Output Expectations
Productivity Trends And Employment:
The Case Of Greek Manufacturing

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1.   Introduction

Recent contributions in dynamic analysis of labor demand suggest that employment in manufacturing can be regarded as being dependent on firms output expectations, factor prices, the level of fixed factors, technical progress and the business conditions at large.

Modelling the mechanism of output expectations is essential for the empirical formulation of the dynamics of such models. Brechling (1965), Ball and StCyr (1966) and Smyth and Ireland (1967), provide early examples of partial adjustment models in which expectations are assumed to be adaptive. Such formulations were not, however, successful in predicting the decline in manufacturing employment in the U.K. during the late seventies and early eighties. This failure was attributed to inadequate treatment of output expectations. More recent studies introduced forward looking expectations utilizing the rational expectations hypothesis (Muellbauer 1979; Mendis and Muellbauer 1983; Nickell 1984; Henry and Wren-Lewis 1984; Wren-Lewis 1984a), or survey data on firms short-term output expectations (Wren-Lewis 1986; Durby and Wren-Lewis, 1991; Pehkonen, 1992). The results of the later suggest that survey data on firms short-run output expectations outperform other alternatives in explaining short-run movements in manufacturing employment.

To this extent Bond (1988) considers the dependence of employment behavior on stabilization policy. Labor hoarding during a recession depends largely on expectations about the strength and timing of the recovery. Since these expectations are likely to be conditioned by the stance of macroeconomic policy, we would expect a relationship between the policy regime and employment behavior. Survey data on firms output expectations do incorporate the effects of perceived changes in policy regimes, and models utilizing such data are expected to perform better. Finally, Oster (1980) investigated the dependence of industry

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productivity patterns upon business conditions at large, independent of variations in own-industry variables. He points out that capital's ability to exercise direction and control over labor processes depends, in part, on the extent of joblessness in the labor market, i.e. on the overall unemployment rate. This may result in the non-constancy of the adjustment coefficient over the business cycle which means that the responsiveness of changes in employment to changes in the level of output will be overestimated when economic activity is high and underestimated when it is low.

Energy and material prices are particularly relevant to the demand of labor and one should specifically include this input in the gross production function, although many authors choose to abstract from the possibility of factor substitution due to changing relative prices.

Introducing capital stock and technical change presents inherent difficulties because these factors are not only difficult to measure but also difficult to separate conceptually. If they could be measured, their combined effect would yield a measure of productivity and the employment equation could be formulated in terms of productivity and output effects. Early studies introduced a deterministic time trend to account for the productivity effect assuming a steady trend for productivity growth. This issue was taken up by Harvey et. al. (1986) who suggested a stochastic time trend in order to allow for changes in the extent and influence of productivity.

The purpose of this paper is to examine whether the recent advances in the dynamic analysis of labor demand, i.e. the use of survey data on short-term output expectations, the stochastic modeling of productivity growth, and the consideration of business conditions at large, contribute significantly in explaining short term movements in manufacturing employment in Greece. Changes in policy regimes were experienced in Greece in 1985-87 and since 1990 and we evaluate our consequent models according to their performance in tracking, out of sample, the collapse of manufacturing employment after 1990.

2.   The Employment - Output Equation

To focus on the relationship between output and employment we take the model of Nickell (1986) as the point of departure. The representative firm is assumed to maximize the discounted net revenue function of the following form:

$$p_t R(E_t, t) - w_t E_t - 1/2 \, \beta \, w_t (\Delta E_t)^2 \tag{1}$$

where p_t is the price of the firms output, E_t is the level of employment, w_t is the nominal wage rate and β indicates the level of adjustment costs. $R(E_t, t)$ is the firms' real revenue function, net of all other costs of production. The last term in (1) reflects the fact that altering the level of employment incurs adjustment

costs, which are assumed to be quadratic for analytical purposes. Nickell (1986) presents a comprehensive solution to this problem and shows that the first order optimizing condition will approximately follow the linear difference equation:

$$\alpha\beta E_{t-1} - [\theta + \beta(1+\alpha)]\ E_t + \beta E_{t-1} = -\theta E_t^* \tag{2}$$

where $\theta > 0$, the parameter α $(0 < \alpha < 1)$ is inversely related to the real rate of interest, and E_t^* is the level of employment which would be desired in the absence of adjustment costs $(\beta = 0)$. The stable solution of (2) gives the so called "fundamental employment equation":

$$E_t = \lambda E_{t-1} + (1-\lambda)\ (1-\alpha\lambda) \sum_{i=0}^{\infty}\ (\alpha\lambda)^i\ E_{t+i}^* \tag{3}$$

where the parameter λ $(0 < \lambda < 1)$ is positively related to the level of adjustment costs.

This particular formulation for the labor demand equation abstracts from movements in other factors of production, such as capital and the possibility of factor substitution due to changing relative prices, allowing them to enter only through the desired levels of employment. It also postulates that current macroeconomic policy rules may affect the employment behavior by influencing only the desired levels of employment which also incorporate all factors related to technology, the environment of the firm, and the changing adjustment costs due to business cycle effects.

To arrive at an estimable representation of (3) requires the specification of E_t^*, s in terms of observables, and the treatment of expectations.

We shall suppose that the firm has a putty-clay technology both because this is intuitively appealing and because the empirical evidence suggests that such models generally outperform those based on putty-putty technology in the context of factor demand [e.g. see Nickell (1984) p. 531]. We, therefore, assume that

$$E_t^* = f\ (PM_t, RW_t, Y_t, U_t, t) \tag{4}$$

where PM_t is the real price of materials and fuel, RW_t is the product real wage, Y_t is an observable indicator of demand, U_t is the unemployment rate and t captures the effects of technical progress. Substituting (4) into the employment equation (3) gives

$$E_t = \lambda E_{t-1} + (1-\lambda)\ (1-\alpha\lambda) \sum_{i=0}^{\infty}\ (\alpha\lambda)^i\ f\ (PM_{t+i}^e, RW_{t+i}^e, Y_{t+i}^e, U_{t+i}^e, t+i) \tag{5}$$

The theoretical model outlined above implies that only one lag of the dependent variable enters the equation. In practice, however, additional lags of

past employment may be significant due to aggregation effects (Nickell, 1986), interrelated factor demand effects (Nadiri and Rosen, 1969), and effects due to the stochastic nature of productivity growth (Harvey et.al. 1986). This leads us to initially consider the following general dynamic formulation, with a longer lag in the dependent variable, and unrestricted leads in our proxies for E_t:

$$E_t = \beta + \sum_{i=1}^{k} \beta_{1i}E_{t-1} + \sum_{i=0}^{l} \beta_{2i}PM^e_{t+i} +$$

$$+ \sum_{i=0}^{m} \beta_{3i}RW^e_{t+i} + \sum_{i=0}^{n} \beta_{4i}Y^e_{t+i} + \sum_{i=0}^{p} \beta_{5i}U^e_{t+i} + f(t) + e_t \qquad (6)$$

where $f(t)$ is some function of time, and e_t an error term.

In the absence of data on forward looking expectations for PM_t and RW_t we adopt the conventional backward looking formulation, according to which expectations depend only on current and past realizations of these variables. Forward looking output expectations are, however, more essential. The procedure of proxying output expectations by current and lagged output is theoretically unsatisfactory since it can be interpreted as incorporating the idea of intertemporal optimizing subject to static or adaptive expectations. Dynamic theories of labor demand suggest that costs of adjustment prevent firms from adjusting employment to the desired level, and require them to consider future developments when setting current employment. Labor hoarding during a recession in output may be considerable if firms confidently expect a rapid recovery. This is especially true for professional and skilled workers, where hiring and firing costs are higher. On the contrary a stabilization policy which aims at reducing inflation and becomes less committed in maintaining a high level of real activity will worsen firms expectations for a recovery in demand, and the fall in employment will be sharper. This was the nature of the policy regimes announced in Greece in 1985 and 1990 which resulted in recessions and a sharp decline in manufacturing employment especially after 1990 (see Figure 1). From the econometric point of view we expect, therefore, that an employment equation which fails to incorporate forward looking output expectations will overestimate employment during stabilization periods. Since, however, forecasts are imperfect proxies for firms output expectations, current and past values of actual output should also be included as they may contain additional expectational information (see Bond, 1988).

