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The Productivity-Inflation Nexus Revisited: Canada, 1969-1988

by

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THE PRODUCTIVITY-INFLATION NEXUS REVISITED: CANADA, 1969-1988

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ABSTRACT

This paper investigates the relationship between productivity and inflation for the 1969-88 period. In an earlier study, which covered the 1963-79 period, Jarrett and Selody estimated a bivariate vector autoregressive (VAR) model and found that a permanent one percentage point positive shock to inflation translates into a 0.23 percentage point reduction in productivity growth. This study examines whether this result remains valid for the extended sample. In this paper it is argued that the linear relationship between productivity and inflation identified by Jarrett and Selody changed in the 1980s owing to a fall in the relative cost of capital and a sharp increase in the ratio of consumer prices to producer prices. These effects are controlled for by substituting total factor productivity for the labour productivity measure chosen by Jarrett and Selody, and by including the consumer real wage in the VAR. Thus, the updated model is a trivariate VAR encompassing rates of change of the GDP price deflator, the consumer real wage, and total factor productivity. The data do not reject the null hypothesis that these variables are cointegrated and the long-run predictions of the estimated model are in line with those of Jarrett and Selody. Specifically, the trivariate VAR predicts that a permanent one percentage point increase in inflation reduces productivity growth by 0.3 percentage points. In this paper, information about the dynamics of the VAR system is provided by simulating one-period shocks to the VAR with orthogonalized innovations, obtained using the Choleski technique. It is shown that even a one-period shock to inflation affects productivity growth. The effect of a one percentage point increase in inflation for one period stabilizes after 5 years at about -0.02 percentage points. Based on a Monte-Carlo exercise to obtain the relevant distribution of the 5th-year effect of inflation on the growth of productivity, it is shown that this negative response is statistically significant.

RÉSUMÉ

Dans une étude traitant de la relation entre la productivité et l'inflation sur la période 1963-1979, Jarrett et Selody avaient estimé un modèle d'autorégression vectorielle à deux variables et conclu qu'une hausse permanente d'un point de pourcentage du taux d'inflation se traduit par une réduction de 0,23 point de pourcentage de la croissance de la productivité. L'auteur de la présente étude réestime une version modifiée de ce modèle sur les années 1969-1988 et tente de déterminer si ce résultat tient également pour cette période plus longue. Il soutient que la relation linéaire dégagée par Jarrett et Selody entre la productivité et l'inflation s'est modifiée dans les années 80 par suite d'une baisse du coût relatif du capital et d'une forte augmentation du rapport entre les prix à la consommation et les coûts de production. Pour tenir compte de cette modification, l'auteur substitue la productivité totale des facteurs à la mesure de productivité du travail retenue dans le modèle de Jarrett et Selody et fait intervenir le salaire réel du point de vue de la consommation. Le modèle ainsi modifié comporte trois variables : le taux de variation de l'indice de prix implicite du PIB, celui du salaire réel du point de vue de la consommation et celui de la productivité totale des facteurs. Les données n'infirment pas

l'hypothèse nulle selon laquelle ces variables sont cointégrées, et les prévisions à long terme issues du modèle réestimé confirment celles qu'ont obtenues Jarrett et Selody. Ce modèle prévoit en particulier qu'une hausse permanente d'un point de pourcentage du taux d'inflation entraîne une baisse de la croissance de la productivité de 0,3 point de pourcentage. L'auteur procède à une orthogonalisation des chocs obtenue à l'aide de la technique de Choleski pour étudier l'effet d'un choc instantané sur le modèle d'autorégression vectorielle. Le résultat obtenu indique que même une variation instantanée du taux d'inflation agit sur la croissance de la productivité. L'incidence qu'une augmentation instantanée d'un point de pourcentage du taux d'inflation induit sur la croissance de la productivité se stabilise aux environs de - 0,02 point de pourcentage au bout de cinq ans; cette incidence négative est statistiquement significative, selon les mesures de distribution calculées à l'aide de la méthode de Monte-Carlo.

