. The findings of the CD test show that there is no proof of cross-sectional dependence across the variables being studied. The outcome of the Cross-Sectional Dependency test is notable and is clearly illustrated in Table 1. Low p-values (all below 5 %), which indicate the existence of cross-sectional dependency at the level of significance equal to 1 % for all series under consideration, indicate that the null hypothesis has been ruled out based on the test results. This finding implies that changes or disturbances in the variables may potentially impact any of the panel regions.

The CD test essentially emphasizes how closely connected the variables are across various locations in the panel dataset. This conclusion is significant because it suggests that things affecting one region may have an impact on others as well, emphasizing the need for a thorough understanding of how different regions are interrelated. Furthermore, this study uses a test by Pesaran and Yamagata (2008) to determine if the coefficients under cointegration remain consistent or homogeneous across the variables. This test has been designed to determine whether the slope parameters of cointegration relationships are uniform or homogeneous. In this test, the null hypothesis is that there are homogeneous slope parameters, which implies that the coefficients are constant between the panels. The alternative hypothesis, on the other hand, suggests that there is no homogeneity and that the coefficients greatly vary between the panels. The test outcome, which is shown in Table 2, offers important insights into the empirical validity of the null hypothesis, and based on the results we conclude that there exists slope heterogeneity.

This study then uses second-generation panel unit root tests, CIPS and CADF, to look at the stationarity characteristics of the variables in more detail. These tests will add to our understanding of the time series properties of the data and aid in identifying any potential long-term patterns or structural fractures, making the analysis more thorough. The findings of these tests are reported in Table 3. The findings show that IF is non-stationary at a level however it becomes stationary after taking the first difference. OP is also non-stationary at the level and stationary at the first difference. Tech is stationary at both the level and the first difference. LMD is stationary at both level and first difference according to CIPS while non-stationary at the level according to CADF and stationary at the first difference.

In this approach, determining whether the variables have a long-term equilibrium connection is the main goal. Understanding how these factors interact through time and whether they have a propensity to move together, in the long run, requires establishing such a relationship. The study makes use of a cointegration test created by Westerlund (2008) to investigate this. The Westerlund cointegration examination was purposefully chosen, and various reasons drove this decision. First off, this test is renowned for being effective even when used with modest sample sizes. It can be difficult to get statistically reliable results in many empirical studies, especially those that include few data points or observations. The Westerlund cointegration test, however, is made to produce accurate results. A crucial issue in panel data analysis, panel heterogeneity, is addressed by the Westerlund cointegration test, which tackles the first issue. Differentiations or

Table 1
CD test results.

Variables	CD-Stat	P value
IF	5.32	0.000 ***
OP	27.98	0.000 ***
TECH	21.57	0.000 ***
LMD	4.98	0.000 ***

Note: IF, inflation; OP, oil price; Tech, technological innovation; LMD, labor market dynamics. *** shows a 1 percent significance level.

Table 2
Slope homogeneity test results.

Test	Statistic	p-value
Delta-tilde	16.09	0.000***
Delta-tilde-adj	19.20	0.000***

Note: *** shows a 1 percent significance level.

Table 3
Outcomes of CIPS and CADF.

Variables	CIPS		CADF	
	level	1st difference	level	1st difference
IF	−1.098	0.145	−1.443	0.113
OP	−0.769	−3.764 ***	−1.024	−3.065 ***
TECH	−3.799 ***	−3.913***	−2.985**	−3.113***
LMD	−2.412**	−3.874***	−1.433	−3.009 ***

Note: ** and *** shows 5 and 1 percent significance level respectively.

variations between the many entities or groups that make up the dataset are referred to as heterogeneity. Different economic conditions, regional differences, or other factors may be the cause of this heterogeneity. The influence of heterogeneity across the long-term and short-term associations between variables is significant. The Westerlund test accounts for and manages this heterogeneity, making sure the findings are reliable and transferable across different panels. The findings are given in Table 4 and results indicate the existence of cointegration.