Smyth (1984) provides evidence that adjustment costs will also depend, in part, on the extent of the unemployment. When the unemployment rate is low, a firm has to search more intensively to hire an additional person, than when there exists a large pool of unemployed labor, and vice versa. Furthermore, when labor markets are tight and job vacancies are relatively numerous, the maintenance or improvement of shop floor productivity is often difficult. On the other hand when unemployment increases, the threat or even the possibility of

discharge becomes a potent weapon with which management can effect desired improvements in shop floor productivity. "Speed-up", job rationalization or the introduction of new methods, which require a significant restructuring of work processes and job tasks, encounter far less work resistance. In addition, an increase in worker pliancy and diligence often results from the increased fear of a prolonged spell of joblessness and declining prospects for alternative employment. Thus, firms incentives to retain or "hoard" their workers depends also on business conditions at large, i.e. the unemployment rate. Current and past values of the unemployment rate may, therefore, contribute significantly in explaining the desired level of employment.

The remaining empirical issue concerns the treatment of technical progress. As it was mentioned earlier technical progress is not only unobservable but also difficult to discriminate conceptually. The usual response to this has been to proxy the effects of technical progress by including a trend in the equation. The choice of a deterministic trend, however, does not seem very useful, for the period considered here. Figure 1 suggests that although this specification appears to work very well in the sixties and early seventies, in the period 1976-1994 this trend appears to "shift" with output per head rising again considerably after 1985, the year of announcement of the first stabilization program. These shifts do not seem to be explained by changes in relative factor prices as the empirical investigation below suggests. Furthermore, a deterministic trend will cause also problems of interpretation because it is expected to pick up the influence of all trending omitted variables. We adopt here the stochastic modeling of the trend component, proposed by Harvey et.al. (1986), and also implemented in recent empirical studies by Darby and Wren-Lewis (1991), and Pehkonen (1992). From the statistical point of view the key device in modeling the stochastic trend is to estimate the employment equation in the state space form by setting in (6):

$$\beta + f(t) = \mu_t \qquad (7)$$

$$\mu_t = \mu_{t-1} + \theta_{t-1} + \eta_t \qquad (8)$$

$$\theta_t = \theta_{t-1} + \zeta_t \qquad (9)$$

This allows the unknown parameters to be estimated via the prediction error decomposition, and for predictions to be computed by extending the Kalman filter. The "state equations" (8) and (9) explain the evolution of μ_t. The disturbance e_t of the "measurement equation" (6) and the disturbances n_t and ζ_t of the state equations are independent, and normally distributed errors. This formulation allows the level μ_t and the slope θ_t of the trend to evolve over time through the respective innovations n_t and ζ_t. The larger the variances σ_n^2 and σ_ζ^2 the greater the stochastic fluctuations in the trend. If $\sigma_n^2 = \sigma_\zeta^2 = 0$, then the deterministic trend model emerges as a special case. The Kalman filter gives optimal estimates $\mu_{t/t}$ of the trend component using all information available at time t. In addition, a smoothing algorithm is used to provide the optimal estimates $\mu_{t/T}$ using all information up to and including the final period of estimation.

The above considerations suggest the following general state-space formulation for the employment equation:

$$E_t = \sum_{i=1}^{k} \beta_{1i} E_{t-i} + \sum_{i=0}^{l} \beta_{2i} PM_{t-i} + \sum_{i=0}^{m} \beta_{3i} RW_{t-i} +$$

$$+ \sum_{i=0}^{n} \beta_{4i} Y_{t-i} + + \sum_{i=0}^{p} \beta_{5i} Y^e_{t+i} + \sum_{i=0}^{q} \beta_{6i} U_{t-i} + \mu_t + \psi_t + \varepsilon_t, \qquad (10)$$

$$\mu_t = \mu_{t-1} + \theta_{t-1} + n_t, \qquad (11)$$

$$\theta_t = \theta_{t-1} + \zeta_t, \qquad (12)$$

where Y^e_{t+i} is the level of output forecast in period t for period t+i. We also allow for a stochastic seasonal pattern in (10), which is the sum of [s/2] cyclical components defined as follows (see Harvey 1989; p.42)[1]:

$$\psi_t = \sum_{i=1}^{[s/2]} \gamma_{it} \qquad (13)$$

$$\gamma_{it} = \gamma_{i,t-1} \cos\lambda_i + \gamma^*_{i,t-1} \sin\lambda_i + w_{it} \qquad (14)$$

$$\gamma^*_{it} = \gamma_{i,t-1} \sin\lambda_i + \gamma^*_{i,t-1} \cos\lambda_i + w^*_{it} \qquad (15)$$

where w_{it} and w^*_{it} are zero mean white noise processes which are uncorrelated with each other with a common variance σ^2_i, $I=1,2,.... [s/2]$, and γ^*_{it} appears by construction.

3.   Data, Estimation And Testing

The investigation period comprises quarterly data from 1976 (I) to 1994 (IV). Employment is defined as the number of wage and salary earners on payrolls of manufacturing establishments with at least ten employees, expressed as an index with 1985 = 100, whereas output is the index (1985 = 100) of total manufacturing output. Both variables are seasonally unadjusted. Full description of the data and sources on all variables is given in the data appendix.

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[1]   Normally we should not allow for seasonals in equation (10) since all variables are seasonally unadjusted. The inclusion of seasonals, however, aims to account for differences in the seasonality patterns between the dependent and the independent variables.

Survey data on firms short - term output expectations are published on a monthly basis by the Institute of Economic and Industrial Research (IOBE), also appearing in OECD, *Main Economic Indicators*. The IOBE survey reports information about firms' output perceptions and expectations. The survey data are published in the form of the percentage of firms expecting output volume to go up, stay the same or fall in the next month, and analogous perceptions for the previous month as well. In transforming this qualitative information into quantitative estimates, we followed the procedure proposed by Wren-Lewis (1986), in which the qualitative answers are treated as probabilities which follow the $sech^2$ (logistic) distribution[2]. We also used the distribution free method of Pesaran (1984) with quite similar results. The monthly quantitative estimates have then been averaged to obtain quarterly estimates. Figures 1, 2 and 3 present the diagrams of employment, actual output and output expectations.

It is clear from Figures 1 and 2 that employment movements are well explained by the level of output until the end of the 80's, whereas in the 90's there is a structural breakdown of the relation between the two variables with significant productivity gains in the 90's. Figure 3 shows that firms' short - term output expectations were pessimistic during the seventies, and not successful in predicting output movements during the eighties and nineties. This suggests that besides expectations, the employment output equation must be augmented to account for the stochastic movements in productivity trend (see Figure 4).

Our investigation starts by estimating equation (10) with a linear deterministic time trend using OLS and adopting the "general to specific" methodology, or best described by its main proponent as "initial overparameterization with data-based simplifications" (Hendry, 1980). The estimation sample runs from 1976 (I) to 1990 (IV) with observations for the next 16 quarters up to 1994 (IV) reserved for testing the forecasting performance of the estimated model. We started with five lags in each explanatory variable and deleting the insignificant lags after a rigorous testing, we ended up with the model reported in Table 1, equation (A), as the most parsimonious one. The joint F-test for the 20 exclusion restrictions was 0.88 which is insignificant at the 5 percent level. This model has a satisfactory fit over the sample period and passes the standard diagnostic tests for serial correlation, functional form, normality, heteroscedasticity and autoregressive conditional heteroscedasticity (ARCH-test). It fails however to track the down turn of manufacturing employment in the 90's, as it is evidenced from the predictive failure test (Chow's second test) and the diagram in Figure 5. The in-sample estimate of the long-term elasticity with respect to output is 0.79 which is a plausible figure, implying increasing returns to scale. The long-run elasticity with respect to real product wage and real material and fuel prices are estimated to be -0.21 and 0.21 respectively and they both have the expected sign if they are capturing substitution effects. Also, the long-run elasticity of the unemployment effect has the correct sign and the low estimate of -0.08 may reflect the in-

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[2] The estimate of the JND parameter for the $sech^2$ distribution was found equal to 2.8.

creased union pressure and the state intervention against excess firings during our sample period. What is surprising however is the low (+0.06) and statistically insignificant long-run elasticity with respect to firms short-run output expectations. This may indicate misspecification errors, or (and) a poor performance of the index of output expectations as an overall index of firms short-term expectations. It may be, for example, that output down turns experienced over the last three months, biases output expectations downwards. Up to this point the evidence suggests a statistically significant contribution of real factor prices and the unemployment rate, although the estimated elasticities seem to be on the low side. The post-sample predictive failure of the model, however, indicates that there are important missing links probably on the side of technical progress and the measurement of firms' expectations.

