CHAPTER 10

THE SHORT-RUN DEMAND FOR NON-PRODUCTION WORKERS

10.1 Introduction

This study has been chiefly concerned with explaining short-run fluctuations in the number of production workers employed and the number of hours paid-for per production worker. It is the purpose of this chapter to examine briefly the short-run fluctuations in the number of non-production workers employed to see whether the short-run demand for non-production workers is influenced by any of the same factors which influence the short-run demand for production workers. An equation similar to (3.9) is derived and estimated, and the results are compared with those in table 4.3 for production workers.

KUH (1965b), DHRYMES (1966), and others have observed that non-production workers are probably more like a fixed factor in the short run than are production workers, and this seems to be confirmed for the seventeen industries considered in this study from an examination of time series plots of the number of non-production workers employed. For almost all of the industries the short-run fluctuations in the number of non-production workers employed were quite small; most of the plots were characterized by relatively smooth upward trends. These results suggest that non-production workers are indeed more like a fixed factor in the short run, and the purpose of this chapter can be looked upon as trying to determine whether the small short-run fluctuations in the number of non-production workers employed are subject to any systematic tendencies at all.

10.2 The model

The model developed and tested here for non-production workers is essentially the same as the model developed in ch. 3 for production workers. The change in the number of non-production workers employed is taken to be a function of the amount of excess (non-production) labor on hand, past changes in output, and expected future changes in output. Let N_{2w_t} denote the number of non-production workers employed during the second week of month t and N_{2wt}^d the desired number employed for that week. Then the basic equation determining the short-run demand for non-production workers is taken to be

$$\begin{aligned}\log N_{2wt} - \log N_{2wt-1} &= \alpha_1(\log N_{2wt-1} - \log N^d_{2wt-1}) \\ &+ \sum_{i=1}^{m} \beta_i(\log Y_{2wt-i} - \log Y_{2wt-i-1}) \\ &+ \gamma_0(\log Y^e_{2wt} - \log Y_{2wt-1}) \qquad (10.1) \\ &+ \sum_{i=1}^{n} \gamma_i(\log Y^e_{2wt+i} - \log Y^e_{2wt+i-1}).\end{aligned}$$

Eq. (10.1) is the non-production workers analogue to eq. (3.9). As before, the past change in output variables are added to help depict the reaction of firms to the amount of excess labor on hand. $\log N_{2wt-1} - \log N^d_{2wt-1}$ is taken to be the measure of the amount of excess non-production labor on hand during the second week of month t − 1.

Eq. (10.1) cannot be estimated the way it is since many of the variables are not directly observed. As before, the (observed) average daily rate of output for the month, Y_d, can be used as a proxy for the (unobserved) amount of output produced during the second week, Y_{2w}, and the equation can be estimated using one of the expectational hypotheses discussed in ch. 3. This still leaves N^d_{2wt-1} unobserved in the equation, however, and some approximation to it must be found. N^d_{2wt-1} was constructed in a manner similar to that used for the construction of M^d_{2wt-1} in ch. 3, except that one additional assumption had to be made due to lack of data on the number of hours paid-for per non-production worker.

Let H^N_{2wt} denote the average number of hours worked per non-production worker during the second week of month t. The short-run production function postulated in eq. (3.5) is now expanded to include non-production workers, and the assumptions of constant returns to scale and no substitution possibilities among the number of non-production workers, the number of production workers, and the number of machines are made. The production function is thus postulated to be

$$Y_{2wt} = \min\{\alpha_{2wt}M_{2wt}H_{2wt},\ \beta_{2wt}K_{2wt}H^K_{2wt},\ \gamma_{2wt}N_{2wt}H^N_{2wt}\}. \qquad (10.2)$$

$N_{2wt}H^N_{2wt}$ in eq. (10.2) is the total number of non-production worker hours used in the production of Y_{2wt}. The $2wt$ subscripts on the parameters α, β, and γ indicate that these parameters may be a function of time. Indeed, α_{2wt} was assumed in ch. 3 to move smoothly through time from peak to peak of the output per paid-for man-hour series. In the production function (10.2) non-production workers are treated in a manner exactly analogous to that for production workers. It is assumed that for any one period of time a given number of non-production worker hours is required to produce the output of the period. The production process is thus rather broadly defined to include managerial, clerical, sales, and other "non-production" activities.