This paper extends and provides an update of Jarrett and Selody's (1982)[1] study of the productivity-inflation nexus in Canada which covered the 1963-79 period. In that study, Jarrett and Selody found that:

> As a long-term prediction ... a permanent one percentage point positive shock to inflation translates into an eventual 6.05 percentage point increase in inflation and a 1.38 percentage point reduction in productivity growth.

This amounts to a 0.23 percentage point reduction in productivity growth for each one percentage point increase in inflation. The aim of this study is to examine whether this result remains valid when data for the 1980s are included in the sample.

Jarrett and Selody use a bivariate vector autoregression (VAR) technique on the inflation rate, measured as the percentage change in the gross domestic product (GDP) deflator, and labour productivity growth, measured as the percentage change in the ratio of seasonally adjusted real GDP to total hours worked. Casual observation would suggest that the relationship reported by Jarrett and Selody does not hold during the 1980s since both the rate of productivity growth and inflation declined. But important structural change was taking place in the Canadian economy through the 1980s. In particular, the growth rate of real wages in terms of producer prices was 2.6 times higher than the growth of real wages in terms of consumer prices, in part because the price of machinery and equipment was falling.[2] Canadian firms faced with a relative factor-cost decline against labour opted for more capital-intensive production techniques in the 1980s. Such structural change has important implications for the relationship between productivity growth and inflation. Therefore, to isolate the inflation-productivity relationship in estimated equations one has to control for the structural change.

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[1] See Jarrett and Selody (1982).

[2] See Cozier (1989).

One way to control for the impact of changes in capital intensity is to use total factor productivity instead of labour productivity in the relationship between inflation and productivity. Total factor productivity is labour productivity corrected for changes in capital intensity. The real wage in terms of consumer prices is also included in the model to control for changes in relative factor prices. The updated model is therefore a trivariate VAR encompassing total factor productivity, the real wage and the GDP price deflator. Sims' modified likelihood-ratio test for block exogeneity indicated that none of the three variables can be excluded from the system (Table XX). A listing of all data used in this study, and their sources, is provided in Appendix 1.

The first question to be answered in estimating the VAR is the nature of any necessary detrending or pre-filtering of the variables. As would be expected in a growing economy, a number of tests (Sargan-Bhargava, Dickey-Fuller, and augmented Dickey-Fuller) confirm that all of the above variables are non-stationary (Table XIV). However, a vector of time series, all of which are stationary only after differencing, may have linear combinations that are stationary without differencing. In such cases, those variables are said to be cointegrated. In economics, equilibrium restrictions relating the levels of growing variables often create the conditions for the variables to be cointegrated. In such an instance, a VAR system detrended by differencing sacrifices significant amounts of information and fails to capture the cointegrating relationship.[3]

The Engle and Yoo test for cointegration of the level of prices, the level of productivity and the level of consumer real wages indicated that these variables cannot be regarded as cointegrated (Table XVII). The same result was obtained in tests for the level of inflation, the level of productivity, and the level of consumer real wages (Table XVIII). Various tests of stationarity on the rates of change of prices (p), productivity (q),

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[3] Granger advocates the use of "equilibrium error" in these models, which allows for the introduction of the impact of long-run or "equilibrium" conditions. Note that a VAR in levels without error correction introduces a downward bias in the estimated coefficients. See Granger (1986).

and the real wage (w) produced some mixed results (Table XIV). The Sargan-Bhargava[4] test rejected the non-stationarity of all three variables, while the augmented Dickey-Fuller test yielded the opposite results for p and w. The spectra of p and w appear to be non-stationary and confirm the augmented Dicky-Fuller test results (Figures 5 to 7). However, the Engle and Yoo test of cointegration indicates that p, q, and w are indeed cointegrated (Table XIX). The Johansen-Juselius Canonical Correlation tests,[5] and the Phillips-Ouliaris Principal Components tests[6] detected a varying number of cointegrating vectors for different lag structures in the system. The results of the Johansen-Juselius test indicated the presence of three cointegrating vectors for a system with two lags (Table XXI). The Phillips-Ouliaris Principal Components tests also indicated the existence of at least one cointegrating vector in a system with two lags[7] (Table XXII). These are rather important results, since the existence of a long-term or *equilibrium* relationship among these variables establishes a basis for using the estimated Jarrett-Selody model for predictions.