As a second step, the model in table 1 was re-estimated by 2SLS, treating current output as an endogenous variable, and using current and lagged values of output in OECD Europe as instruments[3]. This was done in order to cure for the probable downward simultaneity bias in our estimates due to the inclusion of current output in the equation. In addition, since output expectations are measured with error and the OLS coefficient estimate is expected to be biased downwards, the output expectations term needs also to be instrumented to achieve consistency. For this purpose we also used OECD-Europe output in the next period as additional instrument. The results are reported in table 2, equation (B). Sargans $x^2(7)$ misspecification test supports the validity of the proposed instruments and there is an obvious gain in the efficiency of the individual estimates. However, we do not observe any significant improvement in the post-sample dynamic forecasts of the model (see Figure 6).

As a final step to cure for misspecification errors we re-estimated equation (A) with the deterministic trend replaced by the stochastic trend specification defined in equations (11) and (12), in order to account for the impact of stochastic movements of technical progress.

In equation (C) the slope component itself is deterministic (i.e. $\sigma_\zeta^2 = 0$), so that all the variation in the trend is coming from the random walk component (n_t). Almost all the estimated coefficients are statistically significant with a long run output elasticity of employment at 0.69 and no significant changes in the other estimates. The usual diagnostics are satisfactory and the value of $\overline{RD^2} = 0.935$ indicates the superior in-sample performance of the stochastic trend specification over the deterministic one. The improvement in the forecasting performance of the model is impressive. The prediction RMSPE is now down to 3.9

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[3]   The model in table 1 was also estimated in the error correction form (ECF), in order to cure for probable instabilities due to multicollinearity between the lagged values of the explanatory variables. The slight improvement in the post-sample predictive performance was the only visible gain from this effort, since the model failed again to track the deterioration of employment in the 90's.

percent and Figure (7) reveals a close tracking of the post-sample deterioration of employment. The value of the Chow test indicates the statistically significant change in the parameter estimates calculated at the end of the prediction period. The final estimate of the long-run output elasticity of employment at 1994 (IV) is now 1.22 indicating decreasing returns to scale. However, despite the fact that the stochastic trend improves the predictive performance of the model, we are still left with a crucial hiatus. The coefficient of the expectations term remains once again insignificant and the empirical evidence seems unable to support the causal link from expectations, through labor hoarding, to productivity gains.

Up to now the results and the diagnostics of the estimated equations do not reveal significant misspecification or estimation errors, whereas the diagram in figure 4 indicates that the index of output expectations was not successful in predicting future output movements during the eighties and nineties. Consequently, we directed our efforts towards finding a more efficient index for firms short term expectations, and as such we used the composite expectations index published by IOBE. This is based not only on firms output expectations, but also on sales expectations and the accumulation of stocks. On a consistent basis the index is published since January 1981, and this reduces considerably our sample size.

Equations (A), (B) and (C) have been re-estimated for the period 1981 (I) to 1990 (IV), and keeping the 16 quarter projection period constant for comparison purposes. The corresponding results are given in tables 4, 5 and 6, by equations (A´), (B´) and (C´) respectively.

The results suggest an improved in-sample fit and a better out-of sample predictive performance in all three cases (see also Figures 8, 9 and 10), with the stochastic trend specification outperforming once again the other two. Since the dynamics of the model and the estimated coefficients remain quite robust, this improvement must be attributed to the superior performance of the composite expectations index. Firms short term expectations become now a statistically significant explanatory factor in all three specifications. The estimated elasticity of employment with respect to expectations ranges from 0.26 in equation (A´), to 0.32 in equation (B'), and 0.31 in the stochastic trend specification.

4.   CONCLUSIONS

In this empirical investigation we tested whether published short-term firms' output expectations, stochastic variations in the labor productivity trend, and the business conditions at large, do have a significant contribution in explaining the short-run movements of manufacturing employment in Greece. Our concern relates mainly to the nature of the policy regime and the degree of the labor hoarding.

The empirical examination of the performance of the employment output equation included the estimation of the conventional model of employment determination, augmented to allow for firms' output expectations, and a stochastic trend specification as well. The surprising element in our first results was the insignificant and rather controversial performance of output expectations in explaining either in sample or post-sample movements in manufacturing employment. We attributed this to the fact that firms short-term output expectations were biased and not very successful in predicting future output movements. Consequently, we searched for a more efficient index to represent not only output but expectations in general in the employment equation. We found that the composite index published by IOBE, which accounts for output expectations, sales expectations, and finished stocks accumulations as well, outperforms the single output expectations index and contributes significantly in improving the in-sample fit and the out-of-sample predictive performance of the employment equation.

The second finding is that the stochastic trend specification outperforms the deterministic one. This, however, is not surprising. It is well known that adaptive expectations are optimal (in the sense of producing unbiased forecasts) only when the data generating process is IMA (1,1), or ARIMA (1,1,1). Although recent empirical studies conclude that many economic time series are adequately represented as IMA (1,1) processes, and, therefore, fixed coefficient adaptive expectations are optimal, nevertheless, these models do not allow agents to learn slowly about their new environment as new information becomes available. For these adaptive models to be optimal when the data generating process undergoes a "change in gear"[4], as it happens with changes in policy regimes, agents must instantaneously acquire knowledge of the new moving average coefficient. This, however, requires a rather extreme information availability assumption, when the stochastic behavior of the variable changes. The Kalman filter confronts directly this problem since it can be interpreted as a form of adaptive expectations where the adjustment parameter is updated each period, based on the new information[5] [see Cuthbertson et al. (1992), pp. 197-99]. Moreover, the Kalman filter is optimal under more general conditions, and, in fact, produces minimum mean square error estimates under normality.

Our results also imply increasing returns to scale and a one percent reduction in employment due to technical progress. As to the impact of the business conditions at large, both the deterministic and the stochastic specifications reveal a statistically significant contribution of the unemployment effect.

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[4]   See Flemming (1976) for the idea of "change of gear" when forming expectations.

[5]   In the case of the stochastic trend formulation of equation (11) and (12) the variable adjustment, parameter of the "Kalman gain" is $\lambda_t = (\sigma^2_\eta + \sigma^2_\zeta) / (\sigma^2_\epsilon + \sigma^2_\eta + \sigma^2_\zeta)$, where $\lambda=1$ when $\sigma^2_\epsilon=0$, and $\lambda=0$ when $\sigma^2_\eta=\sigma^2_\zeta=0$.

Finally, we have to point out that the sample period chosen for this investigation was particularly demanding. During the 80's Greece experienced a low rate of growth in the GDP (in the region of 1.9% per annum), and this was coupled with strong union pressure against excess firings, under which the socialist governments initiated a labor protective attitude, even in the private sector. On the other hand, the forecasting period coincides with the clearest and more prolonged switch in macroeconomic policy regime, aiming at stabilizing the Greek economy, in order to meet the Maastricht agreement requirements for participating in the European Monetary Union.

