TECHNICAL APPENDIX B

Seasonality

As in the R2000-1 models, we modeled seasonality in Priority Mail and Express Mail models using quarterly dummies and two additional seasonal variables for the movement of pre-Christmas days between postal quarters.

The Postal Service's fiscal calendar is made up of 13 accounting periods of 28 days each. The Postal Service's fiscal calendar is divided into 4 quarters. The first three quarters consist of 3 accounting periods each. The fourth quarter is made up of 4 accounting periods. Because of this, the Postal Service's fiscal calendar is made up of 364 days and does not change in leap years. Thus, the beginning of the Postal fiscal year as well as the beginning of each postal quarter, shifts over time. The Postal fiscal year begins in the Fall. Postal fiscal year 1970 began on October 18, 1969. Postal fiscal year 1999 began on September 12, 1998.

Due to the movement of the Postal quarters within the Gregorian calendar, relative quarterly mail volume changed over time. Mail volumes prior to Christmas are expected to be high. Prior to calendar year 1982, Christmas Day fell in the first Postal quarter. The second Postal quarter of Postal fiscal year 1983 started on Christmas Day of the calendar year 1982. From Postal fiscal year 1983, the number of days prior to Christmas Day in the second Postal quarter has been gradually increasing. The second quarter of Postal fiscal year 1999 began on December 5, 1998 and thus included 15.5 days prior to Christmas Day (Business days exclude Sundays and count

Saturdays as half days). Due to the migration of Christmas Day from the first Postal quarter to the second Postal quarter, the Christmas mail volume shares have changed between the first Postal quarter and the second Postal quarter. This migration of Christmas mail from the first Postal quarter to the second Postal quarter is due to the Postal Services moving calendar. So even if the seasonal variation in mail volume is constant, in the Gregorian calendar, it may not be constant in Postal quarters.

RCF created a set of seventeen seasonal variables. These seasonal variables are constructed so that for any given quarter, the value of the seasonal variable is set equal to the proportion of business days within the quarter that fall within the quarter of interest. A detailed description of these variables is provided in USPS witness Thomas Thress R97-1 testimony USPS-T-7 pp 125-7.

We experimented with these seasonal variables in the Priority Mail and Express Mail models. However, we found that most of the estimated coefficients of these seasonal variables were of unexpected sign. In our model we used the quarterly fixed seasonal dummies for Fall, Winter, Spring, and two additional seasonal variables to capture the moving Christmas Day effect. The two additional seasonal variables were constructed in the same way as RCF's seasonal variables. The first seasonal variable covered the period from December 1 through December 23, while the second seasonal variable covered the period from December 24 through January 1. In the recent history Priority Mail volume has been increasing in the second postal quarter compared to the first postal quarter. To allow for this additional Christmas Day effect the seasonal variable covering the period from December 1 through December 23 was added to the

Priority Mail model beginning in 1997. The estimated coefficients of these seasonal variables had the expected sign. The first seasonal variable covering the period prior to Christmas Day was positive as expected, and statistically significant in both Priority Mail and Express Mail models. The second seasonal variable covering the period from a day before Christmas Day to the first day of January was negative as expected and statistically significant in Priority Mail but not statistically significant in the Express Mail model. The third seasonal variable used only in the Priority Mail model covering the period prior to Christmas Day beginning in 1997 was positive and statistically significant.

The estimated effects of the three seasonal dummies and the additional seasonal variables are combined into a single seasonal index by Postal quarters. The method of computing this index is described in detail below:

Step 1: Multiply the estimated coefficients by the value of the variables and sum across each quarter. For example, the estimated coefficient and the values of the variables in the Priority Mail model are:

	FALL	WINTER	SPRING	DEC1_23	DEC24_JAN1	DDEC1_23
Coefficients	0.0658420	0.0763942	0.0887914	0.2766378	-0.6667887	0.3448305
Values						
1988:1	1.000000	0.000000	0.000000	0.234375	0.000000	0.000000
1988:2	0.000000	1.000000	0.000000	0.054688	0.085938	0.000000
1988:3	0.000000	0.000000	1.000000	0.000000	0.000000	0.000000
1988:4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

	FALL	WINTER	SPRING	DEC1_23	DEC24_JAN1	DDEC1_23
Coefficients	0.0658420	0.0763942	0.0887914	0.2766378	-0.6667887	0.3448305
Values						
1999:1	1.000000	0.000000	0.000000	0.062500	0.000000	0.062500
1999:2	0.000000	1.000000	0.000000	0.226563	0.085938	0.226563
1999:3	0.000000	0.000000	1.000000	0.000000	0.000000	0.000000
1999:4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2000:1	1.000000	0.000000	0.000000	0.046875	0.000000	0.046875
2000:2	0.000000	1.000000	0.000000	0.242188	0.078125	0.242188
2000:3	0.000000	0.000000	1.000000	0.000000	0.000000	0.000000
2000:4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

