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Using Quarterly Seasonal Adjustments to Improve Monthly Adjustments

by

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USING QUARTERLY SEASONAL ADJUSTMENTS

TO IMPROVE MONTHLY ADJUSTMENTS

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ABSTRACT

Occasionally time series which show weak or inconsistent seasonality when examined on a monthly basis can be strongly seasonal when examined on a quarterly basis. An agency which publishes such data on both a monthly and quarterly basis faces a dilemma: how should the monthly series be seasonally adjusted to reflect the seasonality found in the quarterly series? In this paper, we will examine what happens if the monthly seasonally adjusted series is benchmarked to its quarterly counterparts. Since the benchmarking procedure used preserves month-to-month changes in the monthly seasonally adjusted series, weights are added to the benchmarking function to ensure that months with erratic month-to-month changes are downweighted. This procedure is evaluated on a number of Census Bureau economic time series, and the effect of the weighting scheme is examined. Special attention is paid to the stability of the month-to-month change of the seasonally adjusted series (as measured by the sliding spans diagnostics of Findley et. al. (1990)) and the amount of revision to the published monthly seasonally adjusted series caused by the quarterly benchmarking.

KEY WORDS: Seasonal Adjustment, Benchmarking, Sliding Spans Diagnostics, Revisions

1. INTRODUCTION

Sometimes the quarterly version of an economic time series is seasonal but the monthly series is not. This can happen when the major seasonal event, such as a crop harvest or trade show, does not occur in the same month every year, but almost always occurs in the same quarter.

More frequently, the monthly version of a seasonal quarterly series is also seasonal. Typically (with stock as opposed to flow series), the seasonal pattern is more identifiable in the quarterly series because of the smoothing effect of the addition of monthly into quarterly numbers.

When the monthly seasonal adjustments are of mediocre quality or worse but the quarterly adjustments are of good quality, it is natural to ask if the monthly adjustments can be improved by the inclusion of information from the quarterly adjustments. This report describes results from two benchmarking approaches to including such information by constraining the monthly adjustments to sum to the quarterly adjustments. Our conclusion is that series for which these procedures offer significant benefits are rather rare.

2. METHODOLOGY

Given a time series with acceptable quarterly seasonal adjustments but possibly poor monthly seasonal adjustments, our basic idea is to replace the monthly values with closely related ones whose sums over quarters coincide with the good quarterly adjustments. Here, "closely related" means having similar month-to-month percent changes ("monthly trends"), as similar as possible according to a quadratic criterion. Our focus on these percent changes comes from the fact that they are the statistics to which most attention is paid by the majority of users of the Census Bureau's published seasonally adjusted time series data.

To describe our procedure more precisely, we introduce some notation. Let x_t denote the seasonally adjusted time series value in month t. Let q_k denote the result for quarter k of ...lly adjusting the aggregate quarterly values of the time series under consideration, and let b_k and e_k denote the values of the monthly index t associated with the beginning and ending months of quarter k. Suppose we have available x_t, $1 \le t \le T$. For positive weights w_t, $2 \le t \le T$ described below, we are interested in the "improved" seasonal adjustment series y_t that is obtained by minimizing

$$\sum_{t=2}^{T} w_t(x_t/x_{t-1} - y_t/y_{t-1})^2 \qquad (2.1)$$

subject to the constraints

$$\sum_{t=b_k}^{e_k} y_t = q_k, \qquad (2.2)$$

where k ranges over all quarters for which $b_k \geq 1$ and $e_k \leq T$. The y_t are "improved" in the sense that they satisfy these desirable accounting constraints, but it is also hoped that they will have better seasonal adjustment diagnostics, as a consequence of "borrowing strength" from the q_k.