Table 1

Equation (A): Deterministic Trend; OLS; Sample Period 1976 (I) - 1990 (IV) Forecast period 1991 (I) - 1994 (IV).

$$E_t = -2.13 - 0.001t - 0.004Q_2 - 0.000Q_3 + 0.045Q_4$$
$$(-0.45) \quad (-1.82) \quad (-0.46) \quad (-0.03) \quad (5.57)^{**}$$

$$+0.53 \, E_{t-1} + 0.23 \, E_{t-4} + 0.12 \, Y_t + 0.07 \, Y_{t-4}$$
$$(5.33)^{**} \quad (3.68)^{**} \quad (4.36)^{**} \quad (3.22)^{**}$$

$$+ 0.05 \, MP_{t-2} - 0.13 \, RW_t + 0.08 \, RW_{t-4} - 0.02 \, U_{t-1} + 0.016 \, Y^e_{t+1}$$
$$(2.14)^{*} \quad (-3.92)^{**} \quad (2.29)^{*} \quad (-2.31)^{*} \quad (1.47)$$

Diagnostics[6]: $\overline{R}^2 = 0.92$; D.W = 2,01; $F(13,42) = 59.86^{**}$; LM(4) = 3.98; RESET(1) = 1.43; NOR(2) = 0.37; HET(1) = 0.28; ARCH(4) = 0.93; CHOW(13,42) = 9.88**; RMSPE = 8.8%.

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[6] $\overline{R}^2$ is the goodness of fit corrected for degrees of freedom; D.W is the Durbin Watson test for first order autocorrelation; LM is the Lagrangian Multiplier test of residual serial correlation; ARCH is Engle's test for autoregressive conditional heteroscedasticity; RESET is Ramsey's test for functional form using the square of the fitted values as a regressor; NORM is the Bera - Jarque test for the normality of residuals; CHOW is Chow's second F test of adequacy of predictions; RMSPE is the root mean square percentage error of prediction . Numbers in parentheses under the estimates are t - values. * and ** indicate significance at the 5% and 1% levels respectively.

Table 2

Equation (B):   Deterministic Trend; 2SLS; Sample Period 1976(I)-1990 (IV); Additional Instruments: Y_{t-1}, $YEUR_{t+1}$, $YEUR_t$, $YEUR_{t-1}$, $YEUR_{t-2}$, $YEUR_{t-3}$, $YEUR_{t-4}$; Forecast Period: 1991 (I) - 1994 (IV).

$$E_t = -2.18 - 0.001t - 0.006Q_2 - 0.000Q_3 + 0.056Q_4$$
$$\quad (-0.63) \quad (-1.93) \quad (-0.57) \quad (-0.04) \quad (5.83)^{**}$$

$$+0.57\,E_{t-1} + 0.24\,E_{t-4} + 0.09\,Y_t + 0.04\,Y_{t-4}$$
$$\quad (5.55)^{**} \quad (3.75)^{**} \quad (2.65)^{*} \quad (1.91)$$

$$+\,0.04\,MP_{t-2} - 0.15\,RW_t + 0.09\,RW_{t-4} - 0.03\,U_{t-1} + 0.018Y^e_{t+1}$$
$$(2.16)^{*} \quad (-4.12)^{**} \quad (2.41)^{**} \quad (-2.53)^{*} \quad (1.65)$$

Diagnostics[7]: $\bar{R}^2 = 0.91$; D.W $= 1.92$; $F(13,42) = 53.22^{**}$; $SARGAN(7)^{[8]} = 4.37$; $LM(4) = 3.14$; $RESET(1) = 1.83$; $NORM(2) = 0.51$; $HET(1) = 0.24$; $ARCH(4) = 0.91$; $CHOW(13,42) = 10.50^{**}$; $RMSPE = 9.3\%$.

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[7] For the description of diagnostics see footnote 6 in table 1.

[8] SARGAN (7) is Sargan's $X^2(7)$ test for misspecification and the validity of the proposed instruments.

Table 3

Equation (C): Stochastic Trend; Max. Likelihood; Estimation Period: 1976(I) - 1990(IV) [T_1 = 1990 (IV)]; Forecast Period; 1991(I) - 1994(IV).

$$E_t = 0.50\ E_{t-1} + \quad 0.18\ E_{t-4} + 0.14\ Y_t + 0.08 Y_{t-4}$$
$$(3.35)** \qquad (1.87) \qquad (3.81)** \quad (2.67)*$$

$$+\ 0.05\ MP_{t-2} - 0.17\ RW_t + 0.07\ RW_{t-4} - 0.02\ U_{t-1} + 0.013\ Y^e_{t+1} + \mu_{t/T1} + \Psi_{t/T1}$$
$$(2.45)* \qquad (-4.63)** \quad (2.08)* \qquad (-2.29)* \quad (1.51)$$

Estimated Variances:

level (σ^2_n)	slope (σ^2_ζ)	seasonal (σ^2_w)	error (σ^2_e)
0.25×10^{-4}	0.0×10^{-6}	0.3×10^{-6}	0.51×10^{-4}
(3.49)**	(0.0)	(0.68)	(4.43)**

State estimates of the stochastic components at T = 1990 (IV):

level (μ_{T1})	slope (β_{T1})	seasonal ($Q_2, Q_3, Q_4)_{T1}$		
2.52	-0.001	0.016	-0.013	0.032
(6.87)**	(-2.35)*	(2.28)*	(-5.41)**	(6.65)**

Diagnostics[9]: $\overline{R}^2$ = 0.938; $\overline{RD^2}$ = 0.935; LM(12) = 4.24; NORM(2) = 0.20; HET(14,14) = 0.58; RMSPE = 3.9%.

State at T = 1994 (IV):

level (μ_T)	slope (β_T)	seasonal ($Q_2, Q_3, Q_4)_T$		
-0.23	-0.003	-0.007	-0.010	0.042
(-2.21)*	(-5.75)**	(-2.81)*	(-3.84)**	(6,31)**

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[9] For the description of diagnostics see footnote 6 in table 1.

$$E_T = \quad 0.70\ E_{T\text{-}1} + 0.08\ E_{T\text{-}4} + 0.20\ Y_T + 0.07 Y_{T\text{-}4}$$

$$(6.03)^{**} \quad (3.68)^{**} \quad (5.50)^{**} \quad (2.75)^{*}$$

$$+ 0.08\ MP_{T\text{-}2} - 0.19\ RW_T + 0.07\ RW_{T\text{-}4} - 0.03\ U_{T\text{-}1} + 0.018\ Y^e{}_{T+1} + \mu_T + \Psi_T$$

$$(3.38)^{**} \quad (-4.12)^{**} \quad (2.39)^{*} \quad (-2.71)^{*} \quad (1.12)$$

$$\text{CHOW}\ (13{,}42)^{10} = 11.28^{**}$$

Table 4

Equation (A'):   Deterministic Trend; Composite Expectations Index; 0LS; Sample Period 1981 (I) - 1990 (IV); Forecast period 1991 (I) - 1994 (IV).

$$E_t = -1.23\ -\quad 0.001t -\ 0.003Q_2 - 0.001Q_3 + 0.051Q_4$$

$$(-3.42)^{**}\ (-2.01) \quad (-0.85) \quad (-0.05) \quad (5.83)^{**}$$

$$+0.45\ E_{t\text{-}1} + 0.28\ E_{t\text{-}4} + 0.15\ Y_t + 0.06\ Y_{t\text{-}4}$$

$$(4.76)^{**} \quad (3.62)^{**} \quad (5.16)^{**} \quad (3.27)^{**}$$

$$+ 0.05\ MP_{t\text{-}2} - 0.17\ RW_t + 0.09\ RW_{t\text{-}4} - 0.02\ U_{t\text{-}1} + 0.07\ CI^e{}_{t+1}$$

$$(3.06)^{**} \quad (-5.51)^{**} \quad (3.18)^{**} \quad (-2.47)^{*} \quad (3.22)^{**}$$

Diagnostics[11]: $\overline{R}^2 = 0.94$; D.W $= 2.17$; F(13,23) $= 72.45^{**}$; LM(4) $= 2.09$; RESET(1) $= 1.31$; NOR(2) $= 1.15$; HET(1) $= 0.51$; ARCH(4) $= 0.57$; CHOW(13,23) $= 5.92^{**}$; RMSPE $= 6.4\%$.

