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The Impact of the First-Class Worksharing Discount on First-Class Workshared Mail Volumes

I. Introduction

In the econometric demand equations filed with the Postal Regulatory Commission on January 16, 2009, the First-Class single-piece and workshared equations (for both letters, flats, and parcels; as well as cards) include the average First-Class worksharing discount as a measure of price substitution between single-piece and workshared mail.

Logically, the amount of mail that migrates out of (or into) single-piece as a result of a change in the discount should be equal to the amount of mail that migrates into (or out of) workshared mail. Working through the math, this leads to the restriction that the ratio of the discount elasticities in the single-piece and workshared equations is equal to the ratio of the volumes of single-piece and workshared mail.

Because the ratio of the volumes of single-piece and workshared mail has changed over time (single-piece has declined relative to workshared), this means that the discount elasticity for either single-piece or workshared mail (or both) must have also changed over time (specifically, the elasticity for workshared mail must have declined over time relative to the elasticity for single-piece mail). This is modeled econometrically by dividing the worksharing discount by the ratio of these volumes in the First-Class workshared mail equations.

Except that it's not quite that simple. Instead, a fitted value of the worksharing discount divided by this volume ratio is first estimated, and then the fitted value is included in the First-Class workshared mail equations. In effect (simplifying considerably), the "discount" variable in the First-Class workshared equation includes two things: the average First-Class worksharing discount and a time trend.

This creates two problems. First, it's difficult to explain what exactly the "volume ratio" is measuring; in some sense, it is a "trend" factor, but it's not a smooth trend and it tends to defy exact explanation/interpretation. Beyond this, a potentially more serious problem is that the measured impact of changes in worksharing discounts on workshared mail volume is actually being driven (at least in part) by the historical trend in workshared mail volume.

This issue was investigated in some detail over the past year. The results of these investigations are presented below.

II. Econometric Experiments in First-Class Letters Equations

The baseline demand equation for First-Class workshared letters, flats, and parcels, for the initial set of experiments undertaken as part of this research included data through 2009Q2 and included as one of the explanatory variables an instrumental variable, which is a fitted estimate of the average First-Class worksharing discount divided by the ratio of workshared to single-piece mail volumes. This equation parallels the equation submitted to the Commission in January of 2009. The explanatory variables used to fit the instrumental variable include all of the other explanatory variables in the First-Class workshared letters equation as well as the average First-Class worksharing discount (D1_3WS), a time trend (TREND), and the trend squared (TSQ).

In the first experiment the Instrumental variable was replaced with these three variables: D1_3WS, TREND, and TSQ. The results of these two equations are summarized below.

	Baseline Equation	Discount, Trend separate
Own-Price Elasticity	-0.412 (-5.533)	-0.191 (-0.918)
Discount Elasticity	0.105 (25.76)	-0.047 (-0.270)
Employment	0.463 (5.639)	0.680 (3.827)
Broadband	-0.739 (-15.76)	-0.518 (-2.764)
Trend Trend Squared		0.026 (6.164) -8.630 (-4.488)
AR/ARCH Coefficients	AR-4: -0.380 (-3.431)	AR-1: 0.418 (2.254) AR-4: -0.231 (-2.042) ARCH-1: 0.267 (2.185)
Mean-Squared Error AR/ARCH-Corrected Unadjusted	 0.000172 0.000241	 0.000139 0.000579

The results are quite interesting. Most striking, the discount elasticity turns negative. The "discount elasticity" in the baseline equation is driven entirely by the trend term(s). The newer equation does have two weaknesses: one obvious and one less so. The obvious problem is that this equation has a worse AR/ARCH pattern – an AR-1 and an ARCH-1 are both added to the equation.

The less obvious problem is the trend terms. The positive trend coefficient and negative trend-squared coefficient combine to create a variable that increases at a decreasing rate. Left unconstrained the combined impact of these two terms will eventually flip signs and turn negative. In fact, in this case, the combined trend term actually flips sign and turns negative within the regression sample period, specifically in 2008Q4.

As an alternative, the trend and trend-squared terms were replaced with a logistic time trend. This also increases (if the coefficient is positive) at a decreasing rate but stays positive. This specification was investigated with and without the worksharing discount. The results are shown below.

