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### **Construction and Seasonal Patterns of Islamic Hijri Calendar Monthly Time Series: An Application to Consumer Price Index (CPI) in Pakistan**

**Riaz Riazuddin**

**STATE BANK OF PAKISTAN**

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Editor: Riaz Riazuddin

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# **Construction and Seasonal Patterns of Islamic Hijri Calendar Monthly Time Series: An Application to Consumer Price Index (CPI) in Pakistan**

Riaz Riazuddin

## **Abstract**

Time series data are compiled and analysed in accordance with Gregorian calendar, given its world-wise use. This paper presents a simple method of constructing time series in accordance with Hijri Calendar from an already compiled Gregorian time series. Preliminary seasonal analysis of Hijri time series for CPI in Pakistan provides new insights of price behavior that depends both on Gregorian and Hijri seasonality. A spliced series of monthly CPI from January 1976 to December 2008 spanning 33 Gregorian years (396 Gregorian months) is used to capture a full cycle of 34 Hijri years (408 Hijri months). Method presented is general and can be used to construct and analyse any variable of interest. Paper proposes that statistical agencies and central banks of Islamic countries should also compile data according to Hijri Calendar, in addition to existing compilation according to Gregorian calendar. This will add to a better understanding of socioeconomic behaviours in Islamic countries.

**Key words:** Hijri, CPI, Seasonal Effects, Gregorian, Time Series.

## **Acknowledgment**

I am grateful to Mahmood ul Hasan Khan, Muhammad Nadeem Hanif, Muhammad Akmal and Syed Kamran Najam for their very helpful comments and Saghir Pervaiz Ghauri for providing the 33 years spliced monthly series of CPI. I am also thankful to Zia ur Rehman, Amir Abbasi and Omar Farooq for compiling actual dates of beginning of Hijri months from past newspapers. An earlier version of this paper was presented in the 2<sup>nd</sup> International Conference on Islamic Business organized by Riphah International University, Islamabad, 28-29 February 2012.

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## **Introduction**

Time is one of the most important manifestations of existence in the universe and beyond. Life, natural events and other phenomena are observed and analyzed with the measurement of time. Almost every kind of analytical process related to any subject usually takes place within the Gregorian calendar because of its universal acceptance and adoption in secular matters. Business and economic time series are only available in Gregorian calendar and analyses of socioeconomic and business trends are restricted to this calendar. This does not necessarily constrain the evolution of knowledge in western societies where socioeconomic behaviours are mostly secular or influenced by Christian tradition. In Islamic societies, however, the analysis of time series within Gregorian calendar conceals many important aspects that are profoundly influenced by Islamic tradition and Hijri calendar. This is also true for other societies largely following a non-Christian tradition or non-Gregorian calendars. An excellent taxonomy of different calendars still in use today is provided in Dershowitz and Reingold (2008).

In this paper I present a simple method to construct a monthly time series of a variable according to Islamic Hijri calendar. Application of this method to consumer price index in Pakistan reveals some simple characteristics of Hijri time series which remain largely concealed under conventional Gregorian time series analysis. While it is possible to isolate Islamic Hijri calendar effects within a Gregorian time series as shown in Riazuddin and Khan (2002), it has been shown by Yucel (2005) that these effects are better captured when Hijri calendar is used. Yucel (2005) suggested a simple method to transform the values of inflation recorded in Gregorian calendar to the values of inflation in accordance with Hijri calendar. I formalize this method and apply it to CPI in Pakistan for the 33 Gregorian-year period between 1-January-1976 to 31-December-2008, which contains a complete cycle of 34 Hijri years between 1-Muharram-1396 to 30-Zilhaj-1429<sup>1</sup>.

Rest of the paper proceeds as follows. Rationale of the period chosen is described in section 1 along with the data and method of transforming a Gregorian variable to corresponding Hijri variable. Section 2 presents the basic statistical features of Gregorian and Hijri CPI time

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<sup>1</sup> Numbers of days in a Hijri year are 10-12 days less than a Gregorian year. Thus after 33 Gregorian years, the difference becomes one Hijri year.

series along with a preliminary comparison of seasonal characteristics under Gregorian and Hijri calendars. Section 3 presents some basic regressions that reproduce average monthly changes in CPI under the two calendars, besides providing significance tests for presence of seasonal effects. Final section concludes and also presents some suggestions for the way forward in Hijri time series analysis.

### **Section 1: Gregorian Data and Method of Transformation to Hijri Calendar**

Gregorian calendar dates of the beginning of Hijri months become the starting point of constructing a Hijri time series. It would be much simpler to transform Gregorian daily data into Hijri calendar by just reorganizing it into Hijri months and years by using Gregorian-Hijri dates. This can be done easily for the data on stock market prices, foreign exchange rates, gold prices, atmospheric temperatures<sup>2</sup> etc. or any other variable recorded daily. Consumer prices are usually recorded within a period of month to compute a consumer price index (CPI) for any given Gregorian month. These have to be transformed appropriately to conform with the Hijri calendar. This is done as follows.

Let

$CPI_{Hj}$  = consumer price index for the  $j^{\text{th}}$  Hijri month

$CPI_{Gt}$  = consumer price index for the  $t^{\text{th}}$  Gregorian month given that the  $j^{\text{th}}$  Hijri month ended during the  $t^{\text{th}}$  Gregorian month

$n_{jt}$  = number of days of  $j^{\text{th}}$  Hijri month overlapping with  $t^{\text{th}}$  Gregorian month

$n_t$  = number of days in  $t^{\text{th}}$  Gregorian month

CPI for Hijri calendar can then be easily constructed as

$$CPI_{Hj} = CPI_{Gt-1} + \frac{n_{jt}}{n_t} (CPI_{Gt} - CPI_{Gt-1}) \quad (a)$$

This transformation simply takes an index from a Gregorian month and adds (subtracts) the component of differential change in CPI during the next Gregorian month, adjusted by the overlap ratio of Hijri month with the next Gregorian month in which the Hijri month terminates. Assumption implicit in above construction is that the change in CPI within a month is spread uniformly over the number of days of given month. This assumption will not create any distortion because there is only one value of index available for a Gregorian month.

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<sup>2</sup> One should not expect any seasonal pattern in atmospheric temperatures for Hijri calendar.

Proposed transformation takes monthly Gregorian index and converts it into monthly Hijri index.