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[10]   The Chow test is not a predictive failure test, but indicates the statistically significant change in the final parameter estimates at 1994 (IV), compared to estimates at the end of the estimation period, 1990 (IV).

[11]   For the description of diagnostics see footnote 6 in table 1.

Table 5

Equation (B'): Deterministic Trend; Composite Expectations Index; Sample Period 1981(I) - 1990 (IV); Additional Instruments: Y_{t-1}, $YEUR_{t+1}$, $YEUR_t$, $YEUR_{t-1}$, $YEUR_{t-2}$, $YEUR_{t-3}$, $YEUR_{t-4}$; Forecast Period: 1991(I)-1994(IV).

$$E_t = -1.83 - 0.001t - 0.003Q_2 - 0.000Q_3 + 0.054Q_4$$
$$(-4.20)^{**} \quad (-1.62) \quad (-0.90) \quad (-0.05) \quad (5.97)^{**}$$

$$+0.48\ E_{t-1} + 0.30\ E_{t-4} + 0.17\ Y_t + 0.07\ Y_{t-4}$$
$$(4.84)^{**} \quad (3.89)^{**} \quad (5.31)^{**} \quad (3.43)^{**}$$

$$+ 0.05\ MP_{t-2} - 0.15\ RW_t + 0.08\ RW_{t-4} - 0.03\ U_{t-1} + 0.07CI^e_{t+1}$$
$$(2.92)^* \quad (-4.09)^{**} \quad (2.53)^* \quad (-2.58)^* \quad (3.40)^{**}$$

Diagnostics[12]: $\overline{R}^2 = 0.93$; D.W = 2.11; $F(13,23) = 70.13^{**}$; SARGAN(7) = 3.81; LM(4) = 1.92; RESET(1) = 1.12; NORM(2) = 1.56; HET(1) = 0.44; ARCH(4) = 0.47; CHOW(13,23) = 6.32^{**}; RMSPE = 5.9%.

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[12] For the description of diagnostics see footnote 6 in table 1.

Table 6

Equation (C'): Stochastic Trend; Composite Expectations Index; Max. Likelihood; Estimation Period: 1981(I) - 1990(IV) [T_1 = 1990 (IV)]; Forecast Period; 1991(I) - 1994(IV).

$$E_t = 0.43\ E_{t-1} + 0.31\ E_{t-4} + 0.14\ Y_t + 0.07 Y_{t-4}$$

$$(4.03)^{**} \quad (3.17)^{**} \quad (4.83)^{**} \quad (3.32)^{**}$$

$$+ 0.04\ MP_{t-2} - 0.14\ RW_t + 0.07\ RW_{t-4} - 0.03\ U_{t-1} + 0.08\ CI^e_{t+1} + \mu_{t/T1} + \Psi_{t/T1}$$

$$(2.76)^* \quad (-3.59)^{**} \quad (2.41)^* \quad (-2.70)^* \quad (3.81)^{**}$$

Estimated Variances:

level (σ^2_n)	slope (σ^2_ζ)	seasonal (σ^2_w)	error (σ^2_e)
0.14 x 10^{-5}	0.0 x 10^{-6}	0.4 x 10^{-6}	0.41 x 10^{-4}
(2.78)*	(0.0)	(1.32)	(4.13)**

State estimates of the stochastic components at T = 1990 (IV):

level (μ_{T1})	slope (β_{T1})	seasonal ($Q_2, Q_3, Q_4)_{T1}$		
1.87	-0.001	0.012	-0.011	0.027
(4.32)**	(-2.45)*	(2.18)*	(-4.60)**	(5.72)**

Diagnostics[13]: $\overline{R}^2 = 0.954$; $\overline{RD^2} = 0.951$; LM(12) = 2.03; NORM(2) = 0.63; HET(14,14) = 0.48; RMSPE = 1.7%.
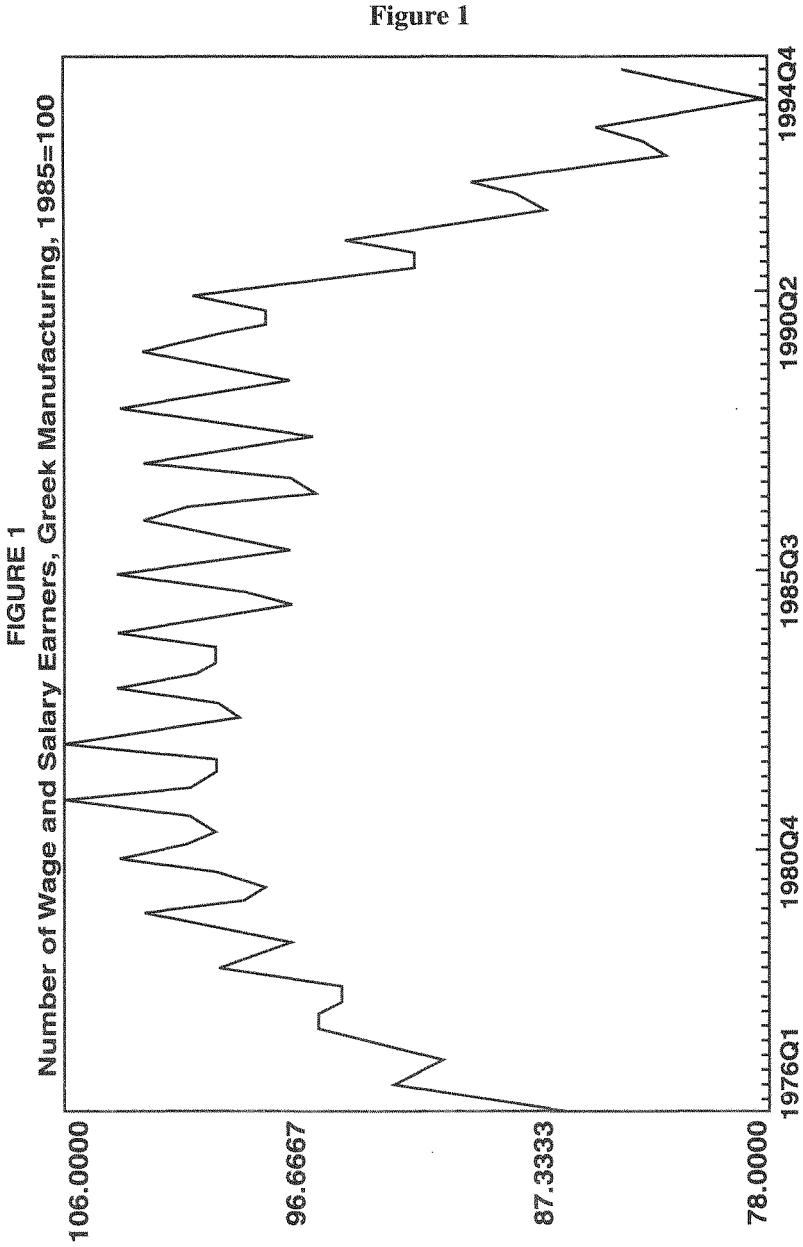
State Estimates of the Stochastic Component at T = 1994 (IV):

level (μ_T)	slope (β_T)	seasonal ($Q_2, Q_3, Q_4)_{T1}$		
-0.33	-0.003	-0.005	-0.010	0.032
(-2.71)*	(-5.24)**	(-2.30)*	(-3.35)**	(5.63)**

---

[13] For the description of diagnostics see footnote 6 in table 1.

$$E_T = 0.62\ E_{T-1} + \quad 0.16\ E_{T-4} + 0.17\ Y_T + \quad 0.03 Y_{T-4}$$

$$(5.57)^{**} \qquad (4.01)^{**} \quad (5.61)^{**} \qquad (2.58)^{*}$$

$$+\ 0.07\ MP_{T-2} - \qquad 0.17\ RW_T + 0.06\ RW_{T-4} - 0.03\ U_{T-1} + 0.09\ Y^e_{T+1} + \mu_T + \Psi_T$$

$$(3.32)^{**} \qquad\qquad (-3.88)^{**} \qquad (2.39)^{*} \qquad (-2.81)^{*} \qquad (4.08)^{**}$$

CHOW $(13,23)^{14}$ = 12.58**

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[14] See footnote 8 in table 3.