The Panel approach is used in this work to calculate the short- and long-term impacts of three important variables on inflation: oil prices, technological innovation, and labor market dynamics. This approach enables the examination of connections, between variables over both long timeframes. Furthermore, to determine the lag length for our model we have deployed Akaike Information Criteria (AIC) to accurately capture the dynamics of these interactions.

Table 5 displays the outcomes of the Panel ARDL estimation. The model is estimated using two widely used estimators, the Mean Group (MG) estimator and the Pooled Mean Group (PMG) estimator. Given that they take into account group-specific data variances, these estimators are useful tools in the analysis of panel data. This study uses the Hausman test to evaluate which of the two estimators—MG or PMG—is more suitable for the model. A statistical test called the Hausman test is used to determine whether the variations within the estimators are consistent or random. By comparing the consistency and effectiveness of the MG and PMG estimators, it is possible to select the best one for this study. The Hausman statistic is stated to have a value of 2.49 and a probability value of 0.330. When analyzing the findings of the Hausman test, researchers decide whether the probability value is less than a predetermined significance level, frequently set at 0.05. Since the probability value (0.330) goes above 0.05 thus we conclude that PMG is better.

Results reported in Table 5 show that error adjustment is taking place. The ECT value of −0.389 in PMG shows that 38.9 percent of error is being adjusted annually however the rate is higher in MG. The coefficient value of OP in both MG and PMG shows that oil prices cause the overall price level to increase over the short and long run. According to PMG 1 percent increase in OP causes inflation to increase by 0.523 percent in the short run and 0.329 percent in the long run. In the short term, rising oil prices directly increase production costs for firms,

Table 4
Westerlund test results.

	Statistic	p-value
DH Group stat	4.092	0.000***
DH Panel stat	3.240	0.000***

Note: *** shows 1 percent significance.

Table 5
Result of ARDL (1,1,0,0).

Variable	MG		PMG	
	Short run	Long run	Short run	Long run
ECT	−0.543 ***		−0.389 ***	
ΔOP	0.335 ***		0.523 ***	
ΔTECH	−0.078		−0.152**	
ΔLMD	0.176		0.688***	
OP		0.105*		0.329**
TECH		−0.787**		−1.098***
LMD		0.045		0.619***
Constant	3.286***		1.542**	
Hausman Test	2.49, p-value (0.330)			
Obs.	140			

Note: *, ** and *** shows 10, 5, and 1 percent significance level respectively.

especially those that depend substantially on petroleum as an input, such as the manufacturing and transportation sectors. Businesses may decide to pass on these greater production costs to customers by increasing the price of their products and services. Cost-push inflation is the term for this process. Expectations of inflation might be affected by persistently high oil prices. Consumers and corporations may alter their behavior if they believe that the price of oil will grow in the long run. Businesses may boost prices in expectation of greater production costs, while employees may demand better wages to compensate for rising energy expenses. These inflation expectations have the potential to self-fulfill, which would raise prices over time. From production to transportation, oil is an essential link in many supply networks. Long-term high oil prices might result in increased expenses across the board for the industrial process. These price rises may spread amongst other businesses, eventually having a wider-ranging inflationary effect.

The coefficient of TECH is insignificant in the short run and significant in the long run according to MG estimates while the PMG estimates show that technological innovation has a decreasing effect on inflation over the short and long run. According to PMG, 1 percent increase in TECH decreases inflation by 0.152 percent in the short run and 1.098 percent in the long run. Production processes are frequently enhanced by technological breakthroughs, making them more effective. Businesses may experience a short-term reduction in production costs as a result of this improved efficiency, allowing them to offer products or services at a reduced cost. Lower overall inflation rates result from the reduction or, in certain circumstances, reversal of cost-push inflationary pressures. Long-term technological advancements can result in steady gains in productivity in a variety of economic sectors. The overall supply of commodities can rise without raising prices as employees and machines grow more effective at creating goods and services. With increased supply capacity, rising demand may be met without having to raise prices, which promotes price stability and decreases inflation.