For the small sample of series and the weighting schemes we have considered up to now, we have found only modest differences and no significant advantages for one weighting scheme over another, with the result that the simplest scheme, with the uniform weight $w_t = 1$ for all t, is competitive with the rest. However, it is important to the motivation of our method to consider the role conceived for the weights: our X-12-ARIMA seasonal adjustment software's sliding spans seasonal adjustment diagnostics (see Findley, Monsell, Shulman and Pugh, 1990) categorize the seasonally adjusted month-to-month change values $m_t = x_t/x_{t-1} - 1$ into groups of increasing unreliability. These groups are determined by the magnitude of the changes in value of m_t that occur when the data window used for the calculation of x_t and x_{t-1} is varied. It seems natural to give relatively high weight in (2.1) to months with stable ≐ reliable m_t's and increasingly smaller weight to months whose m_t values belong to increasingly more unreliable categories.

The weighting schemes we considered have the form $w_t = \alpha^{n(t)}$, with $0.1 \leq \alpha \leq 1$ and with n(t) taking on the values 0, 1, 2, 3, 4, according to the category of instability associated with m_t. With range(m_t) denoting the <u>range</u> (<u>max</u> minus <u>min</u>) of the values of m_t) obtained from all data windows considered containing both months t and t-1, we set n(t) = 0 if range(m_t) ≤ .03; n(t) = 1 if .03 < range(m_t) ≤ .05; n(t) = 2 if .05 < range(m_t) ≤ .07, n(t) = 3 if .07 < range(m_t) ≤ .10; and n(t) = 4 if range(m_t) > .10).

3. RESULTS FOR TEN SERIES

A special version of the benchmarking program described in Bozik and Otto (1988) was created to carry out the constrained minimization calculation with variable weights w_t in (2.1) as just described.

We applied the procedure with $\alpha = 1$ (equal weighting) and $\alpha = 0.1$ to the series listed in Table 1. Some quality control diagnostics from X-11-ARIMA and from the sliding spans analysis for the monthly and quarterly (suffix q) versions of these series are given in Table 2. Here SA% and MM% are the percentages of unstable seasonal adjustments and month-to-month changes, respectively. The only series whose quarterly adjustment diagnostics are not always better than the monthly adjustment diagnostics is u37cvs. The SA% and MM% diagnostics for the unbenchmarked, unweighted benchmarked ($\alpha = 1$) and weighted benchmarked ($\alpha = 0.1$) adjustments are given in Table 3. The most successful results were obtained for solhs, followed by mncrs. These are series whose monthly adjustments before benchmarking are already good (meaning D8 F-Test > 10, M7 < 1.0, Q < 1.0, SA% < 15.0 and MM% < 35.0).

4. REVISIONS OF CURRENT ADJUSTMENTS

When the benchmarking procedure leads to more reliable monthly adjustments of the historical time series, its results could be helpful, for example, to an economist looking for connections between the movements of related series. However, the more typical consumers of Census Bureau data are interested almost exclusively in trends within the very recent data. At the time the first two months of the current quarter receive their initial seasonal adjustments, the benchmark quarterly adjustment of the quarter is not yet available. After the initial seasonal adjustments of such months are published, they are susceptible to large revisions when benchmarking is applied at the time the datum for the final month in the quarter becomes available, and with it the quarterly benchmark. This phenomenom is illustrated with our most successful example, solhs, in Figure 1: the first benchmarking-induced revisions of January and February of 1988 are especially large.

Large revisions are distressing to data users because they undermine the data's credibility. We explored a forecasting approach to avoiding large revisions of the first two months of current quarters by fitting seasonal ARIMA models to the monthly and quarterly series and using the models to forecast values a year and a quarter in advance. Initial seasonal adjustments of current months were obtained by benchmarking adjustments of forecast-extended monthly series to the adjustments of the forecast-extended quarterly series. This worked rather well with solhs: Figure 2 shows initial end-of-quarter revisions. These are much reduced for January and February, 1988 and for some other months as well. Unfortunately, as the analogous Figure 3 shows, this procedure proved disasterous for the first two months of the first and second quarters of 1987 with the series mwlhs, because of large errors in the one-step-ahead forecasts of these quarters, which are displayed in Figure 4. Because large forecast errors are always a possibility with macro-economic time ... we conclude that this approach to implementing benchmark ...ment of current data is unsuitable for official seasonal adjustments.

5. DISCLAIMER

This paper reports the general results of research undertaken by Census Bureau staff. The views are attributable to ...uthors and do not necessarily reflect those of the Census ...eau.