Figure 1

FIGURE 1
Number of Wage and Salary Earners, Greek Manufacturing, 1985=100

Figure 2

FIGURE 2
Output of Greek Manufacturing, 1985=100

Figure 3

FIGURE 3
Actual Output and Firms' Short-Term Output Expectations, 1985=100

Figure 4
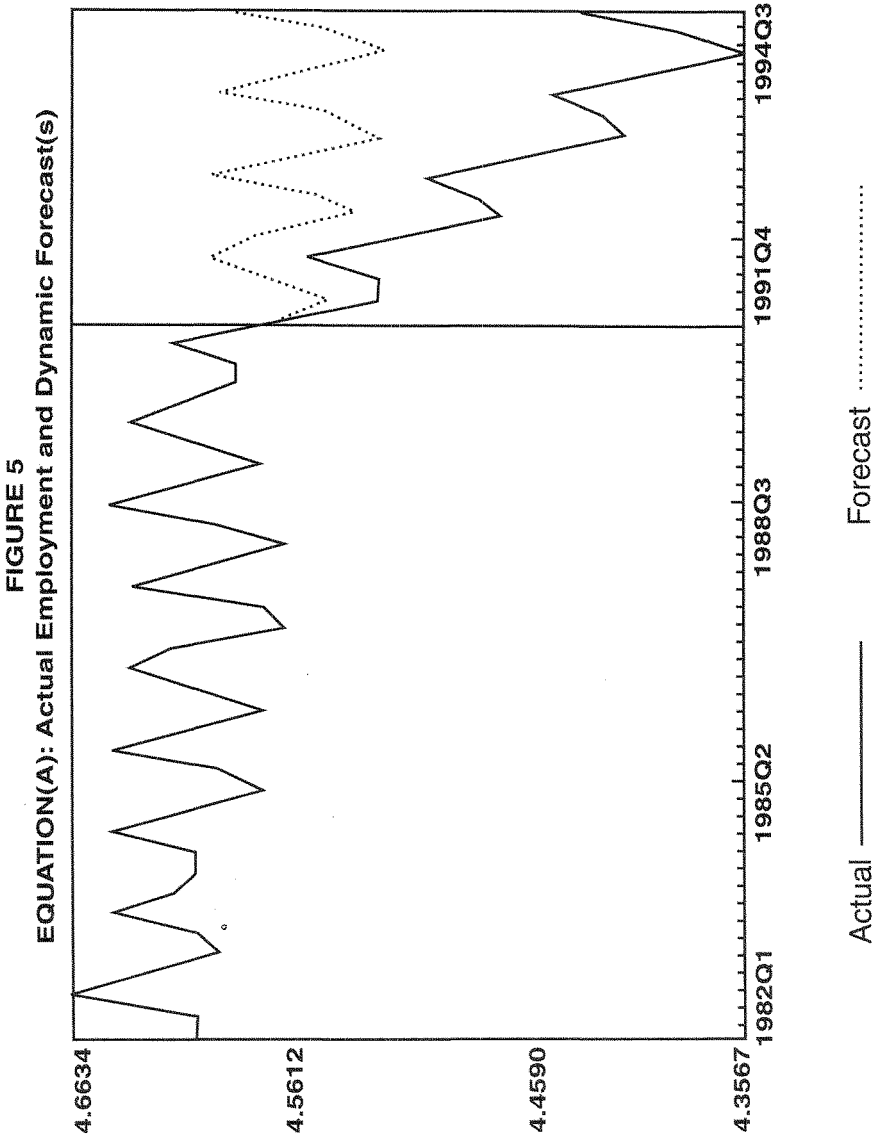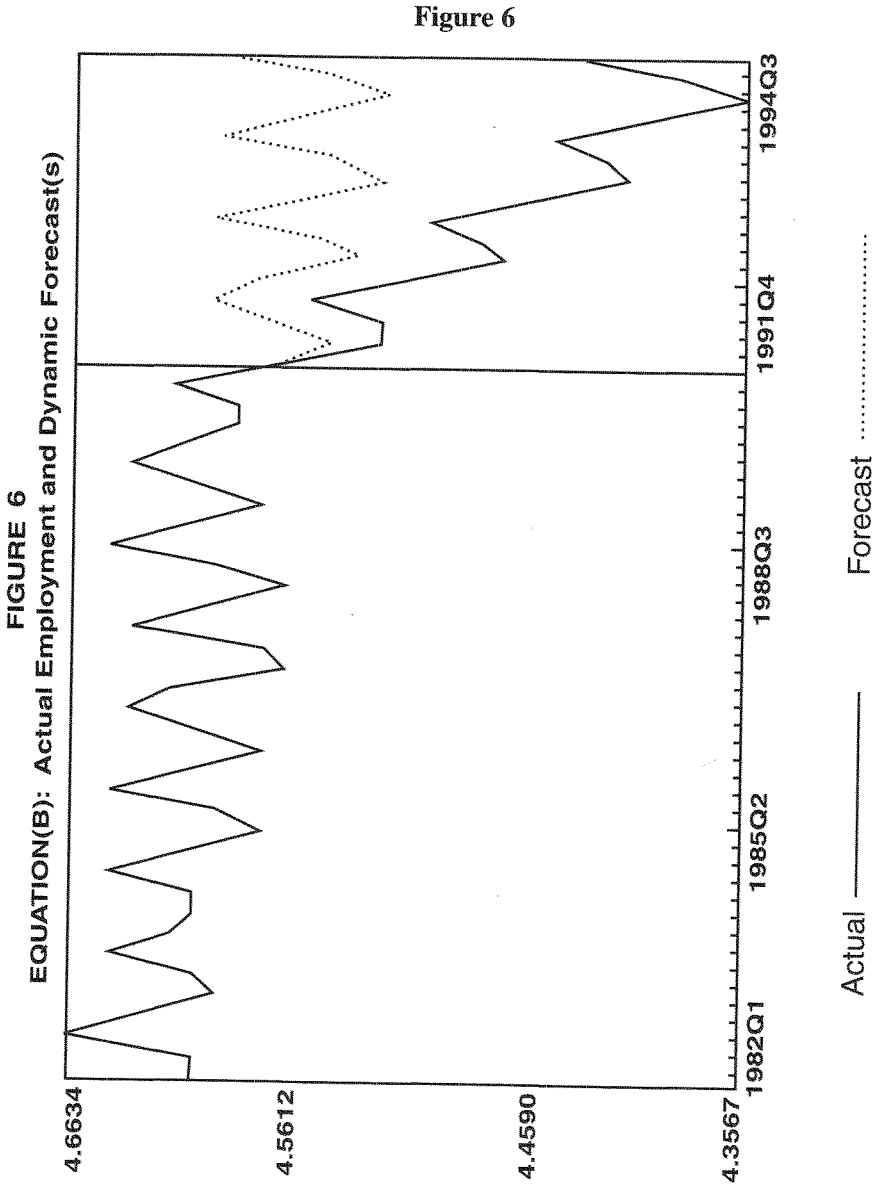