The MG estimates show that LMD has an insignificant effect on inflation in the short run while the effect is significantly positive on inflation in the long run. On the other hand, according to PMG, the coefficient of LMD is positive in both short and long periods. According to PMG, 1 percent increase in LMD increases inflation by 0.688 percent in the short run and 0.619 percent in the long run. Through the idea of demand-pull inflation, labor market dynamics might affect inflation in the short term. Workers frequently have more negotiating leverage to demand higher salaries when labor markets tighten, which means there is an increase in employment and a drop in unemployment. Businesses may increase the price of goods and services for consumers as a result of rising wages. As a result, there is excessive demand for products and services, which exceeds supply, pushing up prices. The concept of cost-push inflation allows for the long-term impact of labor market dynamics to be felt on inflation. Long-term tight labor markets may result in rising wages, which would raise enterprises' production costs. These cost increases may eventually be reflected in increased pricing for products and services, which will help drive up inflation. Long-term fluctuations in

Table 6
Granger-Causality test.

Hypothesis	Z-stat	p-value
IF doesn't cause OP	0.332	0.693
OP doesn't cause IF	1.832	0.032**
IF doesn't cause TECH	0.605	0.441
TECH doesn't cause IF	1.691	0.074*
IF doesn't cause LMD	0.092	0.854
LMD doesn't cause IF	2.647	0.000***
OP doesn't cause TECH	0.139	0.778
TECH doesn't cause OP	0.826	0.410
OP doesn't cause LMD	1.523	0.049**
LMD doesn't cause OP	0.234	0.758
TECH doesn't cause LMD	2.046	0.002***
LMD doesn't cause TECH	1.132	0.127

Note: *, ** and *** shows 10, 5, and 1 percent significance level respectively.

labor productivity, population trends, and employment rates can also have an impact on the economy's overall supply of products and services, which can have an impact on inflation trends.

We have also performed Granger causality test to analyze the causality between variables of the model. The result of causality test is reported in Table 6. Results show that oil price, technology and labor market dynamics affect inflation significantly. Furthermore, oil prices and technology are also found to affect labor market dynamics because several industries are sensitive to changes in oil prices and technological advancements can lead to job displacements.

5. Conclusion and policy suggestions

This study by employing Panel ARDL on selected South Asian countries for the period of 1995–2022, assesses the impact of oil price, technology, and labor market dynamics on inflation. The cointegration test validates the existence of long-run relationships between variables while the Hausman test favors PMG estimates. This study concludes that oil prices significantly affect inflation in South Asian economies. Inflation is significantly impacted by oil prices, which are frequently known for their volatility and vulnerability to world events. Despite the fact that rising costs of production and energy-related expenses can cause short-term spikes in inflation, the long-term implications of oil price shocks are more complex. Technological innovations have the potential to reduce inflationary pressures when used appropriately. Inflation is significantly influenced by the state of the labor market, which is reflected in elements like employment rates. Short-term demand-pull inflation can be caused by tight labor markets when workers seek higher wages. On the other hand, sustained wage rise over time may trigger cost-push inflation.

Based on the findings, this study suggests that the inflationary effects of fluctuating oil prices over time can be reduced by diversifying one's energy supply and increasing energy efficiency. Governments should think about creating strategic petroleum reserves and putting in place price stability mechanisms to lessen the short-term impact of oil price changes on inflation. Energy efficiency and the promotion of renewable energy sources should be prioritized in long-term strategies since they can improve energy security and lessen sensitivity to fluctuations in the price of oil. To enhance the favorable effect of technology on inflation, a climate that encourages technological innovation should be promoted by policymakers. Investments in education, research, and development, and the formation of innovation clusters can help achieve this. Regarding labor market dynamics, this study suggests improving unemployment insurance programs to offer assistance during economic downturns, easing pressure on wages and inflation during times of tight labor markets.