The sum of the product of the coefficients and variables gives

1988:1	0.130679	This equals	0.066*1 + 0.076*0 + 0.089*0 + 0.277*0.234 - 0.667*0.000 + 0.345*0.000
1988:2	0.034221	This equals	0.066*0 + 0.076*1 + 0.089*0 + 0.277*0.055 - 0.667*0.086 + 0.345*0.000
1988:3	0.088791	This equals	0.066*0 + 0.076*0 + 0.089*1 + 0.277*0.000 - 0.667*0.000 + 0.345*0.000
1988:4	0.000000	This equals	0.066*0 + 0.076*0 + 0.089*0 + 0.277*0.000 - 0.667*0.000 + 0.345*0.000

1999:1	0.104684	This equals	0.066*1 + 0.076*0 + 0.089*0 + 0.277*0.063 - 0.667*0.000 + 0.345*0.063
1999:2	0.159893	This equals	0.066*0 + 0.076*1 + 0.089*0 + 0.277*0.227 - 0.667*0.086 + 0.345*0.227
1999:3	0.088791	This equals	0.066*0 + 0.076*0 + 0.089*1 + 0.277*0.000 - 0.667*0.000 + 0.345*0.000
1999:4	0.000000	This equals	0.066*0 + 0.076*0 + 0.089*0 + 0.277*0.000 - 0.667*0.000 + 0.345*0.000
2000:1	0.094973	This equals	0.066*1 + 0.076*0 + 0.089*0 + 0.277*0.047 - 0.667*0.000 + 0.345*0.047
2000:2	0.174813	This equals	0.066*0 + 0.076*1 + 0.089*0 + 0.277*0.242 - 0.667*0.078 + 0.345*0.242
2000:3	0.088791	This equals	0.066*0 + 0.076*0 + 0.089*1 + 0.277*0.000 - 0.667*0.000 + 0.345*0.000
2000:4	0.000000	This equals	0.066*0 + 0.076*0 + 0.089*0 + 0.277*0.000 - 0.667*0.000 + 0.345*0.000

Step 2: Take the anti-log of the above series

1988:1	1.139602	This equals	EXP(0.130679)
1988:2	1.034813	This equals	EXP(0.034221)
1988:3	1.092853	This equals	EXP(0.088791)
1988:4	1.000000	This equals	EXP(0.000000)

1999:1	1.110359	This equals	EXP(0.104684)
1999:2	1.173386	This equals	EXP(0.159893)
1999:3	1.092853	This equals	EXP(0.088791)

1999:4	1.000000	This equals	EXP(0.000000)	
2000:1	1.099630	This equals	EXP(0.094973)	
2000:2	1.191024	This equals	EXP(0.174813)	
2000:3	1.092853	This equals	EXP(0.088791)	
2000:4	1.000000	This equals	EXP(0.000000)	

Step 3: Compute the weighted values of the index using number of business days as the weights.

		Business Days in quarter	Business Days in PFY		
1988:1	0.261414	64	279	This equals	1.139602*64/279
1988:2	0.237376	64	279	This equals	1.034813*64/279
1988:3	0.254607	65	279	This equals	1.092853*65/279
1988:4	0.308244	86	279	This equals	1.000000*86/279
1999:1	0.254706	64	279	This equals	1.110359*64/279
1999:2	0.269164	64	279	This equals	1.173386*64/279
1999:3	0.258524	66	279	This equals	1.092853*66/279
1999:4	0.304659	85	279	This equals	1.000000*85/279
2000:1	0.252245	64	279	This equals	1.099630*64/279
2000:2	0.273210	64	279	This equals	1.191024*64/279
2000:3	0.258524	66	279	This equals	1.092853*66/279
2000:4	0.304659	85	279	This equals	1.000000*85/279

Step 4: Compute the weighted annual sum.

1988:1	1.061641	This equals	0.26141+0.23738+0.25461+0.30824
1988:2	1.061641	This equals	0.26141+0.23738+0.25461+0.30824
1988:3	1.061641	This equals	0.26141+0.23738+0.25461+0.30824
1988:4	1.061641	This equals	0.26141+0.23738+0.25461+0.30824
1999:1	1.087054	This equals	0.25471+0.26916+0.25852+0.30466
1999:2	1.087054	This equals	0.25471+0.26916+0.25852+0.30466
1999:3	1.087054	This equals	0.25471+0.26916+0.25852+0.30466
1999:4	1.087054	This equals	0.25471+0.26916+0.25852+0.30466
2000:1	1.088638	This equals	0.25224+0.27321+0.25852+0.30466

2000:2	1.088638	This equals	0.25224+0.27321+0.25852+0.30466
2000:3	1.088638	This equals	0.25224+0.27321+0.25852+0.30466
2000:4	1.088638	This equals	0.25224+0.27321+0.25852+0.30466

Step 5: Divide the values of the seasonal index from step 2 by the weighted annual sum from step 4.