FIGURE 4
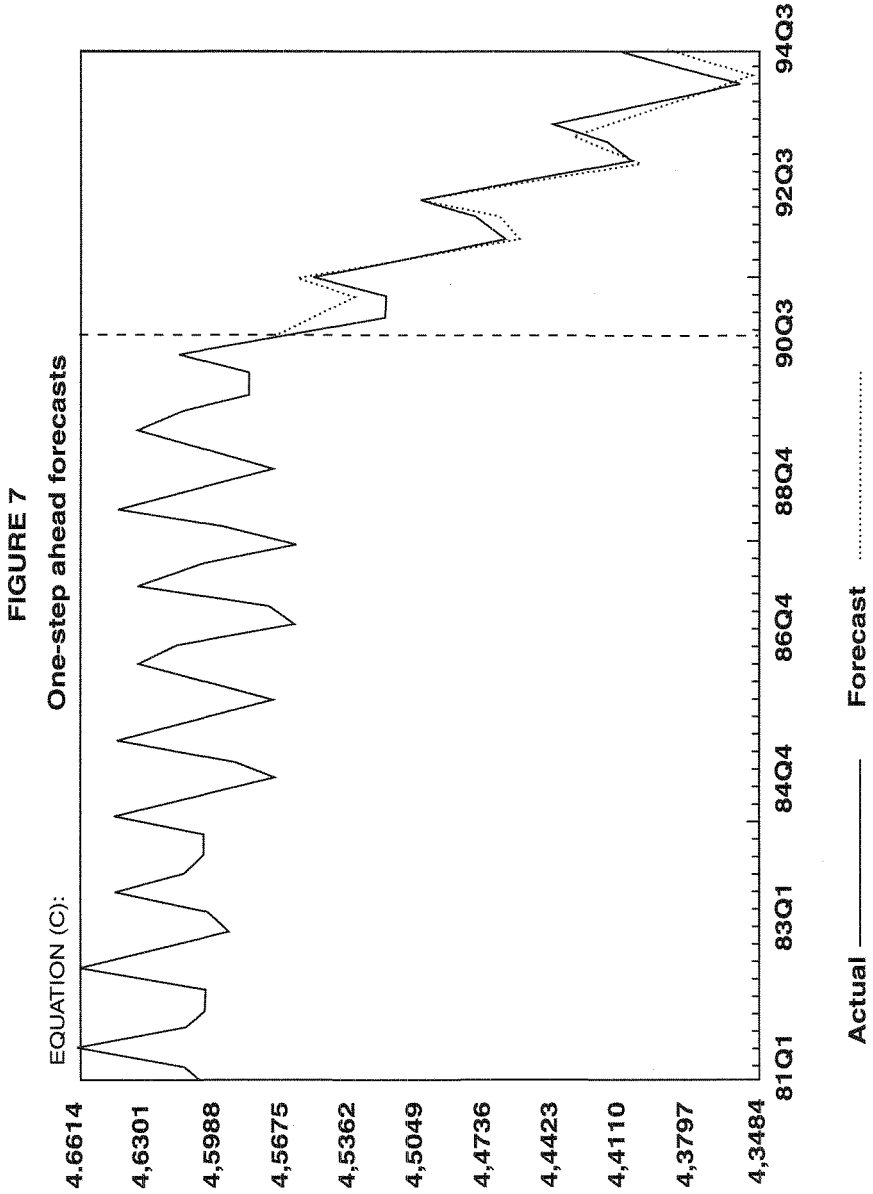Output Per Head, Greek Manufacturing, 1976(I)-1994(IV)

Figure 5

FIGURE 5
EQUATION(A): Actual Employment and Dynamic Forecast(s)

Actual ——— Forecast ·········

Figure 6

FIGURE 6
EQUATION(B): Actual Employment and Dynamic Forecast(s)

Actual ————   Forecast ··········

Figure 7

FIGURE 7

One-step ahead forecasts

EQUATION (C):

Actual ———

Forecast ·············

Figure 8

FIGURE 8

EQUATION(A'): Actual Employment and Dynamic Forecast(s)

Figure 9

FIGURE 9
EQUATION(B'): Actual Employment and Dynamic Forecast(s)

Figure 10

FIGURE 10

One-step ahead forecasts
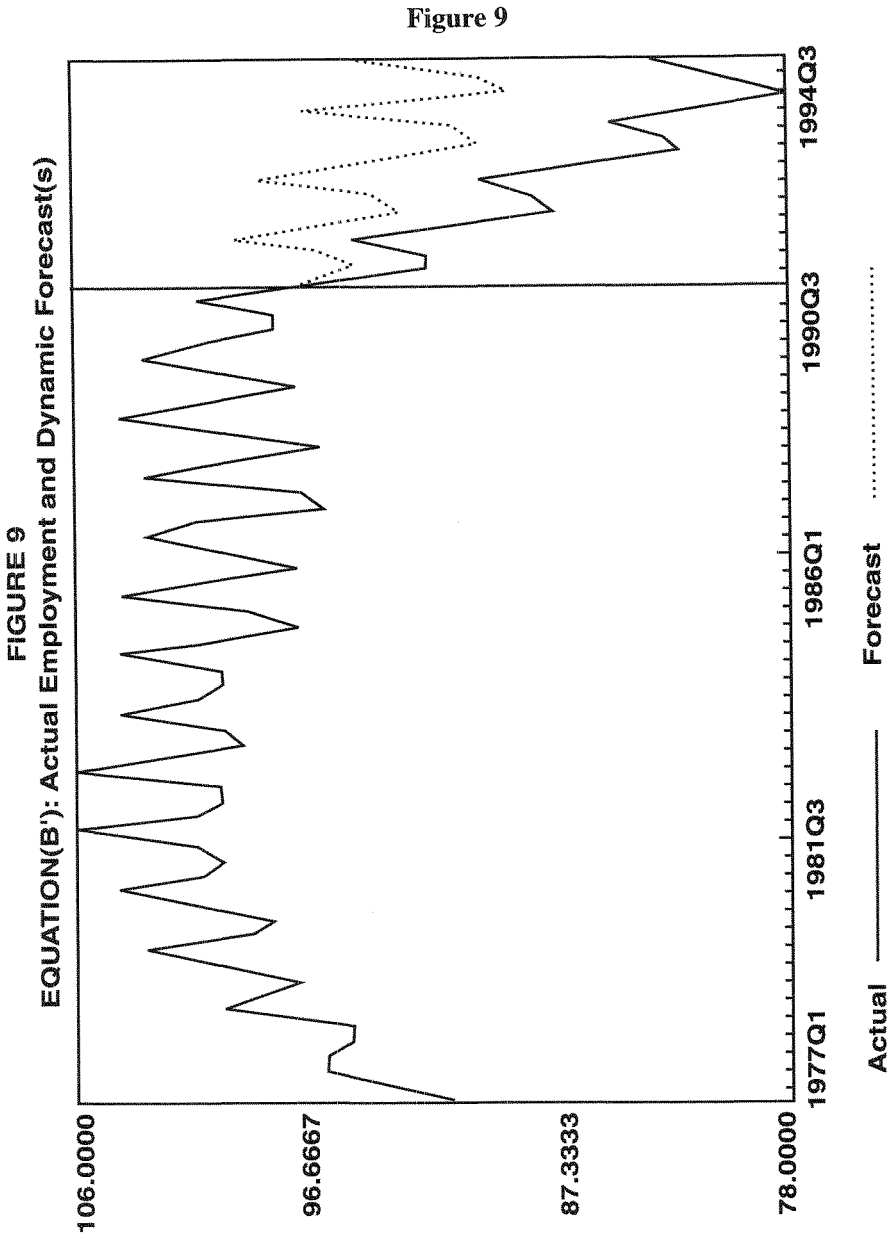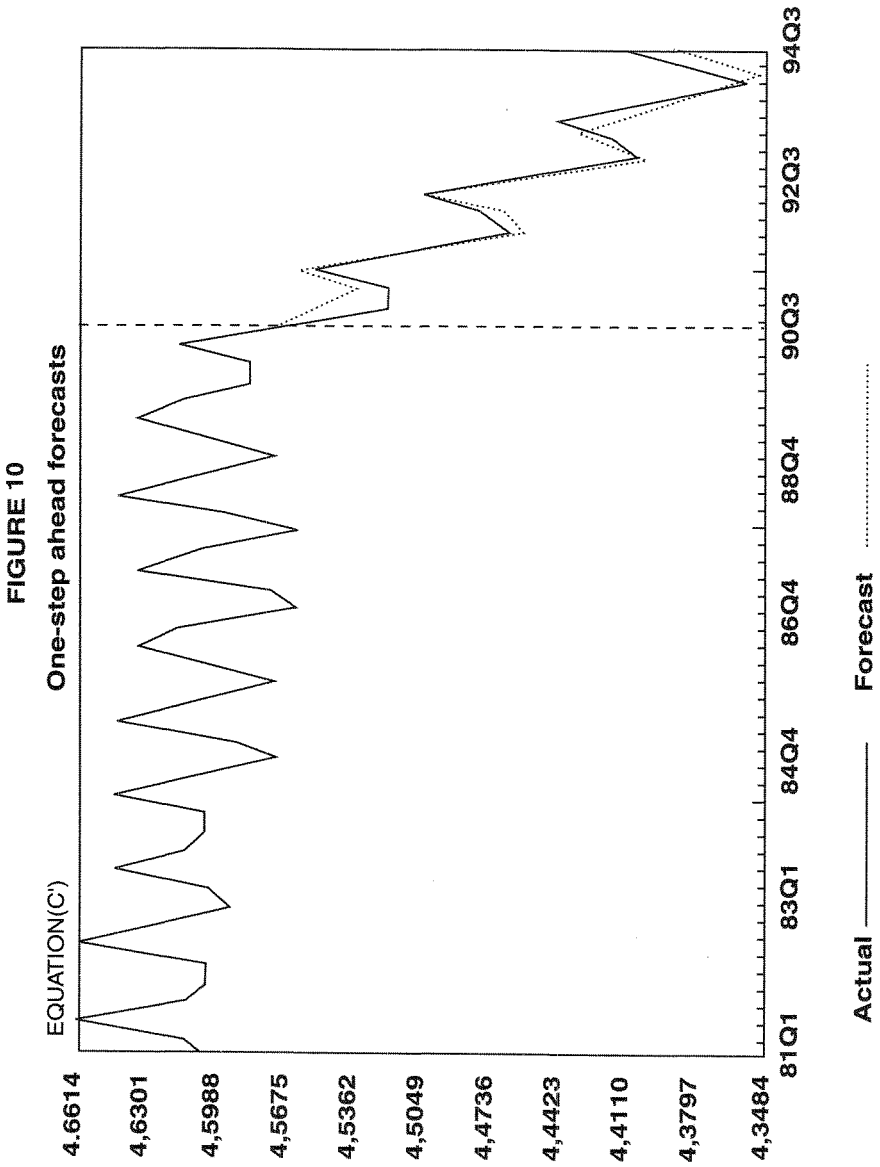
EQUATION(C')