Political, social, and institutional issues can cause differences in a country's endorsement and implementation of policies. The viability and efficacy of the above recommendations may be impacted by differences in governments' desire and ability to implement recommended measures.

5.1. Limitations and future direction

One notable limitation of this research might be that it only considers supply-side variables to explain inflation trends. Even while these issues must be examined, focusing only on supply-side drivers might ignore the complex interactions that effect inflation in the South Asian region due to demand-side dynamics, foreign factors, and monetary policy. Future studies may consider adopting a more adequate methodology that takes into account the complex connections between supply-side and demand-side components in shaping inflation dynamics.

CRediT authorship contribution statement

Maaz Ahmad: Conceptualization, Writing – original draft. **Zebo Kuldasheva:** . **Nilufar Ismailova:** Project administration, Supervision. **Muhammad Eid Balbaa:** Data curation, Formal analysis. **Nazokat Akramova:** Software, Validation. **Noor Ul Ain:** Investigation, Resources.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

Aharon, D. Y., Aziz, M. I. A., & Kallir, I. (2023). Oil price shocks and inflation: A cross-national examination in the ASEAN5+ 3 countries. *Resources Policy, 82*, Article 103573.

Ahmad, M., Kuldasheva, Z., Nasriddinov, F., Balbaa, M. E., & Fahlevi, M. (2023). Is achieving environmental sustainability dependent on information communication technology and globalization? Evidence from selected OECD countries. *Environmental Technology & Innovation, 31*, Article 103178.

Balbaa, M., Ismailova, N., & Kuldasheva, Z. (2021). The impact of innovation and digitalization on service sector at post-pandemic era. In *The 5th International Conference on Future Networks & Distributed Systems* (pp. 334–342).

Barsky, R. B., & Kilian, L. (2002). Oil and the macroeconomy since the 1970s. *Journal of Economic Perspectives, 18*(4), 115–134.

Barth, J. R., & Bennett, J. T. (1975). Cost-push versus demand-pull inflation: Some empirical evidence: Comment. *Journal of Money, Credit and Banking, 7*(3), 391–397.

Blanchard, O. J., & Quah, D. (1989). The dynamic effects of aggregate demand and supply disturbances. *The American Economic Review*, 655–673.

Blanchard, O., & Galí, J. (2007). Real wage rigidities and the new keynesian model. *Journal of Money, Credit and Banking, 39*, 35–65.

Brynjolfsson, E., & McAfee, A. (2014). *The second machine age: Work, progress, and prosperity in a time of brilliant technologies*. WW Norton & Company.

Carrin, G., & Barten, A. P. (1974). International aspects of cost push inflation. In *Inflation in Small Countries: Proceedings of an International Conference Held at the Institute for Advanced Studies Vienna, November 1974* (pp. 243-271). Berlin, Heidelberg: Springer Berlin Heidelberg.

Choi, I. (2001). Unit root tests for panel data. *Journal of International Money and Finance, 20*(2), 249–272.

Corrado, C., Haskel, J., & Jona-Lasinio, C. (2017). Knowledge spillovers, ICT and productivity growth. *Oxford Bulletin of Economics and Statistics, 79*(4), 592–618.

Danninger, S., & Mincer, J. (2000). *Technology, unemployment, and inflation. In Research in Labor Economics* (Vol. 19,, 1–28.

Demary, M., & Hüther, M. (2022). How large is the risk of stagflation in the eurozone? *Intereconomics, 57*(1), 34–39.

Dimand, R. W. (2008). Edmund Phelps and modern macroeconomics. *Review of Political Economy, 20*(1), 23–39.

Dramais, A. (1977). Transmission of inflationary pressures between the EEC members: A tentative measurement using cost-push and demand-pull formulations. *European Economic Review, 9*(1), 21–42.

Filippidis, M., Filis, G., & Kizys, R. (2020). Oil price shocks and EMU sovereign yield spreads. *Energy Economics, 86*, Article 104656.