It should be noted that above formation (a) is appropriate only for index or stock variables. For other variables, following formulation may be used.

$$X_{Hj} = \frac{n_{j,t-1}}{n_t} X_{G,t-1} + \frac{n_{j,t}}{n_t} X_{G,t} \quad (b)$$

Formulation (b) would be relevant for transforming Gregorian series of variables like export, import, production etc.

It is possible that a Hijri month is spread over three Gregorian months instead of just two<sup>3</sup>. In that case, the following formulation would be appropriate.

$$X_{Hj} = \frac{n_{j,t-2}}{n_{t-1}} X_{G,t-2} + \frac{n_{j,t-1}}{n_t} X_{G,t-1} + \frac{n_{j,t}}{n_t} X_{G,t} \quad (c)$$

I use a spliced series of monthly CPI (base year: 2000-2001) from January 1976 to December 2008 and formulation (a) to generate a Hijri monthly series of CPI from Muharram 1396 to Zilhaj 1429 (shown in Annexes A & B). Numbers of days of Hijri months overlapping with Gregorian months are shown in Annex C. I have chosen 33 Gregorian years (396 Gregorian months) to ensure that a complete cycle of 34 Hijri years (408 Hijri months) is present in the time series. While the method does not necessarily demand such a long series, a complete overlap of all 12 Hijri months with all 12 Gregorian months is advantageous to produce a more rich analysis of seasonal behavior. A shorter series will not be able to provide a complete picture of these overlaps, although transformation can easily proceed. A summary of Hijri-Gregorian monthly overlaps is shown in Table 1. Each Hijri month is fully represented in the chosen span of 33 Gregorian years.

[Table 1 here]

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<sup>3</sup> For example, a Hijri month may start from 31 January and terminate on 1 March.

## **Section 2: Statistical Features of Hijri and Gregorian Time Series of CPI**

A picture is worth a thousand words and, therefore, summary characteristics of series of data can aptly be shown in histograms, box plots and time series plots. I first compute the monthly percent changes in CPI for each calendar series. A comparison of statistical features of Hijri and Gregorian CPI month-on-month changes is shown in Figure 1. The first noteworthy point is the presence of outliers in both original Gregorian and transformed Hijri series of monthly changes in CPI. Second noteworthy feature is the non-normality of their distributions. Compared to the normal distribution, both are characterized by high skewness, kurtosis and thick tails. Departure from normality is more severe for the Gregorian series, which is apparent from a value of Jarque-Bera statistic that is more than twice of Hijri value. Spread of Hijri series in terms of standard deviation of monthly CPI changes is 20% lower than that of Gregorian series. This means that fluctuations in price changes under Hijri calendar become considerably dampened compared with those under Gregorian calendar. Any further statistical analysis has to take cognizance of these features.

[Figure 1 here]

I now come to the question of whether seasonal monthly effects are present in Hijri CPI series and how do they compare with the Gregorian seasonal effects. A pictorial representation can be much more effective in displaying the strength of seasonal effects. Figure 2 presents a comparison of Hijri and Gregorian seasonal means and medians of CPI month-on-month percent changes. Top pair of graphs in Figure 2 shows arithmetic means by Hijri and Gregorian months. Here, the influence of outliers is visible. Hijri monthly mean price changes seem to vary from each other, but less so compared with those of Gregorian means. Highest average monthly change occurs in the month of Sha'aban for Hijri series and July for Gregorian series.

Middle pair of Figure 2 compares the box plots of monthly price changes for Hijri and Gregorian months. Differences in mean and median changes come across as more visually significant compared to the top pair. The bottom pair of graphs in Figure 2 shows the comparison of seasonal medians of monthly price changes for Hijri and Gregorian series. Here, the presence of seasonal pattern is even more pronounced than earlier pair of graphs.

[Figure 2 here]

One particular feature of Hijri medians seems to distinguish itself from those of Gregorian medians. Hijri seasonal medians were never negative compared to Gregorian medians, which

are negative for May and December. Also, all Hijri seasonal medians are much closer to their global median (of 408 monthly CPI changes). In contrast, all Gregorian medians fluctuate widely from their global median (of 396 monthly CPI changes). This means that seasonal effects while present in Hijri CPI series, are much more dampened compared to the seasonal effects of Gregorian CPI series. For a lay person (not appropriately aware of the seasonal effects), Hijri monthly inflation is less likely to convey a confounding message about expected signal of inflation direction, compared with relative confounding signals of “fall” in inflation when it is not actually falling! Likewise, in case of increasing inflation, chances are greater for unadjusted Gregorian inflation to convey an exaggerated sense of increase.

In other words, it seems that the need for seasonal adjustment is much more acute for Gregorian series than Hijri series. It also seems that unadjusted Hijri series may be better suited to probing causal analyses compared with unadjusted Gregorian series. This, of course, requires further research before firm conclusions are drawn, but the underlying behavior of inflation seems to be captured in a better way by Hijri time series.

### **Section 3: Strength and Significance of Hijri and Gregorian Seasonal Effects in Gregorian Time Series**

In this section I use simple regressions of monthly changes in Gregorian CPI on indicators of Gregorian months and fractional indicators of presence of Hijri months in Gregorian months (through Hijri-Gregorian overlap ratios).

Let us define  $G_g = 1$  if regressor  $y$  belongs to  $g^{\text{th}}$  Gregorian month  
 $= 0$  otherwise

$$H_{hg} = \frac{n_{hg}}{n_g} \text{ for overlapping } h^{\text{th}} \text{ Hijri month with } g^{\text{th}} \text{ Gregorian month}$$

$= 0$  for non-overlapping Hijri months such that

$$1 = \frac{n_{hg}}{n_g} + \frac{n_{(h+1)g}}{n_g} = F_{hg} = H_{hg} + H_{(h+1)g}$$

where  $F_{hg} = 1$  if regressor  $y$  belongs to  $h^{\text{th}}$  and  $(h+1)^{\text{th}}$  Hijri months overlapping with  $g^{\text{th}}$  Gregorian month. Regressor  $y$  is taken as month-on-month percent changes in Gregorian CPI.

$n_{hg}$  = number of days of overlapping  $h^{\text{th}}$  Hijri month with  $g^{\text{th}}$  Gregorian month

$n_g$  = number of days in  $g^{\text{th}}$  Gregorian month

It should be noted here that above formulation differs slightly from Riazuddin and Khan (2002), where the denominator of F contains the number of days of Hijri month rather than Gregorian month here.