Based on the above results, a VAR in rates of change was chosen. Given that this VAR system is cointegrated, it is evident that the application of a non-stochastic detrending procedure to the integrated variables will result in overdifferencing and is not justifiable. According to Engle and Yoo,[8] conventional estimation techniques appear to

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[4] The Sargan-Bhargava test is the most powerful test for unit root. However, it is not robust to complicated dynamics.

[5] See Johansen, Søren and Juselius (1989).

[6] See Phillips and Ouliaris (1988 and 1990).

[7] It should be noted that the results of Johansen-Juselius (J-J) tests and Phillips-Ouliaris (P-O) tests appear to be sensitive to the number of lags included in the system. For the J-J test, the number of possible cointegrating vectors declines as the number of lags increases (one cointegrating vector for a system with four lags and no cointegrating vectors for six lags). The P-O test yields the opposite results. It cannot reject the possibility of at least one cointegrating vector for a system with two lags and two cointegrating vectors for a system with six lags. Thus the P-O results imply that the number of cointegrating vectors increases with the larger number of lags.

[8] See Engle and Yoo (1987).

underestimate the parameters of such a VAR near the unit circle. Nevertheless, as Granger and Engle[9] argue, although a VAR in levels for cointegrated systems will have omitted constraints, these constraints will be satisfied asymptotically. Although a VAR in levels underestimates the coefficient of inflation for the *rate of change* of productivity, the extent of such a downward bias is unlikely to be important.

Sims' modified likelihood-ratio test was used to specify the lag structure of the system. The results at the 5 per cent level of significance indicate that the data reject a lag restriction of fourth order against the alternative of sixth order, while a restriction of sixth order against eighth can be rejected at 1 per cent (Tables XV and XVI). Although the diagnostic tests improve as we move to lower lag structures (e.g., the significance of the F-test for inflation in the equation of productivity is about 88 per cent for the sixth-order lag structure and about 99 per cent for the fourth order), an eighth-order lag structure was selected. At the risk of some loss of efficiency in estimation, the longer lag structure minimizes any bias and allows the analysis to capture the dynamics of the system over a longer term. The estimated equations of the eighth-order VAR are reported in Tables I to III.

The estimated effect of inflation on productivity is identified by transforming the VAR into its moving-average representation. The result of this transformation is that movements in inflation, productivity and the real wage are explained in terms of innovations in the same variables. The steady state of the transformed model is:

$$p = 6.0\,\epsilon_p + 2.0\,\epsilon_q + 0.6\,\epsilon_w$$
$$q = -3.0\,\epsilon_p + 0.2\,\epsilon_q + 0.7\,\epsilon_w$$
$$w = 1.6\,\epsilon_p -0.2\,\epsilon_q + 3.1\,\epsilon_w$$

where p is the rate of inflation, q is the rate of growth of total factor productivity, w is the rate of growth of real wages in terms of consumer prices, and where ϵ_i represents an

[9] See Granger and Engle (1987).

innovation in variable i. The coefficient of the response of inflation to its own innovations is 6.0, almost exactly the estimate reported by Jarrett and Selody. The coefficient of the response of productivity growth to inflation innovations is -3.0, compared to Jarrett and Selody's -1.4. Although this estimate is twice as large as that reported by Jarrett and Selody, it is not strictly comparable since, in the updated model, it is necessary to control for the feedback effect of inflation on productivity growth transmitted through the real wage. The coefficient of the response of real wage growth to innovations in inflation is 1.6 and the coefficient of real wage innovations to rate of change of productivity is 0.7. Thus, the feedback of inflation-induced real wage innovations to productivity growth is about 1.1 (i.e., 0.7 times 1.6). Once this adjustment is made, the impact of inflation on productivity growth falls, in absolute terms, to about -1.9, much closer to the Jarrett and Selody estimate.