Table 1. Description of Series Examined

apprs	-	retail sales of apparel (1967-1988)
mncrs	-	retail sales of men's clothing (1967-1988)
mw1hs	-	single family home construction starts in the midwestern U.S. (1964-1988)
ne1hs	-	single family home construction starts in the northeastern U.S. (1964-1988)
so1hs	-	single family home construction starts in the southern U.S (1964-1988)
we1hs	-	single family home construction starts in the western U.S (1964-1988)
apevs	-	shipments of electrical appliances (1968-1983)
u37cvs	-	shipments of new commercial aircraft (1978-1992)
i3020r	-	imports of automobile engines from countries other than Canada (1979-1992)
x3020r	-	exports of automobile engines to countries other than Canada (1979-1991)

Table 2. Quality Diagnostics for the Monthly and Quarterly Adjustments

Series Name	D8 F-test	M7	Q	SA%	MM%
apprs	494.2	0.13	0.29	5.6	14.0
apprsq	628.3	0.11	0.25	0.0	0.0
mncrs	1615.8	0.05	0.28	4.6	13.1
mncrsq	3342.0	0.04	0.28	0.0	0.0
mw1hs	390.2	0.11	0.37	29.2	44.8
[illegible]q	1443.6	0.06	0.28	12.5	34.1
[illegible]s	228.6	0.15	0.56	40.3	60.8
ne1hsq	937.4	0.07	0.45	22.9	43.2
so1hs	175.6	0.16	0.41	9.0	25.2
so1hsq	407.5	0.10	0.33	0.0	0.0
[illegible]	100.7	0.21	0.46	10.4	23.8
[illegible]hsq	267.7	0.16	0.45	4.2	11.4
apevs	24.3	0.51	0.85	12.0	31.8
apevsq	34.5	0.41	0.67	0.0	0.0
u37cvs	20.8	0.56	1.30	29.2	55.9
u37cvsq	22.1	0.67	0.70	2.1	25.0
i3020r	3.4	1.25	1.58	29.2	45.5
i3020rq	16.8	0.38	0.89	0.0	6.8
x3020r	7.8	0.87	1.24	22.9	49.0
x3020q	19.1	0.60	0.74	0.0	0.0

Table 3. Stability Diagnostics for Unbenchmarked, Benchmarked and Weighted Benchmarked Adjustments

Series Name	Original Seasonal Adjustment		Benchmark Seasonal Adjustment		Weighted Benchmark Seasonal Adjustment	
	SA%	MM%	SA%	MM%	SA%	MM%
apprs	5.6	14.0	5.6	7.5	5.6	7.5
mncrs	4.6	13.1	1.9	5.6	1.9	5.6
mw1hs	29.2	44.8	27.1	42.7	25.7	39.2
ne1hs	40.3	60.8	44.4	60.8	43.8	60.8
so1hs	9.0	25.2	2.8	12.6	2.1	12.6
we1hs	10.4	23.8	13.2	25.2	13.2	23.8
apevs	12.0	31.8	11.1	20.6	11.1	19.6
u37cvs	29.2	55.9	33.3	58.8	33.5	52.0
i3020r	29.2	45.5	20.8	48.3	19.4	46.7
x3020r	22.9	49.0	20.8	46.9	20.8	45.5

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Figure 1. Revision analysis, for so1hs