To check the strength and significance of seasonal effects in Gregorian time series, I run following three regressions without intercepts.

$$y_t = \sum_{g=1}^{12} \alpha_g G_g + u_t \quad g = 1, 2, \dots, 12; t = 1, 2, \dots, 396 \quad (1)$$

$$y_t = \sum_{h=1}^{12} \beta_h H_{ht} + v_t \quad h = 1, 2, \dots, 12; t = 1, 2, \dots, 396 \quad (2)$$

$$y_t = \sum_{g=1}^{12} \sum_{h=1}^{12} \gamma_{gh} G_g H_{ht} + w_t \quad h = 1, 2, \dots, 12; t = 1, 2, \dots, 396 \quad (3)$$

Equation (1) runs a simple regression of month-on-month percent changes in CPI on 12 Gregorian calendar indicator (dummy) variables without intercept. This reproduces the Gregorian seasonal monthly means as coefficients of corresponding indicator variables. Gregorian seasonal effects account for about 26 percent of total variation in monthly changes in CPI. Strength of Gregorian seasonal mean is highest for July<sup>4</sup>, followed by April, August, March, June, October, February, September, January, November, December and May respectively. Last two of these are negative but not statistically significant. Top ten of these are significant at less than 1percent level. While equation (1) decomposes the global Gregorian monthly mean CPI change as mean of 12 Gregorian monthly means, it is better to include a first order autocorrelation term in regression to check the levels of significance. As can be seen from Table 2, coefficients and p-values do not change much, although autocorrelation came out as significant.

Equation (2) is a regression of month-on-month percent changes on fractional indicator variables of overlaps with Hijri months. Although the coefficients of these are not identical with Hijri monthly seasonal means (of monthly changes in Hijri CPI), these are weighted

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<sup>4</sup> A strong possibility for July increase is the post-budget adjustment of prices every year.

means adjusted for the number of days of presence of particular Hijri month in the total span of 396 Gregorian months. Weighting scheme is complex, determined by the inverse of product of transpose and entire (396x12) matrix of fractional indicators. All Hijri seasonal effects are statistically significant at less than 10 percent level; effects of ten Hijri months are significant at less than 5 percent level. Strength of Hijri seasonal effect is highest for Sha'aban, followed by Shawwal, Rabi-ul-Awwal, Ramazan, Rajab, Ziq'a'd, Muharram, Rabi-us-Sani, Jamadi-us-Sani, Safar, Zilhaj and Jamadi-ul-Awwal. Inclusion of autocorrelation term does not alter the coefficients much, hence the resulting coefficients can be interpreted as seasonal effects also.

One is surprised to see that Ramazan does not emerge with the highest seasonal change in monthly CPI. This is in conformity with the results arrived by Akmal and Abbasi (2010) and Bukhari et al (2011). However, emergence of Sha'aban with the highest price change is in accordance with the common experience of Pakistanis with the special onslaught of inflation prior to the holy month of Ramazan every year. Significant increase in Ramazan is not observed because prices are already largely adjusted upwards in Sha'aban. Notice that all Hijri seasonal effects are positive in contrast with 10 positive and 2 negative (May and December) Gregorian seasonal effects. Results of equations (1) and (2) are shown in Table 2.

[Table 2 here]

Equation (3) is a regression of month-on-month percent changes on 144 possible interactions (overlaps) of 12 Gregorian months with 12 Hijri months. These interactions account for all possible overlaps, either partial or complete. Partial overlaps of Hijri months in any Gregorian month are much more common than complete overlaps of a particular Hijri month with any Gregorian month, which seldom occur. This regression essentially decomposes the average monthly change in Gregorian CPI during the chosen span of 396 months into 144 separate additive monthly average changes for each of 144 interactions. Out of these, 36 interaction effects are statistically significant, 29 at less than 5 percent and 7 at less than 10 percent level of significance. Results of equation (3) are shown in Table 3. Estimation of equation (3) with first order autoregressive term shows autocorrelation to be insignificant and resulting coefficients and p-values seem to hardly change. Hence, coefficients can also be interpreted as effects of Gregorian-Hijri seasonal interactions.

Highest effect (average monthly change in CPI) was observed when the month of July overlapped with Sha'aban (6.41 percent), followed by July's overlap with Ramazan (3.25 percent), etc. Within Hijri months, the highest number (7) of significant interaction effects were reported for Sha'aban, followed by Shawwal (4), Rabi-ul-Awwal (4), Jamadi-us-Sani (4), Rabi-us-Sani (3), Rajab (3), Ramazan (2), Ziq'a'ad (2), Safar (2), Zilhaj (2), Muharram (2) and Jamadi-ul-Awwal (1), all totaling to 36 significant overlaps.

Counting the number of significant interactions Gregorian month-wise reveals that no significant overlap occurred in December, preceded by May (1), January (1), February (2), June (2), September (2), November (2), March (3), October (3), August (5), April (7), and July (8), all summing to 36 significant interactions.

[Table 3 here]

These results show the extreme importance and need for accounting the seasonal effects of both Gregorian and Hijri calendar while explaining the process of monthly evolution of inflation through econometric exercises done using Gregorian monthly time series. Gregorian-Hijri interactions alone explain around 36 percent (adjusted  $R^2 = 0.3623$ ) of variation in monthly inflation.

#### **Section 4: Conclusion and Implications for Future Research**

I have presented a simple method of transforming Gregorian monthly time series of any variable to Hijri time series using Gregorian-Hijri overlap ratios. Its application to Gregorian CPI in Pakistan reveals several new insights. Seasonal effects of all Hijri months are statistically significant, although their strength is lower than those of Gregorian seasonal effects. Seasonal pattern that emerges after transformation to Hijri time series offers a rich information set not revealed by usual analysis of Gregorian series. Highest price change occurs in the Hijri month of Sha'aban, just prior to the holy month of Ramazan.

More research is necessary for developing superior methods of seasonal adjustment that account for both Gregorian and Hijri seasonal effects. Importance of this topic is paramount for all Islamic countries and those having a significant share of Muslim population. A deeper analysis of socioeconomic and business behaviours requires either the original compilation of statistics according to Hijri calendar, or at the least, compilation through transformation approach suggested in this paper. It is proposed that statistical agencies and central banks of

Islamic countries adopt this method as it does not require changing the existing statistical compilation procedures. An essential requirement is the documentation of past actual dates of occurrence of Hijri months in Gregorian calendar.