1988:1	1.073434	This equals	1.13960/1.06164
1988:2	0.974729	This equals	1.03481/1.06164
1988:3	1.029399	This equals	1.09285/1.06164
1988:4	0.941938	This equals	1.00000/1.06164

1999:1	1.021439	This equals	1.11036/1.08705
1999:2	1.079419	This equals	1.17339/1.08705
1999:3	1.005335	This equals	1.09285/1.08705
1999:4	0.919918	This equals	1.00000/1.08705
2000:1	1.010096	This equals	1.09963/1.08864
2000:2	1.094049	This equals	1.19102/1.08864
2000:3	1.003871	This equals	1.09285/1.08864
2000:4	0.918579	This equals	1.00000/1.08864

Step 6: Since the forecasts are quarterly we need to adjust the index to reflect that quarters one, two and three have three accounting periods each, while quarter four has four accounting periods. So we compute the weighted values of the index using the number of accounting periods per quarter as the weights.

		Number of APs in quarter	Number of APs in PFY		
1988:1	0.247716	3	13	This equals	1.073434*3/13

1988:2	0.224938	3	13	This equals	0.974729*3/13
1988:3	0.237554	3	13	This equals	1.029399*3/13
1988:4	0.289827	4	13	This equals	0.941938*4/13
1999:1	0.235717	3	13	This equals	1.021439*3/13
1999:2	0.249097	3	13	This equals	1.079419*3/13
1999:3	0.232000	3	13	This equals	1.005335*3/13
1999:4	0.283052	4	13	This equals	0.919918*4/13
2000:1	0.233099	3	13	This equals	1.010096*3/13
2000:2	0.252473	3	13	This equals	1.094049*3/13
2000:3	0.231663	3	13	This equals	1.003871*3/13
2000:4	0.282640	4	13	This equals	0.918579*4/13

Step 7: Compute the weighted annual sum.

1988:1	1.000034	This equals	0.24772+0.22494+0.23755+0.28983
1988:2	1.000034	This equals	0.24772+0.22494+0.23755+0.28983
1988:3	1.000034	This equals	0.24772+0.22494+0.23755+0.28983
1988:4	1.000034	This equals	0.24772+0.22494+0.23755+0.28983
1999:1	0.999865	This equals	0.23572+0.24910+0.23200+0.28305
1999:2	0.999865	This equals	0.23572+0.24910+0.23200+0.28305
1999:3	0.999865	This equals	0.23572+0.24910+0.23200+0.28305
1999:4	0.999865	This equals	0.23572+0.24910+0.23200+0.28305
2000:1	0.999874	This equals	0.23310+0.25247+0.23166+0.28264
2000:2	0.999874	This equals	0.23310+0.25247+0.23166+0.28264
2000:3	0.999874	This equals	0.23310+0.25247+0.23166+0.28264
2000:4	0.999874	This equals	0.23310+0.25247+0.23166+0.28264

Step 8: Divide the values of the seasonal index from step 5 by the weighted annual sum from step 7 to obtain the final values of the seasonal index.

1988:1	1.073398	This equals	1.07343/1.000034
1988:2	0.974696	This equals	0.97473/1.000034

1988:3	1.029364	This equals	1.02940/1.000034
1988:4	0.941906	This equals	0.94194/1.000034
1999:1	1.021577	This equals	1.02144/0.999865
1999:2	1.079564	This equals	1.07942/0.999865
1999:3	1.005470	This equals	1.00533/0.999865
1999:4	0.920042	This equals	0.91992/0.999865
2000:1	1.010223	This equals	1.01010/0.999874
2000:2	1.094187	This equals	1.09405/0.999874
2000:3	1.003998	This equals	1.00387/0.999874
2000:4	0.918694	This equals	0.91858/0.999874

This index shows the quarterly seasonal pattern and the change in seasonal pattern overtime. The values of the seasonal index in 1988 are:

1988:1	1.073398
1988:2	0.974696
1988:3	1.029364
1988:4	0.941906

So in 1988 the volume in the first postal quarter is the highest. It is no surprise as the first eighteen days of December are included in the first Postal quarter of 1988. As we move through the years the value of the index in 1998 is the highest in the second Postal quarter. Again this is no surprise as the second quarter of 1998 includes Postal volume from December 5, onwards. Thus the index clearly shows the transfer of Postal volume from the first Postal quarter to the second Postal quarter over time. The advantage of using a seasonal index for forecasting Postal volumes is that the index reallocates the forecasts based on the seasonal pattern within each year and does not changes the volume from year to year. This can be seen by weighing each

index value by the proportion of accounting periods in the Postal quarter and summing the result. For example,

1988:1	0.247707	This equals	1.07340*3/13
1988:2	0.224930	This equals	0.97470*3/13
1988:3	0.237546	This equals	1.02936*3/13
1988:4	0.289817	This equals	0.94191*4/13
	1.000000	This equals	0.24771+0.22493+0.23755+0.28982
1999:1	0.235749	This equals	1.02158*3/13
1999:2	0.249130	This equals	1.07956*3/13
1999:3	0.232032	This equals	1.00547*3/13
1999:4	0.283090	This equals	0.92004*4/13
	1.000000	This equals	0.23575+0.24913+0.23203+0.28309
2000:1	0.233128	This equals	1.01022*3/13
2000:2	0.252505	This equals	1.09419*3/13
2000:3	0.231692	This equals	1.00400*3/13
2000:4	0.282675	This equals	0.91869*4/13
	1.000000	This equals	0.23313+0.25250+0.23169+0.28268