In contrast to what may be expected from a general equilibrium perspective, the coefficient on inflation innovations in the real wage equation is positive. This means that higher inflation working through inflation expectations in the labour market results in temporarily higher real wages, making labour less competitive as a production factor. This implies a process of capital substitution in response to increases in the real wage that is corroborated by the negative sign of total factor productivity in the real wage equation.

The Choleski Moving-Average Representation

Using the moving-average representation of the VAR, the estimated impact of a one percentage point increase in inflation on the rate of growth of productivity is about three-tenths of a percentage point (1.9 divided by 6). This is the same as the estimate derived from Jarrett and Selody's extended reduced-form representation. However, because innovations in a VAR are contemporaneously interrelated, their moving averages are not independent. By themselves, these moving averages contain little information about the effects of single-period independent shocks. The system, nonetheless, can be transformed into a moving-average representation of *independent* shocks such that the effects of single-period independent shocks can be ascertained. Thus, to provide information about dynamics, and to study the impacts of independent shocks, the model is orthogonalized so that the innovations are independent white-noise processes.

Various Choleski orderings of the system were examined,[10] but only the results for the ordering w-p-q (i.e., wages causing inflation causing productivity) and q-p-w (i.e., productivity causing inflation causing wages) are reported. Other orderings produced results that were between these two extremes. The first ordering is shown in Tables IV to VI and the next in Tables VII to IX. The results in Table VI show that after twenty quarters, 75 per cent of the variance of productivity growth can be explained by its own variation, 12.6 per cent is explained by inflation, and 12.1 per cent is explained by changes in the real wage. In the second ordering, the comparable figures from Table VII are 73.8 per cent for q, 13.9 per cent for p, and 12.3 per cent for w. The power of the two orderings in explaining productivity is therefore quite close, indicating that ordering is not that important. The w-p-q ordering is used in calculating the impulse response functions because the explanatory power of w's own-variance is the highest among the three variables.

Impulse Response Functions

Figures 1 to 3 show the responses, over twenty-four quarters, of the variables in the system to innovations in themselves and in each of the other variables. The innovations are normalized to represent a shock of one standard error in each variable. Thus, the graphs highlight the *relative* magnitude of the impulse responses, scaled by the variance of each variable.

[10] See Appendix 2 for further details on the orthogonalization methodology.

Figure 1 depicts the responses to a one-standard-error shock to the growth rate of real wages. Productivity growth initially increases by an average of about 10 per cent of one standard error (equivalent to about 0.3 percentage points) over ten quarters, reflecting the substitution of capital for labour. However, the growth rate of total factor productivity declines permanently by about 4 per cent of one standard error (about 0.3 percentage points) fifteen quarters after the shock. This decline is due to the feedback effects of higher inflation rates that resulted from the shock to the real wage.

Figure 2 shows that a one-standard-error shock to inflation reduces the growth rate of total factor productivity by about 30 per cent of a standard error by the fifth quarter after the shock. The growth rate returns to control by the ninth quarter after the shock, thereafter declining by about 5 per cent of a standard error by the fifteenth quarter after the shock, and then remaining 1 to 2 per cent of a standard error below control. Thus, the result shows that the impact of a one percentge point reduction in inflation on the growth of productivity stabilizes after five years at about -0.02 percentage points. The figure also shows that a one-standard-error shock to the inflation rate (equivalent to a 2.1 percentage point increase in the GDP inflation rate) increases real wage growth by about 20 per cent of a standard error (equivalent to 0.5 percentage points) after four quarters. The growth rate of the real wage returns to control seven quarters after the shock, after which it increases slightly and remains permanently above control by about 5 per cent of one standard error.