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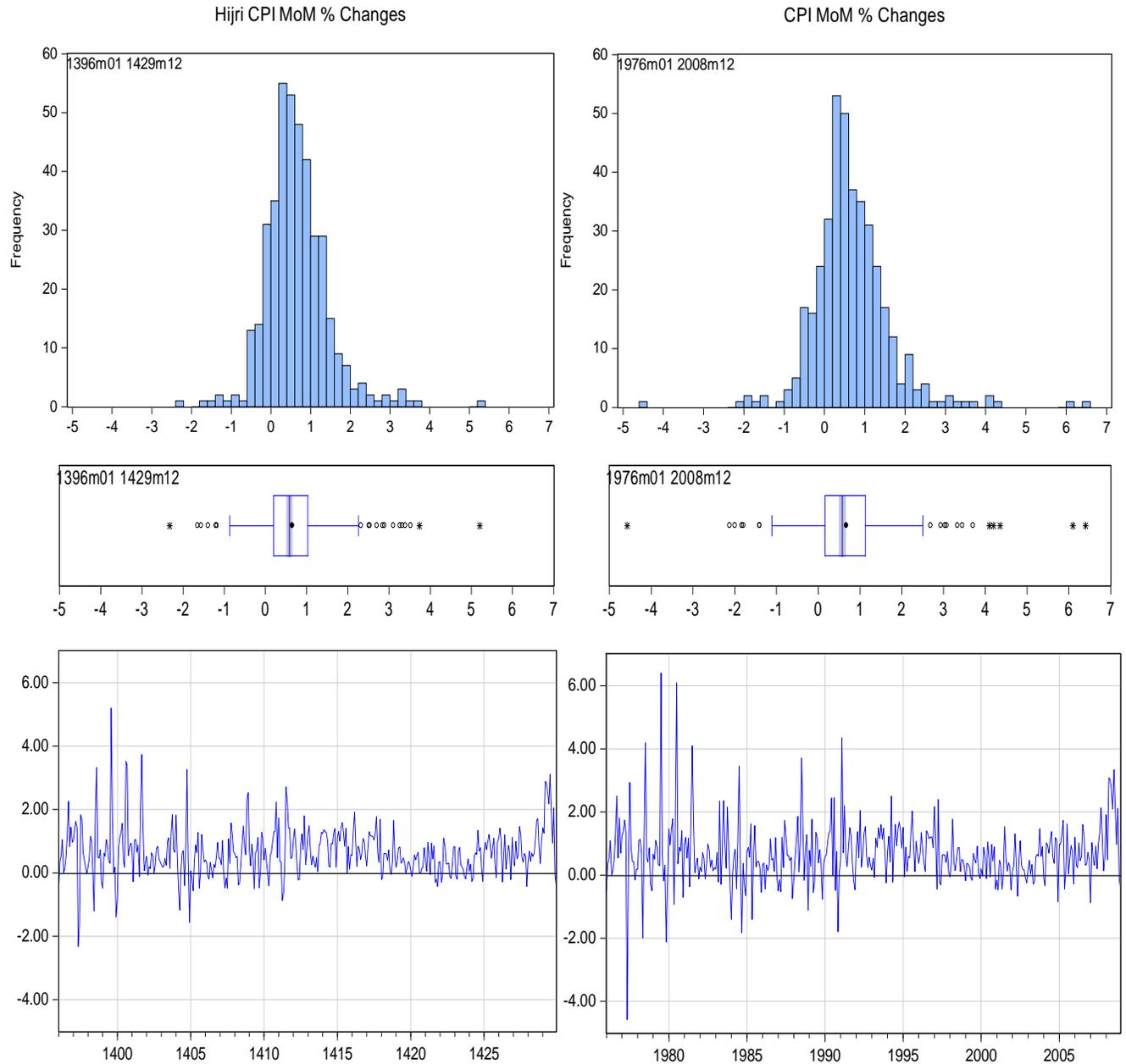
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**Figure 1: Comparison of Statistical Features of Gregorian and Hijri Time Series of CPI MoM % Changes**



Mean	0.651987
Median	0.568060
Maximum	5.203516
Minimum	-2.327008
Std. Dev.	0.791018
Skewness	0.993790
Kurtosis	7.414144

Jarque-Bera	398.3974
Probability	0.000000

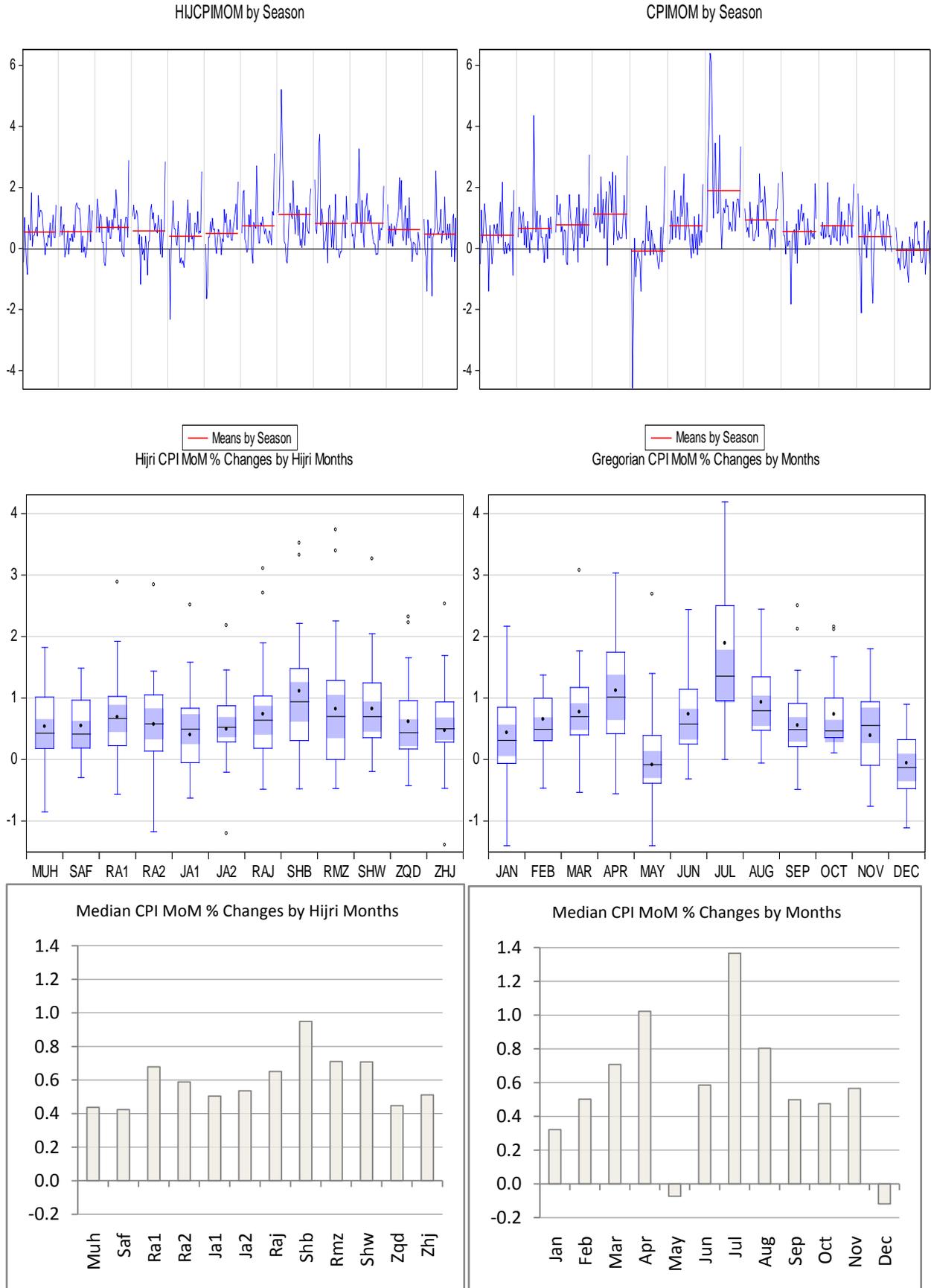
Sum	266.0106
Sum Sq. Dev.	254.6637
Observations	408