Actual ——————   Forecast ··············
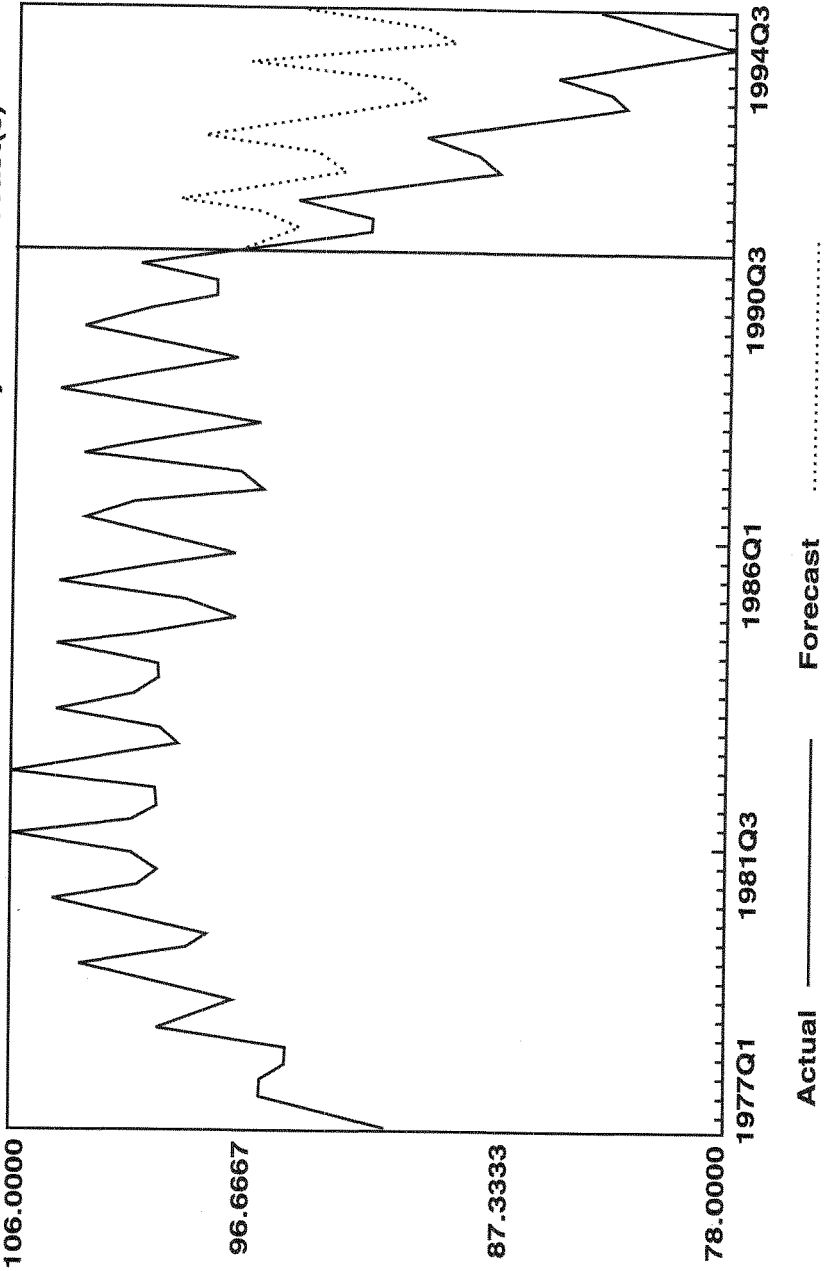
DATA APPENDIX

All variables are expressed in logs.

E_t : Number of wage and salary earners on payrolls of manufacturing establishments with at least ten employees, 1985 = 100, unadjusted. Source: OECD, <u>Main Economic Indicators</u>, various issues.

Y_t : Output of total manufacturing, 1985 = 100, unadjusted. Source: OECD, <u>Main Economic Indicators</u>, various issues.

MP_t : Index for the real price of materials and fuel, constructed as the ratio of the wholesale / producer price index for materials and fuel purchased by manufacturing industries, to the wholesale/producer price index for output, all manufacturing products, home sales, 1985 = 100, unadjusted. Source: Bank of Greece, <u>Monthly Statistical Bulletin</u>, various issues, and OECD, <u>Main Economic Indicators</u>, various issues.

RW_t : Index for the real average weekly earnings constructed as the ratio of gross nominal average weekly earnings of wage and salary earners on payrolls of manufacturing establishments with at least ten employees, to the wholesale / producer price index for output, all manufactured goods, home sales, 1985 = 100, unadjusted. Source: National Statistical Service of Greece, <u>Labor Statistics</u>, various issues, and OECD, <u>Main Economic Indicators</u>, various issues.

Y^e_t : Index of future output expectations, one quarter ahead, constructed from I.O.B.E. survey data using the Wren-Lewis (1985) approach. Source: OECD, <u>Main Economic Indicators</u>, various issues.

CI^e_t : Composite index for firms' short term expectations based on output expectations, sales expectations, and stocks accumulation. Published by I.O.B.E. since January 1981.

U_t : The unemployment rate. Source: National Statistical Service of Greece, <u>Monthly Statistical Bulletin</u>, various issues.

$YEUR_t$: Index of industrial production for OECD Europe, manufacturing industries, 1985 = 100, seasonally adjusted. OECD, <u>Main Economic Indicators</u>, various issues.

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