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

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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**.**

1. 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

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behaviours are mostly secular or influenced by Christian traditions. 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).

The paper presents a simple method to construct a long monthly time series of consumer price index in Pakistan according to Islamic *Hijri* calendar. This construction 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. This author formalized the method and applied 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[1].

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 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

[1] 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.

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[2] 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 to the *Hijri* calendar. This is done as follows.

Let

CPI_{Hj} = consumer price index for the j^{th} *Hijri* month

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

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

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

CPI for *Hijri* calendar can then be easily constructed as

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

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

The author used a spliced series of monthly CPI (base year: 2000-2001) from January 1976 to December 2008 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

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[2] One should not expect any seasonal pattern in atmospheric temperatures for *Hijri* calendar.

months are shown in Annex C. The author has 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 (given in the Annexure). Each *Hijri* month is fully represented in the chosen span of 33 Gregorian years.

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. The author first computed 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 (in the **Annexure**). 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.

The author now comes 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 (Please see the Annexure) 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.

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 casual 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 the author used 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^{th} Gregorian month

= 0 otherwise

$H_{hg} = \frac{n_{hg}}{n_g}$ for overlapping h^{th} Hijri month with g^{th} 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^{th} and $(h+1)^{th}$ Hijri months overlapping with g^{th} Gregorian month. Regressor y is taken as month-on-month % changes in Gregorian CPI.

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

n_g = number of days in g^{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, following three regressions are run without intercepts.

$$y_t = \sum_{g=1}^{12} \alpha_g u_t \qquad g = 1, 2, ..., 12; t = 1, 2, ..., 396 \qquad (1)$$

$$y_t = \sum_{h=1}^{12} \beta_h H_h + v_t \qquad h = 1, 2, ..., 12 \qquad (2)$$

$$y_t = \sum_{g=1}^{12} \sum_{h=1}^{12} \gamma_{gh} G_g H_h + w_t \qquad (3)$$

Equation (1) runs a simple regression of month-on-month % 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% of total variation in monthly changes in

CPI. Strength of Gregorian seasonal mean is highest for July[3], 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 1% 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 (Annexure), coefficients and p-values do not change much, although autocorrelation came out as significant.

Equation (2) is a regression of month-on-month % 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 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% level; effects of ten *Hijri* months are significant at less than 5% level. Strength of *Hijri* seasonal effect is highest for *Sha'aban,* followed by *Shawwal, Rabi-ul-Awwal, Ramzan, Rajab, Ziqa'ad, 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 *Ramzan* 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 *Ramzan* every year. Significant increase in *Ramzan* 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.

Equation (3) is a regression of month-on-month % changes on 144 possible interactions (overlaps) of 12 Gregorian months with 12 *Hijri*

[3] A strong possibility for July increase is the post-budget adjustment of prices every year.

months. These interactions account for all possible overlaps, either partial or complete. Partial overlaps of *Hijri* month 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% and 7 at less than 10% 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%), followed by July's overlap with *Ramzan* (3.25%), 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), *Ramzan* (2), *Ziqa'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.

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% (adjusted $R^2 = 0.3623$) of variation in monthly inflation.

Section 4: Conclusion and Implications for Future Research

This author has 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 *Ramzan*.

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.