Mean	0.673238
Median	0.564925
Maximum	6.400745
Minimum	-4.576579
Std. Dev.	0.988860
Skewness	0.981793
Kurtosis	10.47521

Jarque-Bera	985.6186
Probability	0.000000

Sum	266.6023
Sum Sq. Dev.	386.2488
Observations	396

**Figure 2: Comparison of Hijri and Gregorian Seasonal Means and Medians of CPI MoM % Changes**



**Table 1: Number of Days of Hijri Months overlapping with Gregorian Months during 1-Jan-1976 to 31-Dec-2008 (27-Zhj-1395 to 2-Muh 1430)**

	Muh	Saf	Ra1	Ra2	Ja1	Ja2	Raj	Shb	Rmz	Shw	Zqd	Zhj	Gregorian month total	%
Jan	91	87	84	83	86	84	81	85	86	83	83	90	1023	8.5
Feb	81	86	79	77	74	79	78	73	77	81	72	76	933	7.7
Mar	82	89	94	85	86	82	84	84	83	84	87	83	1023	8.5
Apr	82	79	84	93	81	83	79	81	83	81	81	83	990	8.2
May	85	85	82	85	99	82	86	84	82	86	84	83	1023	8.5
Jun	80	82	82	81	81	96	79	81	82	81	82	83	990	8.2
Jul	87	82	83	85	84	84	100	81	83	86	83	85	1023	8.5
Aug	84	87	84	81	85	85	83	100	81	86	84	83	1023	8.5
Sep	81	82	82	80	80	82	83	80	96	80	82	82	990	8.2
Oct	85	86	83	83	85	82	84	87	83	97	84	84	1023	8.5
Nov	81	81	81	84	79	80	83	80	82	82	92	85	990	8.2
Dec	90	84	82	86	83	82	85	86	82	85	86	92	1023	8.5
Hijri month total	1009	1010	1000	1003	1003	1001	1005	1002	1000	1012	1000	1009	12054	100
%	8.4	8.4	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.4	8.3	8.4	100.0	

Note: Span of Hijri period covers last 2 days of 1395 and initial 2 days of 1430, i.e., this particular 33-year Gregorian span has 4 more days compared with overlapping 34-year Hijri span

Source: Calculated from actual Hijri dates in Pakistan compiled from past newspapers by the staff of SBP Library. Author acknowledges the efforts of Zia ur Rehman, Amir Abbasi and Omar Farooq for compilation of actual Hijri-Gregorian dates.

<b>Table 2: Results of equations 1 and 2. Coefficients and significance probability values of seasonal means of Gregorian and Hijri CPI monthly changes.</b>													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Equation 1	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11	G12	
Coefficient	0.43	0.66	0.77	1.12	-0.09	0.74	1.89	0.93	0.56	0.74	0.39	-0.06	
Prob.	0.00	0.00	0.00	0.00	0.56	0.00	0.00	0.00	0.00	0.00	0.01	0.69	
	R-squared			0.260		Mean dependent var			0.673				
	Adjusted R-squared			0.239		S.D. dependent var			0.989				
	S.E. of regression			0.863		Akaike info criterion			2.573				
	Sum squared resid			285.9		Schwarz criterion			2.693				
	Log likelihood			-497		Hannan-Quinn criter.			2.620				
	Durbin-Watson stat			1.746									
Equation 1	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11	G12	ar1
Coefficient	0.44	0.60	0.69	1.03	-0.23	0.75	1.80	0.70	0.44	0.67	0.30	-0.11	0.12
Prob.	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.01	0.00	0.05	0.47	0.01
	R-squared			0.271		Mean dependent var			0.673				
	Adjusted R-squared			0.249		S.D. dependent var			0.989				
	S.E. of regression			0.857		Akaike info criterion			2.562				
	Sum squared resid			281.4		Schwarz criterion			2.693				
	Log likelihood			-494.3		Hannan-Quinn criter.			2.614				
	Durbin-Watson stat			2.000									
	Muh	Saf	Ra1	Ra2	Ja1	Ja2	Raj	Shb	Rmz	Shw	Zqd	Zhj	
Equation 2	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12	
Coefficient	0.60	0.48	0.82	0.55	0.39	0.50	0.66	1.40	0.69	0.94	0.62	0.42	
Prob.	0.01	0.03	0.00	0.02	0.08	0.03	0.00	0.00	0.00	0.00	0.01	0.06	
	R-squared			0.050		Mean dependent var			0.673				
	Adjusted R-squared			0.023		S.D. dependent var			0.989				
	S.E. of regression			0.977		Akaike info criterion			2.822				
	Sum squared resid			366.8		Schwarz criterion			2.943				
	Log likelihood			-547		Hannan-Quinn criter.			2.870				
	Durbin-Watson stat			1.772									
Equation 2	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12	ar1
Coefficient	0.54	0.42	0.77	0.46	0.33	0.46	0.61	1.33	0.54	0.86	0.51	0.36	0.11
Prob.	0.02	0.07	0.00	0.05	0.15	0.04	0.01	0.00	0.02	0.00	0.03	0.12	0.03
	R-squared			0.062		Mean dependent var			0.67324				
	Adjusted R-squared			0.033		S.D. dependent var			0.98886				
	S.E. of regression			0.972		Akaike info criterion			2.8143				
	Sum squared resid			362.2		Schwarz criterion			2.945				
	Log likelihood			-544.2		Hannan-Quinn criter.			2.86608				
	Durbin-Watson stat			1.97923									