Figure 3 shows that a one-standard-error shock to productivity growth increases inflation by 40 per cent of a standard error after five quarters. The inflation rate slowly returns to control after about eighteen quarters. The initial response of the real wage to a one-standard-error productivity shock is a series of cyclical movements averaging to a decline of 10 per cent of a standard error (equivalent to 0.2 percentage points) over eight quarters. This is consistent with the hypothesis of the increased capital intensity reflecting firms' responses to increasing wage costs. In other words, the increase in total factor productivity growth is interpreted by the VAR as a cost-minimization strategy by firms. However, the increased productivity eventually results in higher real wages (5 per cent of one standard error or 0.2 percentage points above control after twelve quarters).

Robustness of Results

To test the robustness of these results, the means and variances of the Choleski impulse-response functions were derived from a Monte Carlo integration based on 100 draws from the parameter vector of VAR.[11] The posterior mean and standard error for the twenty-step-ahead effect of a shock to inflation on productivity growth were 0.202 and 0.392. The Choleski productivity response to a one-standard-deviation shock to p after twenty quarters was -0.05 (derived from an actual sample of 80 observations). Testing for the null hypothesis that the negative response of productivity was statistically significant, resulted in a calculated z-statistic of more than 5.6. We conclude that the fifth-year negative effect of inflation on the growth of productivity is significant at a 99 per cent level of confidence.

To further test robustness, a VAR including inflation, labour productivity and the capital-labour ratio was estimated. The results are reported in Tables XI to XIII. The steady-state coefficients of this model have the right signs and are quite close to the values estimated from the first model above. The long-term coefficient of the effect of inflation on labour productivity, allowing for feedback, is about -0.6 (compared to -1.9

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[11] A VAR can be represented as:
$y_t = (I \otimes X_t)\beta + u_t,\ t=1,\ldots T$
where y_t is an m by T matrix of observations on m variables. It is assumed that $u_t \sim N(0,\Sigma)$. The likelihood function is conditioned upon the values of y for $t<1$. Using a diffuse prior pdf, the elements of β and Σ are independently distributed, that is, $p(\beta,\Sigma) = p(\beta)\, p(\Sigma)$. Jeffreys' invariance theory gives $p(\beta) =$ const, so $p(\beta,\Sigma)$ is proportional to $|\Sigma|^{-(m+1)/2}$. Then the posterior distribution of(β,Σ) is Normal-inverse Wishart with $\Sigma^{-1} \sim$ Wishart$((TS)^{-1},T)$, and, given Σ,
$\beta \sim N(b,\Sigma \otimes X^TX)^{-1})$,
where b and S are OLS estimates of β and Σ, and $\otimes$ is the Kronecker product. (See Zellner (1971)).

from the first VAR). Diagnostic tests for this second model show signs of misspecification, indicating that the first VAR is the better specification. The weakness of the statistical results for the second VAR might be an indication of the poor quality of data specifically with regard to the capital-labour ratio. Nevertheless, the overall results of the alternative model support the hypothesis of a negative relationship between inflation and productivity growth.

