TECHNICAL APPENDIX A

UPS Person Days Lost Due to Strikes

One of the important economic influences upon Priority Mail is the availability of competing services. When competing services are not available, or the availability is reduced, we would expect more Priority Mail volume. When a strike occurs at United Parcel Service (UPS) we would expect Priority Mail to increase, and our statistical results are consistent with that expectation.

There are many quarters with no strike activity at UPS. The data contains zeros for those periods. A double log model is usually not appropriate in such a situation. To see this, and to see the model that we actually used, we will write a simplified version of the double-log model and our model. We will reduce the number of variables, simplify the notation and omit the discussion of the stochastic specification of the model. None of these issues would compromise our explanation; we only simplify the issues for clarity.

Our symbols are:

V = Volume
X = non-zero explanatory variable
S = Strike data which contain some zeros
a, b, c = parameters to be estimated.

The double log model is derived from equation (1):

$$\mathbf{V = aX^b}, \qquad (1)$$

which becomes:

$$\ln(V) = \ln(a) + b \ln(X) \quad . \tag{2}$$

If we simply added S, we would have

$$V = aX^b S^c \quad \text{, or:} \tag{3}$$

$$\ln(V) = \ln(a) + b \ln(X) + c \ln(S) \, . \tag{4}$$

Equation (3) would imply that Priority Mail would be zero when UPS had no strikes. That is, zero to any non-zero power is zero. If we attempted to use equation (4) we would find it impossible, since the logarithm of zero is undefined.

The model we constructed is analogous to equations 5 and 6 below:

$$V = aX^b e^{cS} \tag{5}$$

$$\ln(V) = \ln(a) + b \ln(X) + c S \quad . \tag{6}$$

As can be seen, the model continues to be linear in the parameters which are to be estimated. The only complication is that the coefficient c is no longer an elasticity.

In equation (2) or (6) it can be shown that the elasticity of V with respect to X is

$$\eta_x = \partial V/\partial X * X/V = \partial \ln(V)/\partial \ln(X) = b \quad . \tag{7}$$

However, the elasticity of **V** with respect to **S** is not equal to c. Simple calculus shows that the elasticity is

$$\eta_s = \partial V/\partial S * S/V = c S \quad . \tag{8}$$

This is obtained by first taking the total differential of equation (6) which is:

$$d \ln (V) = d \ln(a) + \partial \ln(V)/\partial \ln(X) \, d \ln(X) + \partial \ln(V)/\partial S \, dS \tag{9}$$

from equation (6) $\partial \ln(V)/\partial S = c$, and from equation (7) $\partial \ln(V)/\partial \ln(X) = b$.

Since $d \ln (V) = (1/V) \, dV$ equation (9) becomes

$$(1/V) \, d(V) = 0 + b(1/X) \, d(X) + c \, d(S) \quad . \tag{10}$$

Holding X constant and rearranging terms results in

$$1/V * \partial V/\partial S = c \quad (11)$$

and multiplying both sides by **S** results in our elasticity

$$\eta_s = S/V * \partial V/\partial S = c\,S \quad , \quad (12)$$

which is the answer. The elasticity is no longer a constant. The elasticity of **S** varies as **S** varies.

To see how these elasticities vary over time we computed the elasticity for each of the years with UPS strike activity. They are presented in the table below.

TABLE WPA-1

PFY	UPSMDLS (00,000)	COEFFICIENT	ELASTICITY
1970	1.18234	0.0221337	0.0262
1971	0.84276	0.0221337	0.0187
1972	0.42	0.0221337	0.0093
1973	0.11606	0.0221337	0.0026
1974	1.98626	0.0221337	0.0440
1975	1.66077	0.0221337	0.0368
1976	4.6129	0.0221337	0.1021
1977	6.29719	0.0221337	0.1394
1980	0.07217	0.0221337	0.0016
1981	0.147	0.0221337	0.0033
1982	0.25	0.0221337	0.0055
1994	0.40	0.0221337	0.0089