The assumption that non-production worker hours enters as an input in the production function in an analogous manner as production worker hours may not be realistic. It may be, for example, that in the short run an increase in output requires little or no increase in the number of non-production worker hours and that a decrease in output does not reduce the number of non-production worker hours required. In other words, in the short run the number of managerial and clerical hours required in the production process may not be directly proportional to the amount of output produced. Remember, however, that it is non-production worker *hours* which is under discussion and not non-production workers alone. A secretary sitting at her desk doing nothing is not considered to be working unless, for example, she is also a receptionist and must be at her desk at all times. If she is not also a receptionist, then when work is slow (due, say, to less output being produced) and she has nothing to do during part of the day or week, her work could presumably be scheduled so that she needs to be at work only part of the day or week. Only her actually working (non-idle) hours are counted in $N_{2wt}H^N_{2wt}$ in (10.2). The assumption that non-production worker hours enters as an input in the production function in the manner specified in (10.2) thus requires that there be no receptionist type workers whose hourly work is not directly related to the amount of output produced. To the extent that there are a lot of these types of workers, the assumption that $N_{2wt}H^N_{2wt}$ enters the production function as specified in (10.2) is unrealistic, and the construction of the excess (non-production) labor variable below, which is based on (10.2), is inaccurate.

Data on N_{2wt} are available, but unlike for production workers, data are not available on the average number of hours paid-for per non-production worker. Consequently, output per paid-for (non-production) man hour could not be plotted and interpolated as was done for production workers. For present purpose something slightly different was thus done. Output per non-production worker employed, Y_{dt}/N_{2wt}, was plotted for each industry for the 1947–1965 period. (Note that Y_{dt} was used as the output variable as a proxy for Y_{2wt}.) At each of the peaks of this series for each industry it is assumed that the number of hours worked per non-production worker, H^N_{2wt}, is equal to the same constant, denoted as $\overline{H}^N$. Remember that for production workers it was assumed that at the peaks of the output per paid-for man-hour series the number of hours worked per production worker equals the number of hours paid-for per production worker, whereas here the rather stronger assumption is made that at each of the peaks of the output per non-production worker series the number of hours worked per non-production worker is the same.[1]

Using eq. (10.2) and the above assumption, an estimate of $\gamma_{2wt}\overline{H}^N$ is available at each of the peaks:

$$\gamma_{2wt}\overline{H}^N = Y_{dt}/N_{2wt}. \tag{10.3}$$

These values of $\gamma_{2wt}\overline{H}^N$ were then interpolated from peak to next higher or lower[2] peak in a manner similar to that done for α_{2wt} in ch. 3. From these interpolations estimates of $\gamma_{2wt}\overline{H}^N$ are then available for each month of the nineteen-year period.

Let HS^N_{2wt-1} denote the standard number of hours of work per non-production worker for the second week of month $t - 1$. Analogous to eq. (3.7) for production workers, N^d_{2wt-1} is assumed to be

$$N^d_{2wt-1} = N_{2wt-1}H^N_{2wt-1}/HS^N_{2wt-1}; \tag{10.4}$$

and analogous to eq. (3.11) for production workers, HS^N_{2wt-1} is assumed to be a constant or a slowly trending variable:

$$HS^N_{2wt-1} = \overline{H}e^{\mu t}. \tag{10.5}$$

Eq. (10.4) states that the desired number of non-production workers employed for the second week of month $t - 1$ is equal to the number of non-production worker hours required in the production process for that week divided by the standard number of hours of work per non-production worker.

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1 For ease of exposition no distinction is made in this chapter between employed and non-idle non-production workers, as was made for production workers in ch. 3. Only for the interpolations is this distinction important, and here it must be assumed that there are no completely idle workers at the interpolation peaks.

2 *In some industries the trend in Y_{dt}/N_{2wt} was downward – output per non-production worker decreasing through time – and for these industries the interpolation lines were slowly decreasing.*

The above assumptions are now sufficient for the estimation of eq. (10.1). The excess labor variable in the equation becomes