FIGURES

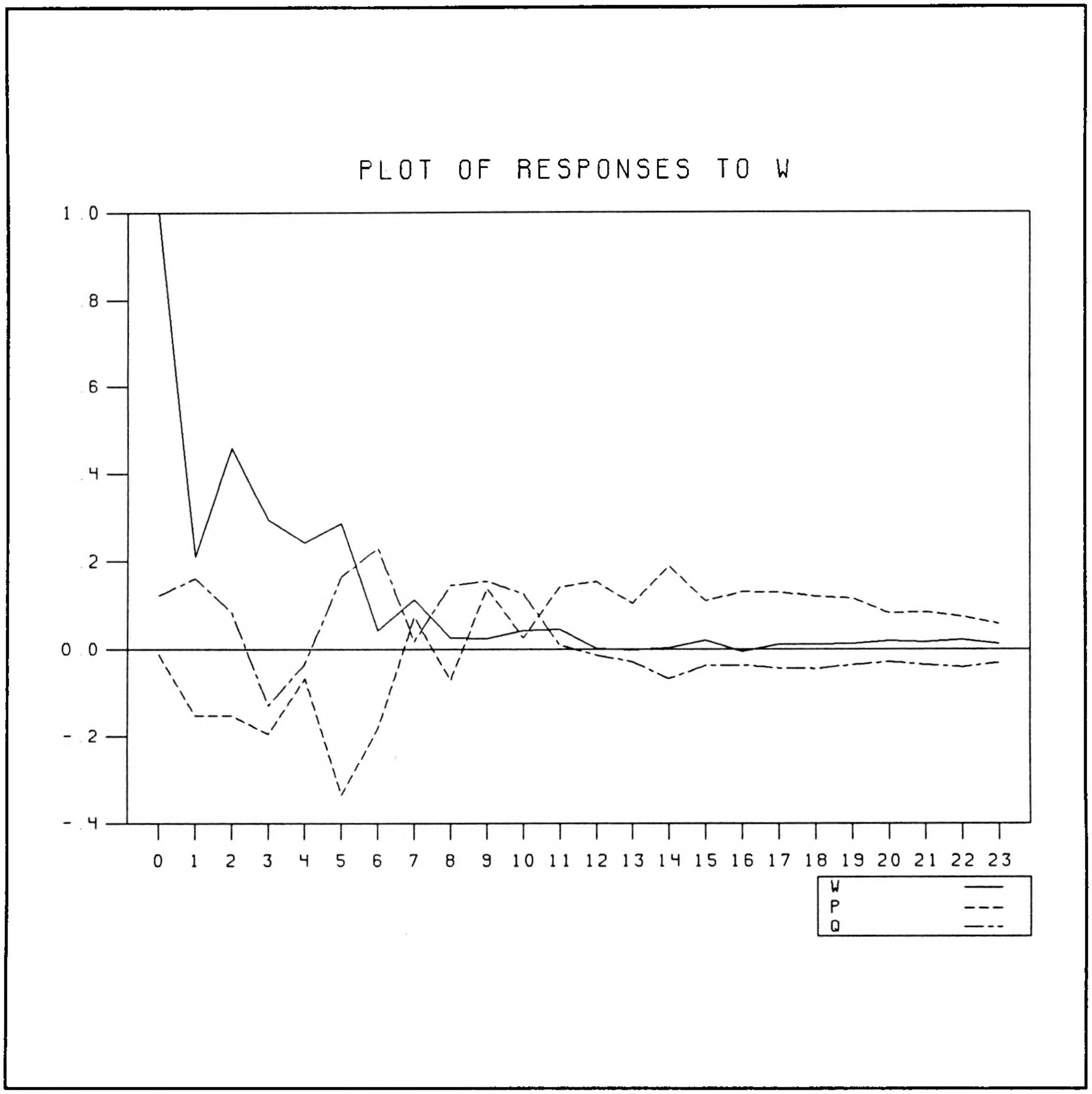


figure 1