	With Discount	Without Discount
Own-Price Elasticity	-0.319 (-1.224)	-0.416 (-2.533)
Discount Elasticity	-0.098 (-0.475)	
Employment	0.381 (1.585)	0.334 (1.514)
Broadband	-0.653 (-5.795)	-0.642 (-6.087)
Logistic Trend	0.206 (16.61)	0.207 (17.29)
AR/ARCH Coefficients	AR-1: 0.594 (5.262) ARCH-1: 0.142 (1.861) ARCH-2: 0.195 (2.079) ARCH-4: 0.327 (3.816)	AR-1: 0.585 (5.209) ARCH-1: 0.142 (1.859) ARCH-2: 0.176 (1.894) ARCH-4: 0.343 (4.036)
Mean-Squared Error AR/ARCH-Corrected Unadjusted	 0.000056 0.009740	 0.000055 0.009361

The results here are intriguing. On the one hand, the AR/ARCH-corrected mean-squared errors here are stunningly good. On the other hand, though, as the unadjusted mean-squared error shows, the AR/ARCH corrections are doing a lot of the work in these equations.

Large positive ARCH coefficients indicate that there is a high correlation in the magnitude (but not necessarily the sign) of residuals with nearby residuals. In other words, it suggests that there may be a cluster of high-variance residuals. One possible solution to such a problem could be to simply shorten the sample period. This, of course, works best if the problematic time period is at the beginning of the sample period.

In this case, this seems to be the problem. The Postal Service's methodology for estimating First-Class workshared mail volumes was changed in 1993 to rely on mailing statement data. The equations shown above use a sample period starting in 1991Q1. Experimenting with starting the sample period later suggested that the best results can probably be obtained using a sample period that begins in 1994Q1, a year after the switch to mailing statement data. The equations in the preceding table were re-estimated using a sample period starting in 1994Q1. The results are shown below.

	With Discount	Without Discount
Own-Price Elasticity	-0.264 (-1.623)	-0.339 (-3.491)
Discount Elasticity	-0.068 (-0.440)	
Employment	0.572 (4.277)	0.525 (4.592)
Broadband	-0.737 (-11.21)	-0.720 (-12.16)
Logistic Trend	0.220 (19.24)	0.216 (17.87)
AR/ARCH Coefficients	None	None
Mean-Squared Error		
AR/ARCH-Corrected	0.000173	0.000166
Unadjusted	0.000173	0.000166

The second of these equations (i..e, without a discount) has no AR/ARCH-corrections and a lower mean-squared error than the current baseline First-Class workshared letters equation (and the lowest unadjusted mean-squared error of any equation shown in this report). The logistic trend translates into annual growth of around 1.4% per year over the last five years. In contrast, the "trends" implied by the Instrumental variable from the baseline equation explained volume growth of about 1.5% per year over the same time period.

Of course, one potential weakness of this equation is that it implies no impact of changes to the average First-Class worksharing discount on First-Class workshared mail volume. In contrast, the freely estimated discount elasticity for First-Class single-piece letters, flats, and parcels is -0.020 with a t-statistic of -0.615. This would imply a workshared elasticity of around 0.015 or so. One possibility could be to introduce a constraint along these lines, although, neither of these discount elasticities are statistically significant.

Based on these results, four tentative conclusions were drawn.

(1) Based on these results, a solid econometric argument can be made that First-Class single-piece and workshared mail volumes are not affected by changes to First-Class worksharing discounts,

(2) If First-Class worksharing discounts are included in the First-Class equations, the results should be constrained from the single-piece equation,

(3) If First-Class worksharing discounts are included in the First-Class workshared mail equations, the discount should probably be entered into these equations directly,

(4) If the First-Class worksharing discount is entered into the workshared mail equations directly, then some type of trend term (TREND and TSQ, logistic trend, etc.) would also need to be added to this equation.

III. Extension of Research to First-Class Cards Demand Equations

The experiments described above with respect to First-Class workshared letters, flats, and parcels were extended to First-Class workshared cards as well. The baseline equation used for this set of experiments modeled First-Class workshared cards volume as a function of Trend and Cyclical components of Retail Sales, the number of Broadband subscribers lagged four quarters interacted with a time trend starting in 2002Q4, a dummy variable for R97-1, a rate crossover dummy measuring the percentage of Standard Regular letters for which First-Class workshared cards rates are lower, the price of First-Class workshared cards, and an Instrumental variable.

The last of these variables, the Instrumental variable, was the focus of this set of experiments. The Instrumental variable in the First-Class workshared cards equation described above was a fitted estimate of the average First-Class worksharing discount divided by the ratio of workshared to single-piece cards volumes. The explanatory variables used to fit the instrumental variable included all of the other explanatory variables in the First-Class workshared cards equation as well as the average First-Class worksharing discount (D5_7WS) and ISP Consumption (CS_ISPADJ). Simplifying greatly, the former of these (D5_7WS) measures (actually, is) the numerator of the Instrumental variable while the latter variable (CS_ISPADJ) measures the denominator of the Instrumental variable, the ratio of First-Class workshared to single-piece cards volumes.