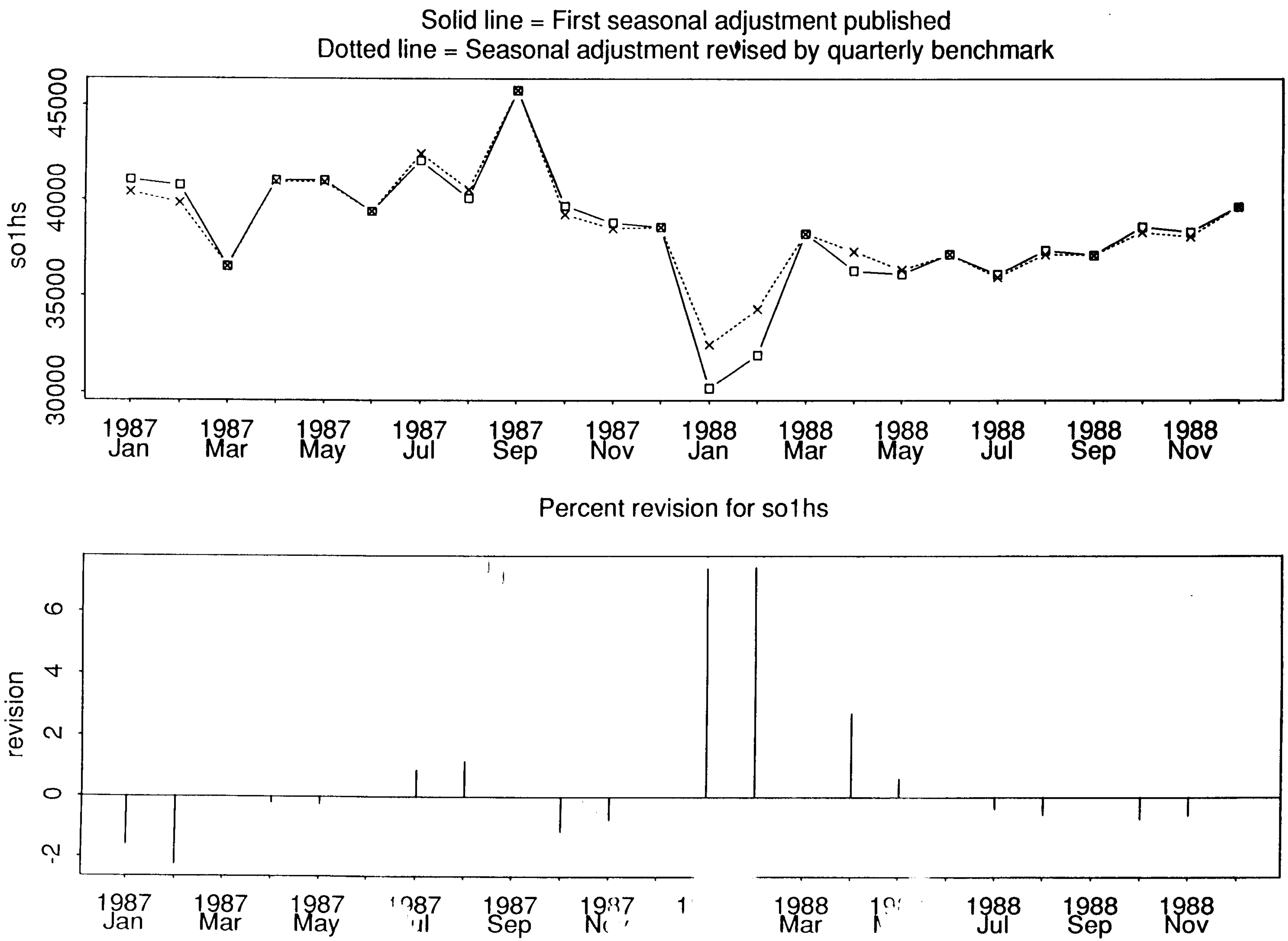
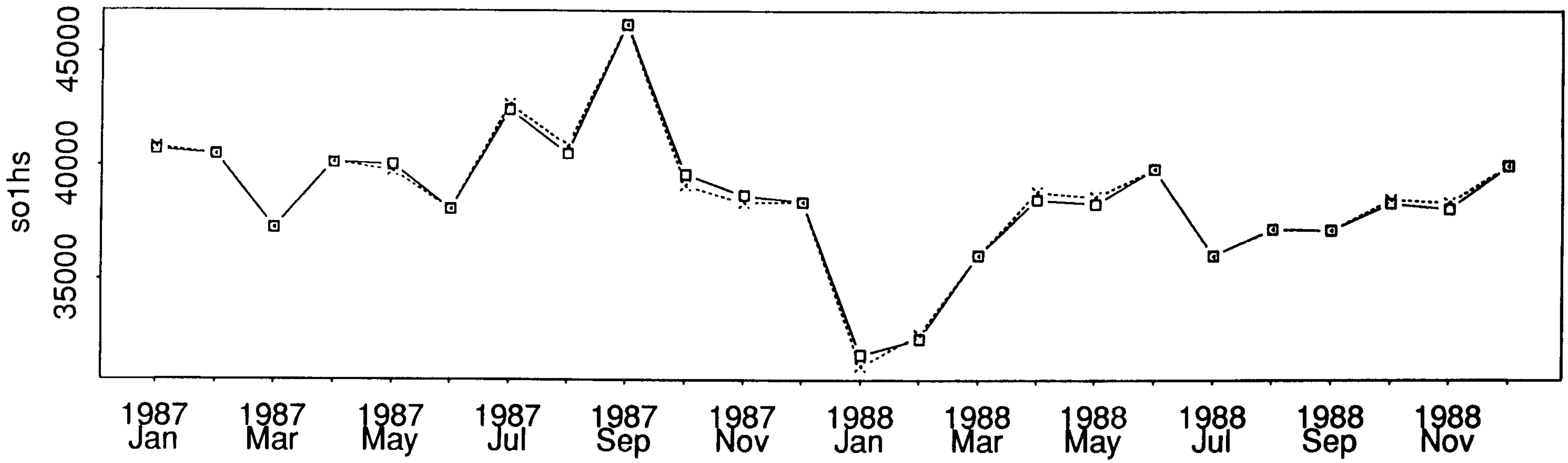