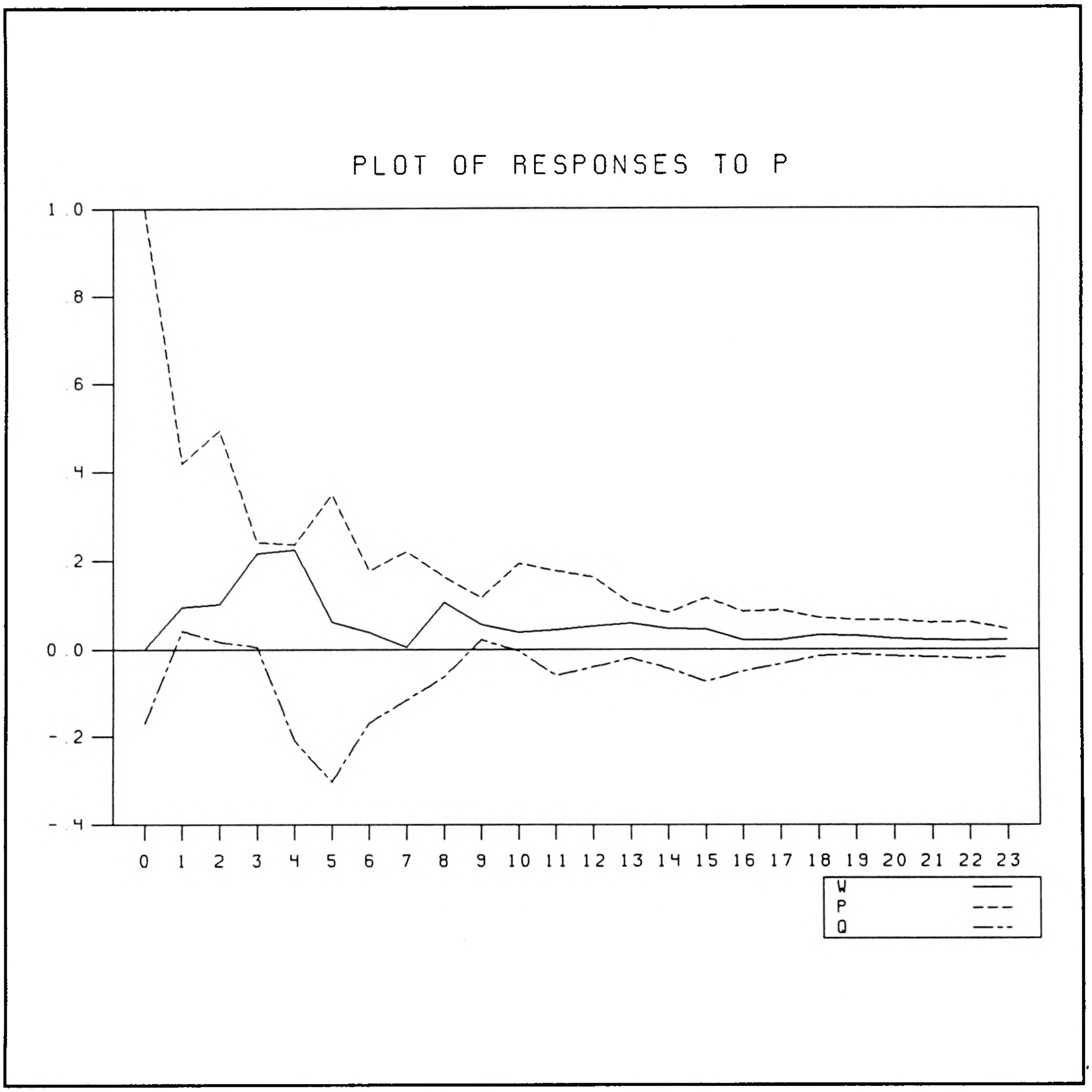
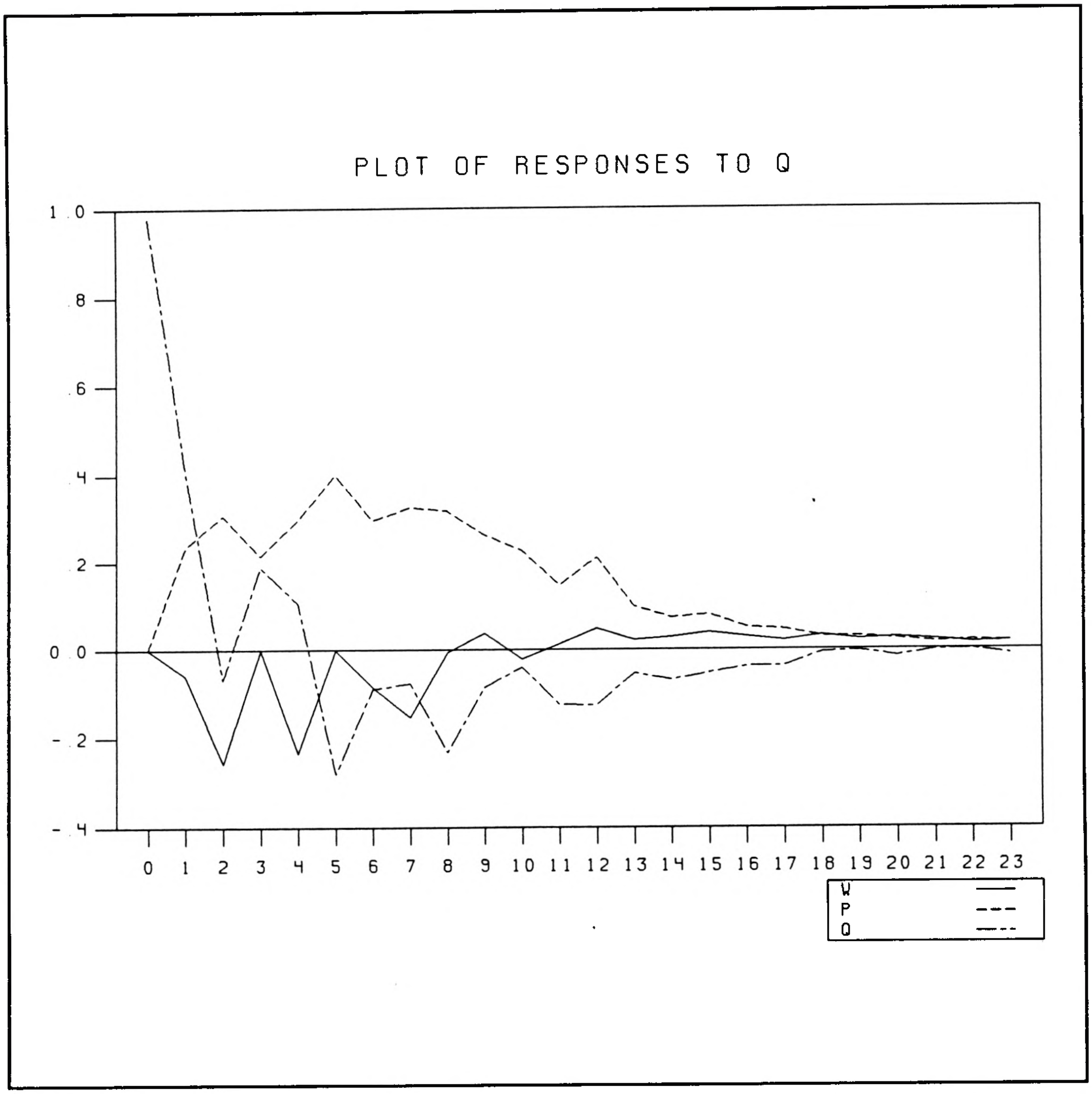