Filis, G., & Chatziantoniou, I. (2014). Financial and monetary policy responses to oil price shocks: Evidence from oil-importing and oil-exporting countries. *Review of Quantitative Finance and Accounting, 42*, 709–729.

Friedman, M. (1968). Keynes offered simultaneously an explanation for the presumed importance of monetary policy to stem the depression, a nonmonetary interpretation of the depression, and an alternative to monetary policy. *The American Economic Review, 58*(1).

Galı, J., & Gertler, M. (1999). Inflation dynamics: A structural econometric analysis. *Journal of Monetary Economics, 44*(2), 195–222.

Gordon, R. J. (2012). *Is US economic growth over? Faltering innovation confronts the six headwinds* (No. w18315). National Bureau of Economic Research.
Gu, X., Alamri, A. M., Ahmad, M., Alsagr, N., Zhong, X., & Wu, T. (2023). Natural resources extraction and green finance: Dutch disease and COP27 targets for OECD countries. *Resources Policy, 81*, Article 103404.
Hamilton, J. D. (1996). This is what happened to the oil price-macroeconomy relationship. *Journal of Monetary Economics, 38*(2), 215–220.
Hassel, A. (2014). The paradox of liberalization—Understanding dualism and the recovery of the G erman political economy. *British Journal of Industrial Relations, 52* (1), 57–81.
Hussain, A., & Obaid, Z. (2013). Cost-push vs demand-pull inflation: Evidence from an emerging economy (Pakistan). *Journal of Humanities & Social Sciences, 21*(2).
Jain, M. P., Sharma, A., & Kumar, M. (2022). Recapitulation of demand-pull inflation & cost-push inflation in an economy. *Journal of Positive School Psychology*, 2980–2983.
Javed, Z. H., Farooq, M., & Akram, S. (2010). Cost-push shocks and inflation: An empirical analysis from the economy of Pakistan. *Journal of Economics and International Finance, 2*(12), 308.
Koks, E. E., & Thissen, M. (2016). A multiregional impact assessment model for disaster analysis. *Economic Systems Research, 28*(4), 429–449.
Kuldasheva, Z., Ahmad, M., Salahodjaev, R., & Fahlevi, M. (2023). Do tourism and renewable energy influence CO2 emissions in tourism-dependent countries? *International Journal of Energy Economics and Policy, 13*(6), 146–152.
Laidler, D. (2007). Milton Friedman–a brief obituary. *The European Journal of the History of Economic Thought, 14*(2), 373–381.
Lei, X., Yang, Y., Alharthi, M., Rasul, F., & Raza, S. M. F. (2022). Immense reliance on natural resources and environmental challenges in G-20 economies through the lens of COP-26 targets. *Resources Policy, 79*, Article 103101.
Lindbeck, A., & Snower, D. J. (2001). Insiders versus outsiders. *Journal of Economic Perspectives, 15*(1), 165–188.
Lipsey, R. G. (1960). The relation between unemployment and the rate of change of money wage rates in the United Kingdom, 1862–1957: A further analysis. *Economica*, 1–31.
Lv, L., Liu, Z., & Xu, Y. (2019). Technological progress, globalization and low-inflation: Evidence from the United States. *PloS one, 14*(4), e0215366.
Machlup, F. (2020). Another view of cost-push and demand-pull inflation. In *Economic Semantics* (pp. 241–268). Routledge.
Mankiw, N. G. (2001). The inexorable and mysterious tradeoff between inflation and unemployment. *The Economic Journal, 111*(471), 45–61.
Masanori, A. M. A. N. O. (2020). Inflation: Demand-pull or cost-push? Optimization-based, three-country estimation. 千葉大学経済研究= *Economic Journal of Chiba University, 34*(3–4), 47–64.
McAdam, P., & Willman, A. (2013). Technology, utilization, and inflation: What drives the new Keynesian Phillips curve? *Journal of Money, Credit and Banking, 45*(8), 1547–1579.