Figure 2. Revision analysis for so1hs

Solid line = Concurrent seasonal adjustment from forecasted benchmarks
Dotted line = Seasonal adjustment from actual quarterly benchmark



Percent revision for so1hs

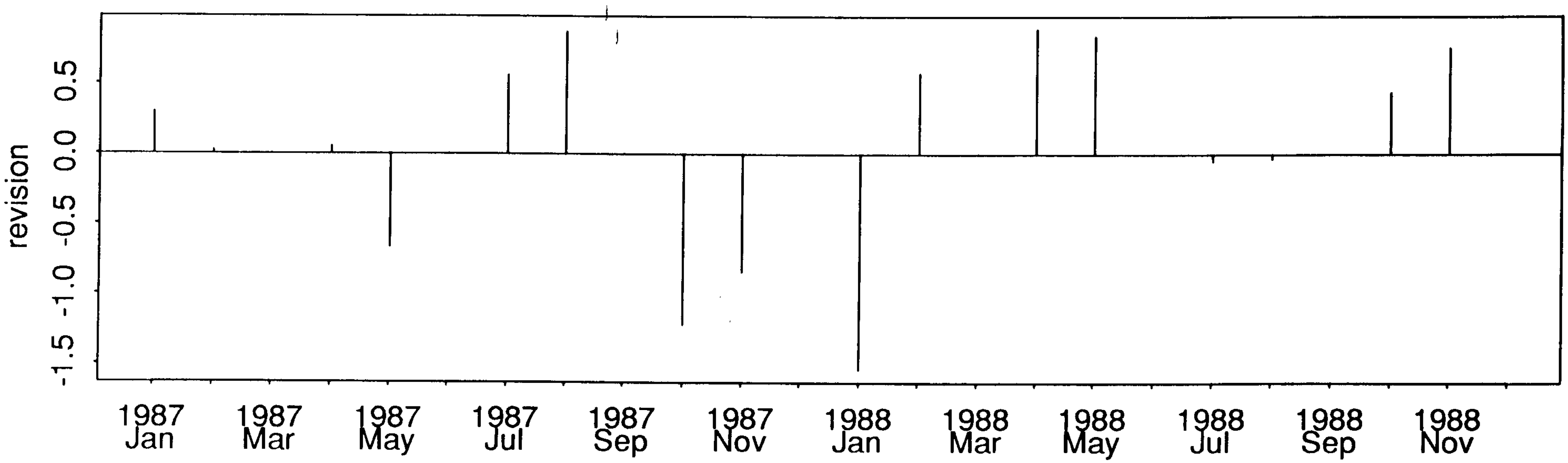


Figure 3. Revision analysis for mw1hs

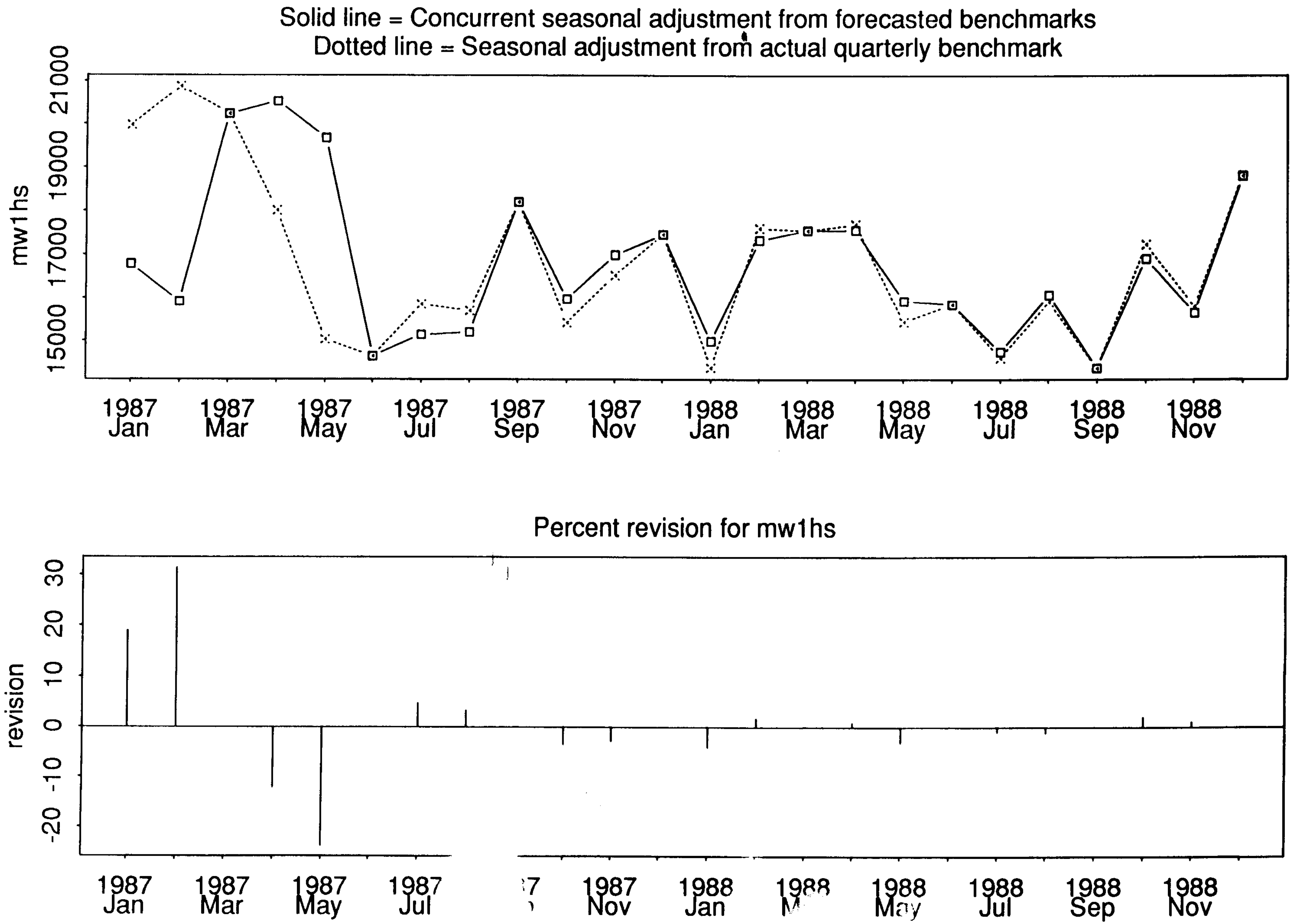


Figure 4. Forecasts for mw1hsq