References

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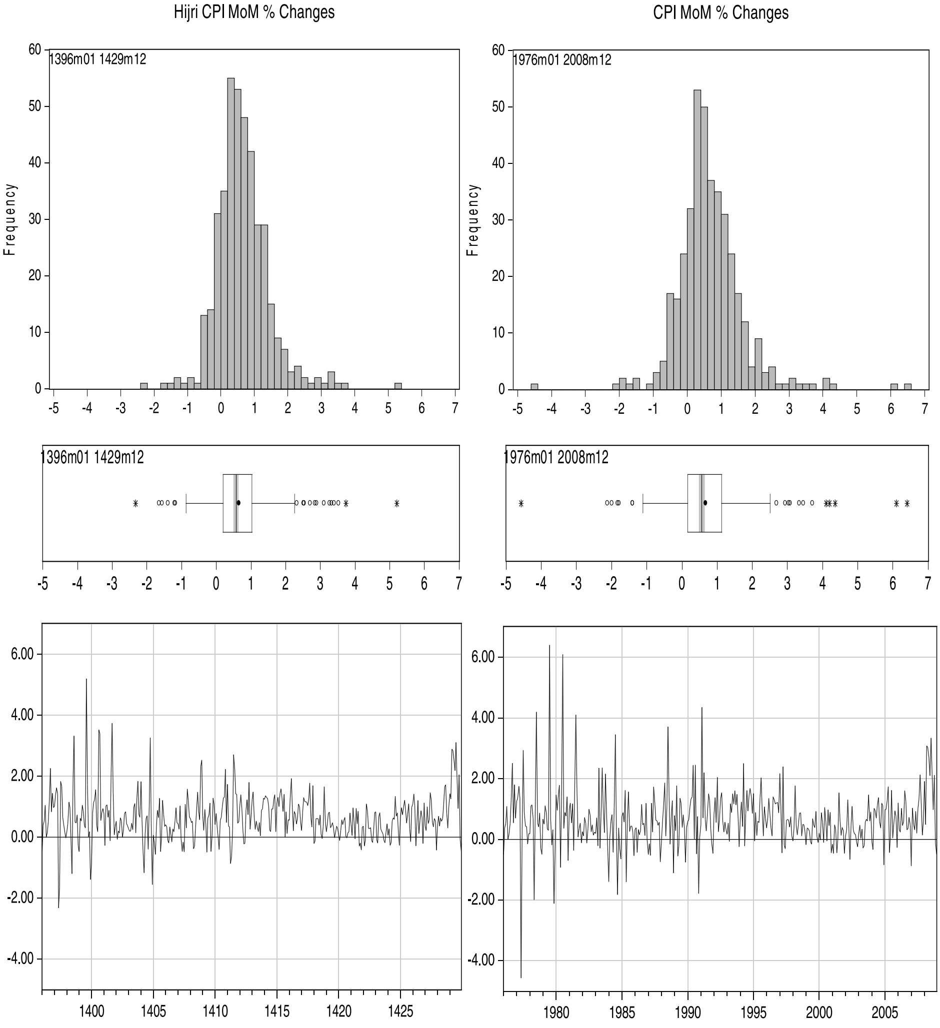
Annexures