**Table 3: Results of Equation 3. Coefficients and significance probability values of 144 interactions of Hijri months with Gregorian months**

		Muh	Saf	Ra1	Ra2	Ja1	Ja2	Raj	Shb	Rmz	Shw	Zqd	Zhj
Coefficient		H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12
Dec	Jan G1	0.281	0.977	0.728	-0.474	0.000	0.737	0.276	1.355	0.537	-0.191	0.127	0.801
	Feb G2	0.608	0.758	0.998	0.608	0.542	-0.065	1.522	1.864	0.247	0.792	-0.322	0.290
	Mar G3	0.760	0.725	1.669	1.297	0.489	0.379	-0.278	1.878	-0.137	0.828	0.816	0.702
	Apr G4	0.061	0.724	1.192	1.673	0.863	1.357	1.287	1.025	0.736	2.405	0.775	1.280
	May G5	0.072	-0.349	-0.377	0.895	-0.127	-2.058	0.252	-0.896	-0.021	0.624	0.528	0.319
	Jun G6	0.704	-0.202	0.632	0.167	0.547	0.859	0.671	1.393	0.543	0.979	1.732	0.800
	Jul G7	0.920	1.674	0.577	1.032	0.894	1.779	1.235	6.478	3.237	2.192	1.745	1.281
	Aug G8	1.452	1.602	1.583	0.834	0.150	0.583	0.541	1.928	0.098	1.322	0.348	0.482
	Sep G9	0.782	0.067	0.878	1.386	0.368	0.568	0.297	0.494	1.938	-0.048	0.685	-0.983
	Oct G10	1.231	0.065	0.678	0.534	1.267	0.505	0.416	0.975	0.739	1.420	0.356	0.536
	Nov G11	0.862	-0.223	1.389	-0.786	-0.096	1.571	0.611	0.416	0.345	0.834	0.722	-0.902
	Dec G12	-0.380	-0.198	-0.263	-0.652	-0.137	-0.245	0.786	0.465	-0.547	0.093	-0.123	0.423
Prob.		H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12
Dec	Jan G1	0.650	0.115	0.273	0.487	0.999	0.251	0.682	0.033	0.394	0.775	0.846	0.202
	Feb G2	0.306	0.184	0.097	0.326	0.392	0.913	0.013	0.004	0.684	0.176	0.619	0.642
	Mar G3	0.254	0.245	0.005	0.039	0.441	0.563	0.666	0.004	0.836	0.196	0.188	0.289
	Apr G4	0.926	0.265	0.053	0.004	0.179	0.036	0.049	0.110	0.251	0.000	0.216	0.042
	May G5	0.911	0.597	0.567	0.161	0.822	0.002	0.695	0.161	0.974	0.341	0.414	0.616
	Jun G6	0.266	0.752	0.325	0.790	0.384	0.123	0.296	0.027	0.384	0.129	0.007	0.199
	Jul G7	0.142	0.010	0.379	0.110	0.163	0.006	0.028	0.000	0.000	0.001	0.008	0.048
	Aug G8	0.024	0.010	0.015	0.210	0.815	0.361	0.405	0.001	0.883	0.033	0.593	0.474
	Sep G9	0.239	0.915	0.164	0.034	0.561	0.363	0.638	0.439	0.001	0.940	0.269	0.133
	Oct G10	0.062	0.920	0.293	0.417	0.056	0.441	0.520	0.131	0.248	0.015	0.587	0.398
	Nov G11	0.171	0.737	0.033	0.193	0.883	0.018	0.322	0.521	0.594	0.182	0.214	0.144
	Dec G12	0.533	0.757	0.697	0.304	0.831	0.718	0.226	0.457	0.412	0.888	0.845	0.480
Highlighted cells show significance below 5% (yellow/dark grey; 29 cells) and 10% (olive/light grey; 7 cells)													
R-squared				0.5955				Mean dependent var				0.6732	
Adjusted R-squared				0.3659				S.D. dependent var				0.9889	
S.E. of regression				0.7874				Akaike info criterion				2.6352	
Sum squared resid				156.25				Schwarz criterion				4.083	
Log likelihood				-377.77				Hannan-Quinn criter.				3.2088	
Durbin-Watson stat				1.8244									