$$
\begin{aligned}
&\alpha_1(\log N_{2wt-1} - \log N^d_{2wt-1}) \\
&= \alpha_1(\log N_{2wt-1} - \log N_{2wt-1} - \log H^N_{2wt-1} + \log HS^N_{2wt-1})\ \text{[from (10.4)]} \\
&= \alpha_1(-\log Y_{dt-1} + \log \gamma_{2wt-1} + \log N_{2wt-1} + \log HS^N_{2wt-1})\ \text{[from (10.3)]} \\
&= \alpha_1(\log N_{2wt-1} - \log Y_{dt-1} + \log \gamma_{2wt-1} + \log \overline{H}^N - \log \overline{H}^N + \log HS^N_{2wt-1}) \\
&= \alpha_1(\log N_{2wt-1} - \log Y_{dt-1} + \log \gamma_{2wt-1} \overline{H}^N - \log \overline{H}^N + \log HS^N_{2wt-1}) \\
&= \alpha_1(\log N_{2wt-1} - \log Y_{dt-1} + \log \gamma_{2wt-1} \overline{H}^N) - \alpha_1 \log \overline{H}^N \\
&\qquad + \alpha_1 \log \overline{H} + \alpha_1 \mu t \qquad \text{[from (10.5)]}.
\end{aligned} \tag{10.6}
$$

Since data on Y_{dt-1} and N_{2wt-1} are available, data on the expression in parentheses in the last line in (10.6) are available (remember that data on $\gamma_{2wt}\overline{H}^N$ are available from the interpolations), and $-\alpha_1 \log \overline{H}^N + \alpha_1 \log \overline{H}$ in (10.6) can be absorbed in the constant term in eq. (10.1). Using (10.6) and Y_d as a proxy for Y_{2w}, eq. (10.1) becomes

$$
\begin{aligned}
\log N_{2wt} - \log N_{2wt-1} = {} & \alpha_1(\log N_{2wt-1} - \log Y_{dt-1} + \log \gamma_{2wt-1} \overline{H}^N) \\
& + (\alpha_1 \log \overline{H} - \alpha_1 \log \overline{H}^N) \\
& + \alpha_1 \mu t + \sum_{i=1}^{m} \beta_i(\log Y_{dt-i} - \log Y_{dt-i-1}) \\
& + \gamma_0(\log Y^e_{dt} - \log Y_{dt-1}) \\
& + \sum_{i=1}^{n} \gamma_i(\log Y^e_{dt+i} - \log Y^e_{dt+i-1}). \qquad (10.1)'
\end{aligned}
$$

Eq. (10.1)′ is now in a form in which it can be estimated, given some assumption about how expectations are formed.

10.3 The results

For each industry, the expectational hypothesis which gave the better results for the production workers equation (see table 4.3) was assumed to be the correct one for that industry and was used in the estimation of equation (10.1)′ for non-production workers. As was done for production workers, the past output change variables were carried back and the expected future output change variables were carried forward until in general they lost their significance. The current output change variable was included even if it was not significant, however, and a few of the expected future output change variables which were included in the final equation were not significant. The same periods of estimation were also used here as were used for production workers.

The results of estimating eq. (10.1)′ for each of the seventeen industries are presented in table 10.1. The coefficient δ denotes the coefficient of log Y_{dt-1} − log Y_{dt-13} for those industries for which future output expectations were significant and for which the non-perfect expectational hypothesis was used.

For all seventeen industries the estimate of the coefficient α_1 of the excess labor variable is negative, and for all but four industries – 212, 231, 232, and 233 – it is significant. The amount of excess non-production labor on hand does appear to be a significant factor in determining short-run changes in the number of non-production workers employed. Regarding the construction of the excess labor variable, for every industry the estimate of the constant term is positive, which combined with the fact that the estimate of α_1 is negative for every industry implies that the number of hours worked per non-production worker at the interpolation peaks, $\bar{H}^N$, is greater than $\bar{H}$ (the standard number of hours of work per non-production worker less trend). This seems to be consistent with the above construction, since at the peaks (which are generally peaks in output as well) the number of hours worked per worker is likely to be greater than the standard number.

For all but industry 271 the estimate of the coefficient γ_0 of log Y^e_{dt} − log Y_{dt-1} is positive, but it is only significant for eight of the industries. For every industry the size of the estimate of γ_0 is smaller for non-production workers than it is for production workers in table 4.3. These results suggest that at least in some industries short-run changes in the number of non-production workers employed respond to current output changes, but that the tendency is much less pronounced here than it was for changes in the number of production workers employed.

Only for 201 and 242 were any of the past output change variables significant. These variables do not appear to be a help in depicting the reaction of firms to the amount of excess non-production labor on hand. For a few industries the expected future output change variables were significant, but again this tendency is much less pronounced here than it was for production workers.