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

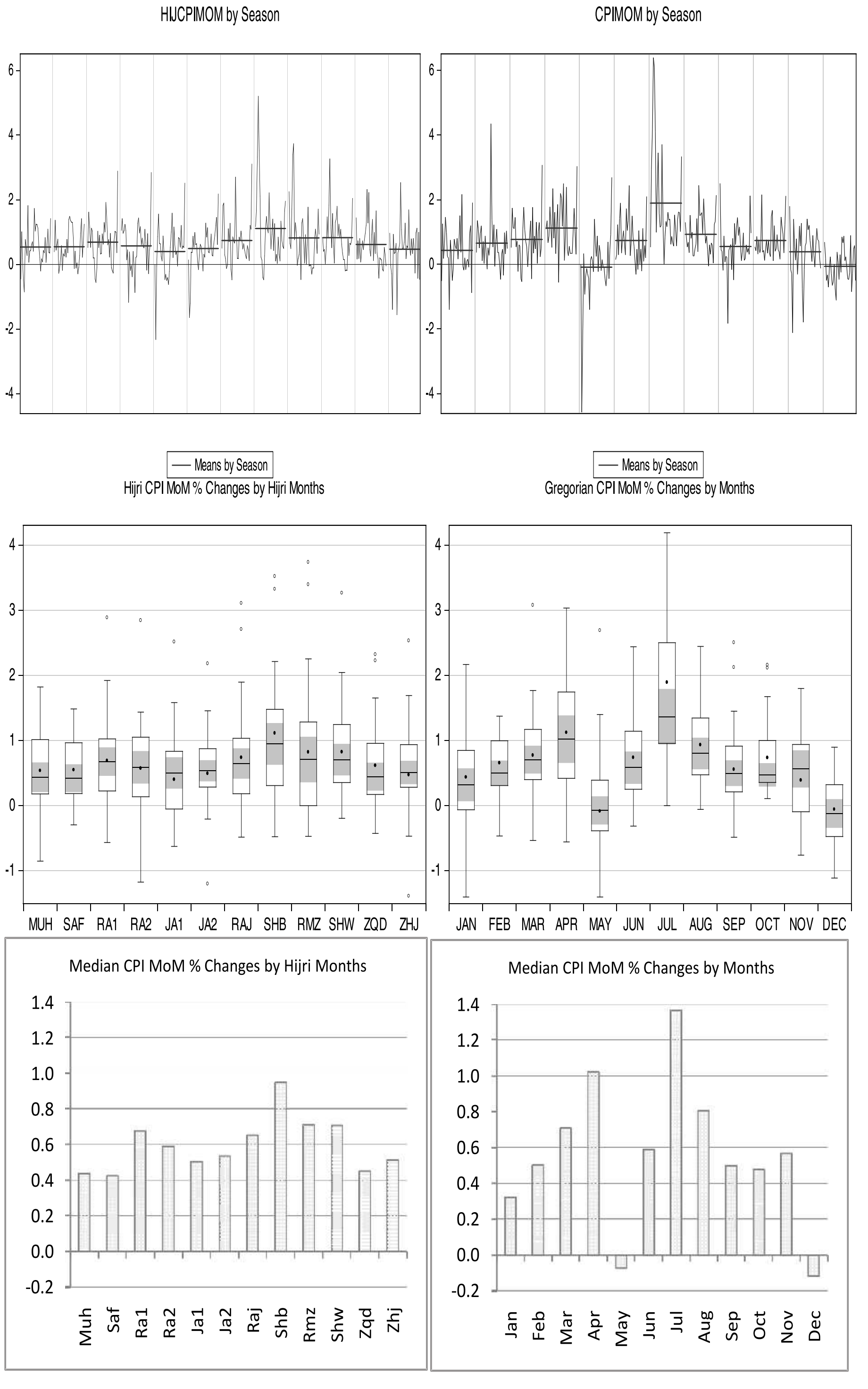


Table 1: Number of Days of Hijri Months overlapping with Gregorian Months during 1-Jan-1976 to 31-Dec-2008 (27-Zhj-1395 to 2-Muh 1430)

	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.

Table 2: Results of equations 1 and 2. Coefficients and significance probability values of seasonal means of Gregorian and Hijri CPI monthly changes.

	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

Coefficient		Muh H1	Saf H2	Ra1 H3	Ra2 H4	Ja1 H5	Ja2 H6	Raj H7	Shb H8	Rmz H9	Shw H10	Zqd H11	Zhj H12
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.		Muh H1	Saf H2	Ra1 H3	Ra2 H4	Ja1 H5	Ja2 H6	Raj H7	Shb H8	Rmz H9	Shw H10	Zqd H11	Zhj H12
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 siginificance 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		

Annex A: Consumer Price Index according to Islamic Hijri Calendar in Pakistan during Muharram 1396 to Zilhaj 1429

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

Annex B: Consumer Price Index (CPI) in Pakistan : Base Year 2000-01

	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	Ra1	Ra2	Ja1	Ja2	Raj	Shb	Rmz	Shw	Zqd	Zhj	
Jan-76	28											3	31
Feb-76	1	28											29
Mar-76		2	29										31
Apr-76			1	29									30
May-76				1	30								31
Jun-76						29	1						30
Jul-76							29	2					31
Aug-76								27	4				31
Sep-76									25	5			30
Oct-76										24	7		31
Nov-76											22	8	30
Dec-76	9											22	31
Jan-77	20	11											31
Feb-77		19	9										28
Mar-77			21	10									31
Apr-77				19	11								30
May-77					19	12							31
Jun-77						18	12						30
Jul-77							18	13					31
Aug-77								16	15				31
Sep-77									15	15			30
Oct-77										14	17		31
Nov-77											12	18	30
Dec-77	20											11	31
Jan-78	10	21											31
Feb-78		8	20										28
Mar-78			10	21									31
Apr-78				9	21								30
May-78					8	23							31
Jun-78						7	23						30
Jul-78							7	24					31
Aug-78								6	25				31
Sep-78									4	26			30
Oct-78										4	27		31
Nov-78											2	28	30
Dec-78	30											1	31
Jan-79		29	2										31
Feb-79			27	1									28
Mar-79				29	2								31
Apr-79					27	3							30
May-79						27	4						31
Jun-79							26	4					30
Jul-79								25	6				31
Aug-79									24	7			31
Sep-79										23	7		30
Oct-79											22	9	31
Nov-79	9											21	30
Dec-79	20	11											31
Jan-80		19	12										31
Feb-80			17	12									29
Mar-80				18	13								31
Apr-80					16	14							30
May-80						15	16						31
Jun-80							14	16					30
Jul-80								14	17				31
Aug-80									12	19			31
Sep-80										11	19		30
Oct-80											10	21	31
Nov-80	21											9	30
Dec-80	9	22											31
Jan-81		7	24										31
Feb-81			6	22									28
Mar-81				7	24								31
Apr-81					6	24							30
May-81						5	26						31
Jun-81							3	27					30
Jul-81								3	28				31
Aug-81									1	30			31
Sep-81											29	1	30
Oct-81	2											29	31
Nov-81	28	2											30
Dec-81		28	3										31
Jan-82			26	5									31
Feb-82				25	3								28
Mar-82					27	4							31
Apr-82						25	5						30
May-82							24	7					31
Jun-82								22	8				30
Jul-82									21	10			31
Aug-82										20	11		31
Sep-82											19	11	30
Oct-82	13											18	31
Nov-82	17	13											30
Dec-82		17	14										31
Jan-83			15	16									31
Feb-83				14	14								28
Mar-83					16	15							31
Apr-83						14	16						30
May-83							14	17					31
Jun-83								12	18				30
Jul-83									11	20			31
Aug-83										10	21		31
Sep-83											8	22	30
Oct-83	24											7	31
Nov-83	6	24											30
Dec-83		6	25										31
Jan-84			5	26									31
Feb-84				3	26								29
Mar-84					4	27							31
Apr-84						3	27						30
May-84							2	29					31
Jun-84									29	1			30
Jul-84										29	2		31
Aug-84											28	3	31
Sep-84	4											26	30
Oct-84	26	5											31
Nov-84		24	6										30