<b>Annex A: Consumer Price Index according to Islamic Hijri Calendar in Pakistan during Muharram 1396 to Zilhaj 1429</b>												
Hijri Years	Muh	Saf	Ra1	Ra2	Ja1	Ja2	Raj	Shb	Rmz	Shw	Zqd	Zhj
1396	13.58	13.63	13.70	13.85	13.85	13.87	13.94	14.10	14.42	14.54	14.75	14.89
1397	15.04	15.25	15.49	15.71	15.35	15.09	15.37	15.63	15.73	15.79	15.82	15.81
1398	15.84	15.91	16.09	16.25	16.24	16.05	16.35	16.89	16.98	17.06	17.18	17.13
1399	17.05	17.16	17.25	17.43	17.58	17.64	17.70	18.62	18.94	18.94	18.97	18.71
1400	18.55	18.70	18.91	19.14	19.44	19.51	19.55	20.23	20.92	21.04	21.20	21.40
1401	21.57	21.51	21.73	21.96	22.10	22.30	22.27	22.74	23.59	23.94	23.95	24.04
1402	24.16	24.14	24.19	24.23	24.38	24.51	24.51	24.56	24.75	24.96	25.07	25.16
1403	25.23	25.28	25.33	25.44	25.50	25.76	26.04	26.08	26.42	26.90	27.10	27.27
1404	27.77	27.93	27.81	27.48	27.51	27.68	27.87	27.76	28.04	28.95	29.09	28.63
1405	28.65	28.60	28.44	28.55	28.80	28.98	29.35	29.21	29.20	29.56	29.78	29.88
1406	30.00	30.10	30.07	30.01	30.11	30.14	30.09	30.17	30.22	30.38	30.67	30.82
1407	30.95	31.03	31.35	31.34	31.19	31.14	30.99	31.33	31.42	31.92	32.30	32.52
1408	32.71	32.87	33.04	32.92	32.81	32.91	33.19	33.68	33.97	34.16	34.95	35.84
1409	36.09	36.17	36.50	36.65	36.47	36.70	36.96	37.38	37.20	37.22	37.69	38.10
1410	38.25	38.55	38.68	38.68	38.52	38.73	38.99	39.37	39.87	40.40	41.30	41.49
1411	42.21	42.36	42.51	42.14	41.87	42.00	43.13	44.09	44.71	45.34	45.55	45.78
1412	46.25	46.90	47.34	47.44	47.33	47.24	47.66	48.24	48.60	49.47	49.60	49.94
1413	50.56	51.31	51.63	51.76	52.03	52.20	52.30	52.55	52.56	53.03	53.52	54.21
1414	54.88	55.63	56.35	57.06	57.64	57.76	57.87	58.40	58.94	59.68	60.51	60.62
1415	61.29	62.09	62.72	63.62	64.63	65.45	66.00	66.93	66.93	67.49	67.57	67.95
1416	68.33	69.22	70.55	71.23	71.38	71.98	72.52	72.82	73.27	74.06	74.80	75.18
1417	75.34	75.96	76.95	77.85	78.75	79.65	80.47	81.49	82.94	83.46	83.74	85.16
1418	84.98	84.87	85.38	85.90	86.42	86.76	87.39	87.48	87.44	87.75	89.20	89.66
1419	89.82	90.19	90.89	91.63	91.91	92.24	92.68	92.97	92.95	93.09	93.42	93.69
1420	93.76	93.66	93.87	94.40	94.79	95.30	95.92	95.94	95.92	96.06	96.24	97.00
1421	97.42	97.47	98.41	98.91	98.85	99.78	100.22	101.07	100.77	100.57	100.15	100.48
1422	100.84	100.54	100.45	101.54	102.39	102.69	102.97	103.29	103.18	103.00	103.21	104.04
1423	104.91	104.81	104.60	105.30	106.15	106.42	106.61	106.72	106.61	106.41	106.60	107.06
1424	107.13	107.42	107.13	106.94	107.51	108.19	108.83	110.28	111.04	111.92	112.08	111.77
1425	112.48	113.57	114.40	115.49	116.89	117.94	118.48	119.37	120.68	121.01	120.83	122.01
1426	123.34	125.09	126.37	126.00	126.62	128.14	128.29	129.02	130.13	130.99	130.71	132.18
1427	132.67	132.96	134.28	134.88	135.65	137.63	139.30	139.98	140.46	141.32	142.07	141.45
1428	141.95	142.92	143.44	144.34	145.09	145.99	147.58	150.01	152.58	153.74	154.19	155.72
1429	157.94	159.92	164.54	169.22	173.48	177.26	182.77	186.35	188.10	191.95	191.86	190.96

Source: Calculated using Spliced series of CPI in Annex B and applying the method described in this paper

<b>Annex B: Consumer Price Index (CPI) in Pakistan : Base Year 2000-01</b>												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	13.58	13.63	13.70	13.85	13.85	13.87	13.94	14.12	14.48	14.55	14.82	14.92
1977	15.11	15.31	15.58	15.79	15.07	15.11	15.56	15.69	15.76	15.83	15.80	15.83
1978	15.86	16.04	16.22	16.33	16.00	16.20	16.88	16.97	17.04	17.18	17.13	17.05
1979	17.16	17.25	17.44	17.59	17.65	17.70	18.84	18.97	18.93	18.99	18.59	18.53
1980	18.80	18.98	19.26	19.60	19.42	19.69	20.89	20.97	21.15	21.31	21.61	21.46
1981	21.67	21.93	22.05	22.31	22.23	22.65	23.58	23.94	23.96	24.04	24.17	24.14
1982	24.20	24.23	24.40	24.53	24.50	24.59	24.83	25.03	25.09	25.21	25.24	25.30
1983	25.35	25.53	25.48	26.08	26.00	26.20	26.81	27.08	27.14	27.73	27.95	27.87
1984	27.48	27.49	27.65	27.88	27.76	28.05	29.02	29.09	28.56	28.67	28.58	28.39
1985	28.61	28.86	29.02	29.49	29.08	29.28	29.74	29.81	29.94	30.07	30.14	29.98
1986	30.07	30.19	30.06	30.16	30.20	30.29	30.64	30.78	30.95	30.98	31.35	31.35
1987	31.19	31.15	30.98	31.35	31.43	31.97	32.35	32.55	32.75	32.91	33.09	32.84
1988	32.80	32.97	33.33	33.95	33.98	34.34	35.61	36.12	36.06	36.33	36.80	36.39
1989	36.67	36.77	37.42	37.22	37.13	37.63	38.09	38.23	38.54	38.68	38.38	38.53
1990	38.76	39.00	39.42	39.94	40.50	41.49	41.49	42.51	42.30	42.62	41.86	41.89
1991	42.09	43.92	44.23	45.20	45.50	45.62	46.01	46.70	47.29	47.46	47.38	47.16
1992	47.54	48.20	48.46	49.45	49.58	49.90	50.56	51.34	51.65	51.78	52.07	52.23
1993	52.32	52.60	52.56	53.18	53.64	54.45	55.08	55.97	56.60	57.44	57.83	57.69
1994	58.12	58.84	59.08	60.56	60.43	60.94	61.93	62.50	63.41	64.47	65.38	65.94
1995	66.93	66.90	67.49	67.57	67.97	68.34	69.28	70.68	71.32	71.39	72.16	72.64
1996	72.91	73.42	74.41	75.02	75.30	75.38	76.43	77.43	78.33	79.27	80.22	80.93
1997	82.68	83.58	83.21	85.20	85.03	84.77	85.29	85.85	86.39	86.74	87.38	87.48
1998	87.43	87.75	89.30	89.70	89.84	90.26	91.04	91.83	91.94	92.39	92.83	93.05
1999	92.88	93.23	93.55	93.80	93.73	93.58	94.22	94.66	95.02	95.89	95.97	95.87
2000	96.06	96.05	96.89	97.44	97.33	98.35	98.91	98.85	99.82	100.26	101.16	100.71
2001	100.55	100.08	100.56	100.90	100.44	100.45	101.99	102.61	102.74	103.14	103.43	102.95
2002	103.06	103.39	104.74	105.10	104.40	104.90	106.04	106.37	106.57	106.74	106.65	106.39
2003	106.56	107.06	107.09	107.45	107.14	106.92	107.53	108.24	108.89	110.49	111.15	112.15
2004	112.05	111.67	112.81	113.89	114.68	115.96	117.56	118.25	118.69	120.10	121.44	120.41
2005	121.58	122.78	124.37	126.53	125.97	126.09	128.13	128.18	128.82	130.03	131.02	130.66
2006	132.23	132.66	132.97	134.33	134.94	135.73	137.91	139.63	140.07	140.57	141.59	142.26
2007	141.01	142.47	143.17	143.62	144.94	145.23	146.70	148.64	151.80	153.66	153.87	154.77
2008	157.73	158.50	163.38	168.34	172.87	176.50	182.39	186.29	188.10	192.08	191.85	190.90

