Date: 16 August 1996
To: Matt Henry
From: Henry Eskew
Subj: Structural Change in Indirect Manning Relationships

Several weeks ago, in connection with N81's review of my paper on indirect manning costs (CRM 95-203), you had conjectured that different structural relationships between afloat and ashore manning might have existed during the build-up and build-down phases. We talked about it a bit and I took a look at some numbers George Akst had generated, but I pretty much put the matter aside at that point. Thinking that it might arise again in the "True Cost of a Sailor" meeting scheduled for 20 August, I decided that a revisitation was in order. The following is what I came up with. The bottom line is that the statistical results, while far short of ideal, don't support the existence of separate relationships.

You'll recall that I had specified a partial adjustment model, where the dependent variable was personnel ashore, and the predictor variables were personnel afloat and personnel ashore lagged one year (plus a constant term). I estimated separate functions for officers and enlistees and then used those results to deduce values for the parameters in the original (unobservable) structural equations. What I've done to pursue your conjecture, as George did, is to split the original database into the build-up and build-down phases: 1981-1988 and 1989-1996, respectively. (Data for 1980 were in the base, but because of the lagged value of ashore manning on the right-hand-side, the first observation on the dependent variable was for 1981.) I then estimated separate functions for each period. Results for officers are in table 1, along with the original estimates from the combined database.

Table 1. Estimates for the officer model

Time period:	1981-1996		1981-1988		1989-1996	
	$R^2 = 0.87$; F = 43.4		$R^2 = 0.84$; F = 12.9		$R^2 = 0.90$; F = 22.4	
Variable	Coef. est.	Stnd err.	Coef. est.	Stnd err.	Coef. est.	Stnd err.
Constant	15,105	4,930	22,153	7,336	14,610	9,830
Afloat	0.511	0.127	0.444	0.395	0.635	0.250
Ashore (lag)	0.457	0.113	0.335	0.597	0.420	0.281

Casual inspection of the table suggests that (1) the parameter estimates are reasonably stable, but (2) the combination of small sample sizes and reduced variability in the two sub-periods take their toll on the standard errors of the coefficient estimates. (Note that for 1981-1988, nothing is significant except the constant term.)

It's possible to do more than just casual inspection. There is a formal test for the hypothesis that the parameter vectors are different. It's known in the econometric literature as the *Chow* test (for Gregory Chow)[1]. Based on the separate and combined residual sums of squares, the test's accompanying intuition is that if the parameters are the same for both sub-periods, the separate sums of squares, when added together, will equal the combined sum of squares. If the parameters are different, the separate sums of squares, when added, will be considerably smaller than the combined sum because the latter forces the union of two different functions. The test is carried out by computing an F statistic (analysis of variance). In this case the numerator and denominator degrees of freedom are 3 and 10, respectively, with a critical $F_{.05}$ value of 3.71. The computed F was only 0.67, providing no evidence for rejecting the null hypothesis that the parameters are the same.

Results for the enlisted model are in table 2. Here the build-up period seems to be characterized largely by noise. (Not even the F statistic for the function as a whole is significant.) The coefficient estimates appear on the surface to be rather dissimilar, but they need to be viewed with reference to their very large standard errors. The computed F value for the Chow test here was 0.49, which is even lower than with the officer results. Again, we find no statistical basis for concluding that different structures apply over the two phases.

Table 2. Estimates for the enlisted model

Time period:	1981-1996		1981-1988		1989-1996	
	$R^2 = 0.88$; $F = 48.3$		$R^2 = 0.60$; $F = 3.75$		$R^2 = 0.92$; $F = 27.2$	
Variable	Coef. est.	Stnd err.	Coef. est.	Stnd err.	Coef. est.	Stnd err.
Constant	5,264	27,971	23,712	91,206	14,257	38,695
Afloat	0.358	0.105	-0.113	0.360	0.482	0.279
Ashore (lag)	0.636	0.162	1.031	0.425	0.492	0.340

As I said at the outset, the numbers here are not totally satisfying, but they do seem to suggest that it's not a mistake to combine the two sub-periods.

Copy to:
G. Akst
[redacted]
P. Speer

[1] A reference for this is Wm. H. Greene, *Econometric Analysis*, New York: Macmillan Publishing Company, 1990.