	Muh	Saf	Ra1	Ra2	Ja1	Ja2	Raj	Shb	Rmz	Shw	Zqd	Zhj	
Jul-92	29											2	31
Aug-92		30	1										31
Sep-92			28	2									30
Oct-92				27	4								31
Nov-92					26	4							30
Dec-92						25	6						31
Jan-93							24	7					31
Feb-93								23	5				28
Mar-93									24	7			31
Apr-93										23	7		30
May-93											23	8	31
Jun-93	9											21	30
Jul-93	21	10											31
Aug-93		19	12										31
Sep-93			18	12									30
Oct-93				17	14								31
Nov-93					15	15							30
Dec-93						14	17						31
Jan-94							13	18					31
Feb-94								11	17				28
Mar-94									13	18			31
Apr-94										12	18		30
May-94											12	19	31
Jun-94	19											11	30
Jul-94	11	20											31
Aug-94		9	22										31
Sep-94			7	23									30
Oct-94				6	25								31
Nov-94					5	25							30
Dec-94						4	27						31
Jan-95							2	29					31
Feb-95								1	27				28
Mar-95									2	29			31
Apr-95										1	29		30
May-95	1											30	31
Jun-95	29	1											30
Jul-95		29	2										31
Aug-95			28	3									31
Sep-95				26	4								30
Oct-95					25	6							31
Nov-95						23	7						30
Dec-95							23	8					31
Jan-96								21	10				31
Feb-96									20	9			29
Mar-96										20	11		31
Apr-96											19	11	30
May-96	13											18	31
Jun-96	17	13											30
Jul-96		17	14										31
Aug-96			16	15									31
Sep-96				14	16								30
Oct-96					14	17							31
Nov-96						12	18						30
Dec-96							11	20					31
Jan-97								10	21				31
Feb-97									8	20			28
Mar-97										10	21		31
Apr-97											8	22	30
May-97	23											8	31
Jun-97	6	24											30
Jul-97		6	25										31
Aug-97			5	26									31
Sep-97				3	27								30
Oct-97					3	28							31
Nov-97						1	29						30
Dec-97							1	29	1				31
Jan-98									29	2			31
Feb-98										28			28
Mar-98											29	2	31
Apr-98	3											27	30
May-98	27	4											31
Jun-98		25	5										30
Jul-98			25	6									31
Aug-98				23	8								31
Sep-98					22	8							30
Oct-98						21	10						31
Nov-98							20	10					30
Dec-98								20	11				31
Jan-99									18	13			31
Feb-99										17	11		28
Mar-99											19	12	31
Apr-99	13											17	30
May-99	16	15											31
Jun-99		15	15										30
Jul-99			14	17									31
Aug-99				13	18								31
Sep-99					11	19							30
Oct-99						10	21						31
Nov-99							9	21					30
Dec-99								9	22				31
Jan-00									8	23			31
Feb-00										7	22		29
Mar-00											7	24	31
Apr-00	24											6	30
May-00	5	26											31
Jun-00		4	26										30
Jul-00			3	28									31
Aug-00				1	29	1							31
Sep-00						29	1						30
Oct-00							28	3					31
Nov-00								27	3				30
Dec-00									27	4			31
Jan-01										26	5		31
Feb-01											24	4	28
Mar-01	5											26	31
Apr-01	25	5											30
May-01		24	7										31