Monfort, B., & Peña, S. (2009). *Inflation determinants: Cost push versus demand pull factors* (p. 141). Paraguay: Addressing the Stagnation and Instability Trap.
Pan, X., Ashraf, A., Raza, S. M. F., Nasriddinov, F., & Ahmad, M. (2023). Exploring the asymmetric effects of urbanization and trade on CO2 emissions: Fresh evidence from Pakistan. *Environmental Science and Pollution Research, 30*(38), 89770–89783.
Pesaran, M. H. (2007). A simple panel unit root test in the presence of cross-section dependence. *Journal of Applied Econometrics, 22*(2), 265–312.
Pesaran, M. H. (2015). Testing weak cross-sectional dependence in large panels. *Econometric Reviews, 34*(6–10), 1089–1117.
Pesaran, M. H., & Smith, R. (1995). Estimating long-run relationships from dynamic heterogeneous panels. *Journal of Econometrics, 68*(1), 79–113.
Pesaran, M. H., & Yamagata, T. (2008). Testing slope homogeneity in large panels. *Journal of Econometrics, 142*(1), 50–93.
Pesaran, M. H., Shin, Y., & Smith, R. P. (1999). Pooled mean group estimation of dynamic heterogeneous panels. *Journal of the American Statistical Association, 94* (446), 621–634.
Phelps, E. S. (1968). Money-wage dynamics and labor-market equilibrium. *Journal of Political Economy, 76*(4, Part 2), 678–711.
Phillips, A. W. (1958). The relation between unemployment and the rate of change of money wage rates in the United Kingdom, 1861–1957. *Economica, 25*(100), 283–299.
Rudd, J. B. (2022). Why do we think that inflation expectations matter for inflation? (and should we?). *Review of Keynesian Economics, 10*(1), 25–45.
Schwarzer, J. A. (2018). Retrospectives: Cost-push and demand-pull inflation: Milton Friedman and the "cruel dilemma". *Journal of economic perspectives, 32*(1), 195–210.
Shone, R. (1981). Technical change, inflation and pricing decisions. *Managerial and Decision Economics, 2*(3), 169–178.
Sihotang, J., & Nopeline, N. (2020). Analysis of the Influence of Interest Rate, Rupiah Exchange Value, Household Consumption, and Import on Inflation in Indonesia Period 2010. Q1-2018. Q4. *International Journal of Science and Management Studies (IJSMS)*, *3*(6), 81-91.
Solow, R. M. (1956). A contribution to the theory of economic growth. *The Quarterly Journal of Economics, 70*(1), 65–94.
Solow, R. M. (1969). *Price expectations and the behavior of the price level: Lectures given in the University of Manchester*. Manchester University Press.
Takami, N. (2015). The baffling new inflation: How cost-push inflation theories influenced policy debate in the late-1950s United States. *History of Political Economy, 47*(4), 605–629.
Tobin, J. (1972). Inflation and unemployment. *American Economic Review, 62*(1), 1–18.
Tufail, M., Song, L., Umut, A., Ismailova, N., & Kuldasheva, Z. (2022). Does financial inclusion promote a green economic system? Evaluating the role of energy efficiency. *Economic Research-Ekonomska Istraživanja, 35*(1), 6780–6800.
Wakeford, J. (2006). The impact of oil price shocks on the South African macroeconomy: History and prospects. In *Accelerated and Shared Growth in South Africa: Determinants, Constraints and Opportunities,(18-20 October 2006). The Birchwood Hotel and Conference Centre, Johannesburg, South Africa*.
Westerlund, J. (2008). Panel cointegration tests of the Fisher effect. *Journal of Applied Econometrics, 23*(2), 193–233.
Yuldashev, M., Khalikov, U., Nasriddinov, F., Ismailova, N., Kuldasheva, Z., & Ahmad, M. (2023). Impact of foreign direct investment on income inequality: Evidence from selected Asian economies. *PLoS One, 18*(2), e0281870.
Zhang, X. (2012). China's inflation: Demand-pull or cost-push? *Asian Economic Papers, 11* (3), 92–106.