For the first experiment, the Instrumental variable was replaced with these two variables: D5_7WS and CS_ISPADJ. The results of these two equations are summarized below.

	Baseline Equation	Discount, Trend separate
Own-Price Elasticity	-0.522 (-1.475)	-0.948 (-1.641)
Avg. Worksharing Discount	0.112 (1.971)	-0.014 (-0.059)
Std Regular Rate Crossover	0.145 (1.222)	0.158 (0.819)
Retail Sales		
Trend Component	0.650 (1.778)	0.627 (0.377)
Cyclical Component	1.658 (5.128)	2.031 (5.255)
Broadband (*T02Q4)	-0.017 (-1.558)	-0.014 (-0.341)
CS_ISPADJ		3.642 (0.430)
AR/ARCH Coefficients	None	None
Mean-Squared Error	0.000703	0.001529

At first glance, the results here appear to replicate the results for First-Class workshared letters: the discount, considered alone, has no explanatory power in the First-Class workshared cards equation.

Removing the discount had no particular effect on any of the other results. The t-statistic on CS_ISPADJ was 0.44 and the mean-squared error of the equation was 0.001478. Removing CS_ISPADJ as well produced a full-sample mean-squared error of 0.001440, still more than double the equation including the Instrumental variable.

Next, paralleling the First-Class workshared letters experiments outlined above, the ISP variable was replaced with a logistic time trend. The coefficient on the logistic trend was unexpectedly negative (−0.15) and highly insignificant (t-statistic less than 0.2 in absolute value). Repeating that experiment with a linear trend, the coefficient was significant, but still negative (offset by a positive Broadband coefficient).

Going back to the Instrumental variable, it is constructed by fitting a regression of the discount variable as a function of all of the explanatory variables in the First-Class workshared cards equation as well as the discount (D5_7WS) and the Internet variable, CS_ISPADJ. In the baseline equation, the coefficient on the worksharing discount in this first-stage equation was 2.42 with a t-statistic of 1.911. This is the expected sign (the Instrument should be positively correlated to the discount) and fairly significant. The coefficient on CS_ISPADJ, on the other hand, is 11.58 (which is the expected sign) but with a t-statistic of only 0.269.

Looking at those results suggested two more experiments: removing CS_ISPADJ from the first-stage equation used to estimate the Instrumental variable and removing the Instrumental variable and entering only the discount variable, D5_7WS, directly into the First-Class workshared cards equation.

Results of these experiments are shown in the table below.

	Baseline Equation (Instrument function of D5_7WS, CS_ISPADJ)	Instrument function of D5_7WS only	Discount entered directly
Own-Price Elasticity	-0.522 (-1.475)	-0.526 (-1.158)	-0.843 (-1.633)
Avg. Worksharing Discount	0.112 (1.971)	0.111 (1.831)	0.022 (0.098)
Std Regular Rate Crossover	0.145 (1.222)	0.145 (1.109)	0.196 (1.157)
Retail Sales			
Trend Component	0.650 (1.778)	0.637 (0.635)	1.327 (3.858)
Cyclical Component	1.658 (5.128)	1.658 (5.016)	2.105 (6.182)
Broadband (*T02Q4)	-0.017 (-1.558)	-0.017 (-0.618)	0.003 (0.436)
AR/ARCH Coefficients	None	None	None
Mean-Squared Error	0.000703	0.000728	0.001487

The discount elasticity has the “right” sign in the last column here, but is extremely insignificant, with a t-statistic of only 0.098.

Several additional experiments were undertaken which looked at various alternate specifications. In general, these all confirmed the results here that the average worksharing discount is, at best, an insignificant influence on First-Class workshared cards volume.

IV. Updated Analysis of First-Class Worksharing Discount Elasticities

Based on a number of other areas of econometric investigation, the model specifications associated with First-Class Mail were changed in fairly significant ways since the initial investigation of the impact of worksharing discounts on First-Class Mail reported in Sections II and III of this document, which were undertaken in the first half of calendar 2009.

Average First-Class worksharing discounts were therefore re-investigated more recently, using updated equations reflecting other improvements made since the earlier investigations.

Preliminary results for the four First-Class Mail demand equations, excluding discount variables, which served as the baseline for this analysis, are presented in the first table below.

Average First-Class worksharing discounts were added to each of these four equations. In theory, the expected sign of the discount elasticities here is negative for First-Class single-piece letters and cards and positive for First-Class workshared letters and cards.

The results are summarized in the second table below.