Source: Spliced from CPIs (with base years of 1975-76, 1980-81, 1990-91 and 2000-01) released by the Federal Bureau of Statistics

**Annex C: Number of Days of Hijri Months falling in Gregorian Calendar Months during January 1976 to December 2008**

	Muh	Saf	Raj1	Raj2	Jai1	Jai2	Raj	Shb	Ronz	Shw	Zhd	Zhi		Muh	Saf	Raj1	Raj2	Jai1	Jai2	Raj	Shb	Ronz	Shw	Zhd	Zhi	
Jan-76	28											31	Jul-92	29										2	31	
Feb-76	1	28											Aug-92	30	1										31	
Mar-76		2	29										Sep-92		28	2									30	
Apr-76			1	29									Oct-92			27	4								31	
May-76				1	30								Nov-92				26	4							30	
Jun-76						29	1						Dec-92				25	6							31	
Jul-76							29	2					Jan-93						24	7					31	
Aug-76								27	4				Feb-93							23	5				28	
Sep-76									25	5			Mar-93								24	7			31	
Oct-76										24	7		Apr-93									23	7		30	
Nov-76											22	8	May-93										23	8	31	
Dec-76	9											22	Jun-93	9										21	30	
Jan-77	20	11											Jul-93	21	10										31	
Feb-77		19	9										Aug-93		19	12									31	
Mar-77			21	10									Sep-93			18	12								30	
Apr-77				19	11								Oct-93				17	14							31	
May-77					19	12							Nov-93					15	15						30	
Jun-77						18	12						Dec-93					14	17						31	
Jul-77							18	13					Jan-94						13	18					31	
Aug-77								16	15				Feb-94							11	17				28	
Sep-77									15	15			Mar-94								13	18			31	
Oct-77										14	17		Apr-94									12	18		30	
Nov-77											12	18	May-94										12	19	31	
Dec-77	20											11	Jun-94	19										11	30	
Jan-78	10	21											Jul-94	11	20										31	
Feb-78		8	20										Aug-94		9	22									31	
Mar-78			10	21									Sep-94			7	23								30	
Apr-78				9	21								Oct-94				6	25							31	
May-78					8	23							Nov-94					5	25						30	
Jun-78						7	23						Dec-94						4	27					31	
Jul-78							7	24					Jan-95						2	29					31	
Aug-78								6	25				Feb-95							1	27				28	
Sep-78									4	26			Mar-95								2	29			31	
Oct-78										4	27		Apr-95									1	29		30	
Nov-78											2	28	May-95	1										30	31	
Dec-78	30											1	Jun-95	29	1										30	
Jan-79		29	2										Jul-95		29	2									31	
Feb-79			27	1									Aug-95			28	3								31	
Mar-79				29	2								Sep-95				4								30	
Apr-79					27	3							Oct-95				26	4							31	
May-79						3	4						Nov-95					25	6						30	
Jun-79							4	26					Dec-95						6	23	7				31	
Jul-79								4	25	6			Jan-96							21	10				31	
Aug-79									24	7			Feb-96								20	9			29	
Sep-79										23	7		Mar-96									20	11		31	
Oct-79											22	9	Apr-96										19		30	
Nov-79	9											21	May-96	13											31	
Dec-79	20	11											Jun-96	17	13										30	
Jan-80		19	12										Jul-96		17	14									31	
Feb-80			17	12									Aug-96			16	15								31	
Mar-80				18	13								Sep-96				14								30	
Apr-80					16	14							Oct-96				14	17							30	
May-80						15	16						Nov-96					12	18						30	
Jun-80							14	16					Dec-96						11	20					31	
Jul-80								14	17				Jan-97							10	21				31	
Aug-80									12	19			Feb-97								8	20			28	
Sep-80										11	19		Mar-97									10	21		31	
Oct-80											10	21	Apr-97										8	22	30	
Nov-80	21											9	May-97	23										8	31	
Dec-80	9	22											Jun-97	6	24										30	
Jan-81		7	24										Jul-97		6	25									31	
Feb-81			6	22									Aug-97			5	26								31	
Mar-81				7	24								Sep-97				3	27							30	
Apr-81					6	24							Oct-97					3	28						31	
May-81						5	26						Nov-97						1	29					30	
Jun-81							3	27					Dec-97							1	29	1			31	
Jul-81								3	28				Jan-98								29	2			31	
Aug-81									1	30			Feb-98									28			28	
Sep-81													Mar-98										29	2	31	
Oct-81	2												Apr-98	3										2	30	
Nov-81	28	2											May-98		4										31	
Dec-81		28	3										Jun-98	27	25	5									30	
Jan-82			26	5									Jul-98			25	6								31	
Feb-82				25	3								Aug-98				6	8							31	
Mar-82					27	4							Sep-98				23	22	8						30	
Apr-82						4	5						Oct-98					8	21	10					31	
May-82							24	7					Nov-98						21	20	10				30	
Jun-82								22	8				Dec-98							20	10				31	
Jul-82									21	10			Jan-99								18	13			31	
Aug-82										20	11		Feb-99									17	11		28	
Sep-82											19	11	Mar-99										19	12	31	
Oct-82	13												Apr-99	13											30	
Nov-82	17	13											May-99		15	15									31	
Dec-82		17	14										Jun-99	16											30	
Jan-83			15	16									Jul-99			14	17								31	
Feb-83				14	14								Aug-99				13								31	
Mar-83					16	15							Sep-99					11	19						30	
Apr-83						14	16						Oct-99						10	21					31	
May-83							14	17					Nov-99							9	21				30	