Very little of the variance of log N_{2wt} − log N_{2wt-1} has been explained here. For all but industry 271 less than twenty percent has been explained, and in industries like 212 and 231 none of the coefficient estimates are significant. In about half of the industries there appears to be evidence of

TABLE 10.1

Parameter estimates for eq. (10.1)[a]

Industry	No. of obs.	$\widehat{\alpha_1 \log \bar{H} - \alpha_1 \log \bar{H}^N}$	$\hat{\alpha}_1$	$1000\,\widehat{\alpha_1 \mu}$	$\hat{\beta}_2$	$\hat{\beta}_1$	$\hat{\gamma}_0$	$\hat{\gamma}_1$
201	192	.014	−.036	−.050		.033	.034	.004
		(2.54)	(2.12)	(2.31)		(2.16)	(1.88)	(0.24)
207	136	.014	−.046	.044			.027	
		(2.23)	(3.60)	(1.20)			(2.09)	
211	136	.046	−.187	−.079			.026	.064
		(3.93)	(3.74)	(1.36)			(0.41)	(1.85)
212	136	.020	−.073	−.089			.064	
		(1.39)	(1.88)	(1.11)			(1.18)	
231	136	.008	−.033	−.010			.007	
		(1.33)	(1.81)	(0.30)			(0.32)	
232	136	.008	−.025	−.003			.041	
		(1.53)	(1.28)	(0.13)			(2.87)	
233	136	.009	−.010	−.022			.038	
		(1.53)	(0.64)	(0.73)			(2.46)	
242	154	.021	−.071	−.075	.043	−.035	.062	.044
		(3.13)	(3.12)	(2.52)	(2.27)	(1.62)	(2.75)	(2.10)
271	166	.007	−.045	−.001			−.006	.001
		(4.48)	(3.75)	(0.11)			(0.63)	(0.06)
301	134	.008	−.023	−.029			.007	
		(2.63)	(2.87)	(1.97)			(0.61)	
311	170	.024	−.146	−.050			.017	.091
		(3.49)	(4.56)	(1.59)			(0.38)	(2.79)
314	170	.016	−.064	−.030			.080	.027
		(2.83)	(2.80)	(1.39)			(3.98)	(1.28)
324	187	.008	−.032	.016			.040	.019
		(2.26)	(2.25)	(0.73)			(3.17)	(1.24)
331	128	.003	−.060	.069			.023	
		(0.52)	(3.95)	(1.45)			(0.49)	
332	170	.006	−.037	.008			.046	
		(2.81)	(5.95)	(0.52)			(3.26)	
336	170	.034	−.082	−.124			.113	
		(3.31)	(3.80)	(2.22)			(2.30)	
341	191	.014	−.038	.029			.018	.038
		(2.70)	(3.96)	(1.11)			(1.94)	(3.90)

t-statistics are in parentheses.

[a] $\hat{\delta}$ is the coefficient estimate of $\log Y_{dt-1} - \log Y_{dt-13}$ under the non-perfect expectational hypothesis.

$\hat{\gamma}_2$	$\hat{\gamma}_3$	$\hat{\gamma}_4$	$\hat{\gamma}_5$	$\hat{\gamma}_6$	[a]$\hat{\delta}$	R^2	SE	DW
.048	.041	.023	.039	.047	−.046	.162	.0109	2.41
(2.90)	(2.69)	(1.62)	(2.74)	(3.33)	(3.02)			
						.097	.0253	2.62
					−.026	.124	.0380	2.46
					(0.47)			
						.028	.0453	2.52
						.028	.0218	2.81
						.063	.0161	2.52
						.045	.0189	1.86
.031						.147	.0184	2.27
(1.69)								
.030						.332	.0051	2.01
(3.46)								
						.062	.0088	2.03
.057	.050	.042	.012			.159	.0222	2.36
(1.88)	(1.81)	(1.67)	(0.55)					
.055					−.030	.193	.0130	2.08
(4.26)					(1.39)			
.024	.004	.029			−.019	.072	.0153	2.79
(1.72)	(0.27)	(2.15)			(1.24)			
						.113	.0305	1.56
						.196	.0115	2.69
						.098	.0393	3.98
.032						.120	.0209	2.57
(3.24)								

negative first-order serial correlation. The model developed in this study has obviously been much less successful in explaining the short-run demand for non-production workers than in explaining the short-run demand for production workers. The over-all results indicate that changes in the number of non-production workers employed are only marginally influenced by the same factors which influence changes in the number of production workers employed. Remember, of course, that the variance of $\log N_{2wt} - \log N_{2wt-1}$ is small to begin with, and the fact that only a small percentage of this variance appears capable of being explained does not imply that N_{2wt} cannot be adequately predicted for most purposes.