	First-Class Single-Piece		First-Class Workshared	
	Letters	Cards	Letters	Cards
Own-Price Elasticity	-0.158 (-2.058)	-0.435 (-4.729)	-0.410 (-5.087)	-1.484 (-5.367)
Employment				
Trend Component	0.927 (5.420)			
Cyclical Component				
(Lag)	(0)		(2)	
(Coefficient)	0.607 (3.699)		1.317 (8.981)	
Retail Sales				
Trend Component				
Cyclical Component				2.250 (6.847)
ISP Consumption				
Coefficient	-1.264 (-9.740)	-1.386 (-11.82)		
* EMPL_TN_L	32.72 (3.659)	95.41 (10.57)		
* EMPL_TN_L * Trend	-0.233 (-4.481)	-0.626 (-11.79)		
Lambda	0.429 (14.68)	0.332 (2.605)		
Broadband Subscribers				
Starting in			2003Q2	2002Q2
(Lag)			(11)	(7)
Coefficient				-0.230 (-1.105)
* EMPL_TN_L			-13.34 (-19.11)	
Logistic Time Trend			0.180 (21.14)	0.433 (4.906)
Dummy Variables				
MSADJ		-0.063 (-5.246)		
MC95			-0.067 (-7.648)	
R97-1				-0.166 (-4.015)
R2006PHOP	-0.031 (-2.117)	-0.029 (-1.377)		
Quarter 1, Election Years			0.007 (1.252)	
AR / ARCH Corrections				
AR-4		-0.451 (-3.778)		
Mean Squared Error				
Full Sample (inc. AR/ARCH)	0.000332	0.000869	0.000112	0.001529
Full Sample (exc. AR/ARCH)	0.000332	0.001215	0.000112	0.001529
Last 5 Years	0.000279	0.000467	0.000094	0.000807
Last 4 Years	0.000278	0.000436	0.000081	0.000939
Last 3 Years	0.000328	0.000454	0.000087	0.000951
Last 2 Years	0.000327	0.000513	0.000122	0.000688
Last 1 Year	0.000407	0.000354	0.000158	0.000133

	First-Class Single-Piece		First-Class Workshared	
	Letters	Cards	Letters	Cards
Own-Price Elasticity	-0.165 (-2.127)	-0.357 (-2.496)	-0.491 (-3.574)	-1.609 (-4.889)
Discount Elasticity	**0.010 (0.363)**	**-0.097 (-0.705)**	**0.090 (0.730)**	**0.135 (0.713)**
Employment				
Trend Component	0.872 (4.698)			
Cyclical Component	0.610 (3.701)		1.272 (7.951)	
Retail Sales				
Trend Component				
Cyclical Component				2.364 (6.426)
ISP Consumption				
Coefficient	-1.279 (-9.668)	-1.526 (-11.78)		
* EMPL_TN_L	33.35 (3.639)	100.0 (8.417)		
* EMPL_TN_L * Trend	-0.237 (-4.448)	-0.650 (-9.009)		
Lambda	0.435 (10.78)	0.356 (2.486)		
Broadband Subscribers				
Coefficient				-0.449 (-1.207)
* EMPL_TN_L			-12.93 (-14.28)	
Logistic Time Trend			0.181 (20.87)	0.514 (3.576)
Dummy Variables				
MSADJ		-0.065 (-5.218)		
MC95			-0.097 (-2.324)	
R97-1				-0.181 (-3.867)
R2006PHOP	-0.031 (-2.100)	-0.028 (-1.320)		
Quarter 1, Election Years			0.007 (1.251)	
AR / ARCH Corrections				
AR-4		-0.460 (-3.828)		
Mean Squared Error				
Full Sample (inc. AR/ARCH)	0.000336	0.000880	0.000113	0.001555
Full Sample (exc. AR/ARCH)	0.000336	0.001232	0.000113	0.001555
Last 5 Years	0.000278	0.000459	0.000090	0.000793
Last 4 Years	0.000277	0.000418	0.000076	0.000917
Last 3 Years	0.000328	0.000437	0.000080	0.000964
Last 2 Years	0.000327	0.000509	0.000111	0.000675
Last 1 Year	0.000405	0.000334	0.000138	0.000123

Three of the four discount elasticities are the correct sign (i.e., match theoretical expectations), the exception being First-Class single-piece letters, with all three correct-signed elasticities being a reasonable magnitude as well. None of these discount elasticity estimates are significant, however, with all three correct-signed elasticities having t-statistics of 0.7 (in absolute value). Not surprisingly, therefore, adding the discount variable increases the full-sample mean-squared errors of all four equations. Based on these results, it was therefore decided that leaving the worksharing discount variables out of the First-Class Mail demand equations would improve the models' forecasting ability, and that determination is reflected in the equations that were filed with the Postal Regulatory Commission on January 20, 2010.