Dec-84			24	7									31
Jan-85				22	9								31
Feb-85					21	7							28
Mar-85						23	8						31
Apr-85							21	9					30
May-85								21	10				31
Jun-85									19	11			30
Jul-85										19	12		31
Aug-85											17	14	31
Sep-85	14											16	30
Oct-85	15	16											31
Nov-85		14	16										30
Dec-85			13	18									31
Jan-86				12	19								31
Feb-86					10	18							28
Mar-86						12	19						31
Apr-86							10	20					30
May-86								10	21				31
Jun-86									8	22			30
Jul-86										8	23		31
Aug-86											7	24	31
Sep-86	24											6	30
Oct-86	5	26											31
Nov-86		4	26										30
Dec-86			3	28									31
Jan-87				2	29								31
Feb-87						28							28
Mar-87						1	29	1					31
Apr-87								28	2				30
May-87									28	3			31
Jun-87										27	3		30
Jul-87											27	4	31
Aug-87	6											25	31
Sep-87	24	6											30
Oct-87		24	7										31
Nov-87			22	8									30
Dec-87				22	9								31
Jan-88					20	11							31
Feb-88						19	10						29
Mar-88							19	12					31
Apr-88								17	13				30
May-88									17	14			31
Jun-88										15	15		30
Jul-88											15	16	31
Aug-88	17											14	31
Sep-88	13	17											30
Oct-88		13	18										31
Nov-88			11	19									30
Dec-88				11	20								31
Jan-89					9	22							31
Feb-89						7	21						28
Mar-89							9	22					31
Apr-89								7	23				30
May-89									6	25			31
Jun-89										5	25		30
Jul-89											4	27	31
Aug-89	28											3	31
Sep-89	2	28											30
Oct-89		2	29										31
Nov-89				30									30
Dec-89					29	2							31
Jan-90						28	3						31
Feb-90							26	2					28
Mar-90								27	4				31
Apr-90									26	4			30
May-90										25	6		31
Jun-90											24	6	30
Jul-90	8											23	31
Aug-90	22	9											31
Sep-90		21	9										30
Oct-90			20	11									31
Nov-90				19	11								30
Dec-90					18	13							31
Jan-91						17	14						31
Feb-91							16	12					28
Mar-91								17	14				31
Apr-91									15	15			30
May-91										15	16		31
Jun-91											13	17	30
Jul-91	18											13	31
Aug-91	11	20											31
Sep-91		10	20										30
Oct-91			9	22									31
Nov-91				8	22								30
Dec-91					7	24							31
Jan-92						6	25						31
Feb-92							5	24					29
Mar-92								5	26				31
Apr-92									4	26			30
May-92										4	27		31
Jun-92											2	28	30

Jun-01			23	7									30
Jul-01				22	9								31
Aug-01					20	11							31
Sep-01						18	12						30
Oct-01							18	13					31
Nov-01								16	14				30
Dec-01									16	15			31
Jan-02										15	16		31
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Apr-02	14	16											30
May-02		13	18										31
Jun-02			12	18									30
Jul-02				11	20								31
Aug-02					10	21							31
Sep-02						8	22						30
Oct-02							7	24					31
Nov-02								6	24				30
Dec-02									5	26			31
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Feb-03											2	26	28
Mar-03	27											4	31
Apr-03	3	27											30
May-03		3	28										31
Jun-03			1	29									30
Jul-03				1	29	1							31
Aug-03						29	2						31
Sep-03							27	3					30
Oct-03								27	4				31
Nov-03									25	5			30
Dec-03										24	7		31
Jan-04											23	8	31
Feb-04	8											21	29
Mar-04	22	9											31
Apr-04		21	9										30
May-04			20	11									31
Jun-04				19	11								30
Jul-04					18	13							31
Aug-04						17	14						31
Sep-04							16	14					30
Oct-04								15	16				31
Nov-04									13	17			30
Dec-04										13	18		31
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Feb-05	18											10	28
Mar-05	11	20											31
Apr-05		10	20										30
May-05			9	22									31
Jun-05				8	22								30
Jul-05					8	23							31
Aug-05						6	25						31
Sep-05							5	25					30
Oct-05								5	26				31
Nov-05									3	27			30
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Jan-06	1										1	29	31
Feb-06	28												28
Mar-06	1	29	1										31
Apr-06			29	1									30
May-06				28	3								31
Jun-06					27	3							30
Jul-06						27	4						31
Aug-06							25	6					31
Sep-06								24	6				30
Oct-06									24	7			31
Nov-06										22	8		30
Dec-06											22	9	31
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Jun-08					5	25							30
Jul-08						4	27						31
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Sep-08								1	29				30
Oct-08										30	1		31
Nov-08											29	1	30
Dec-08	2											29	31