PLOT OF RESPONSES TO P
1.0
.8
.6
.4
.2
0.0
-.2
-.4
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
W
P
Q

figure 2


PLOT OF RESPONSES TO Q
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.8
.6
.4
.2
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-.2
-.4
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
W
P
Q

figure 3

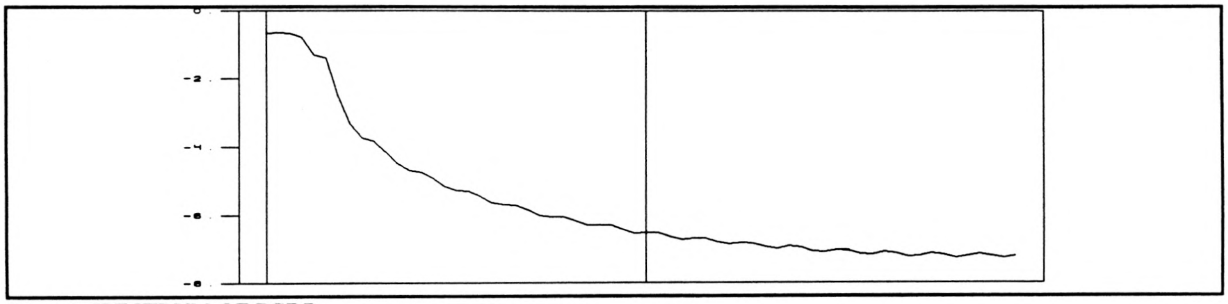

figure 4, SPECTRUM OF PGDP

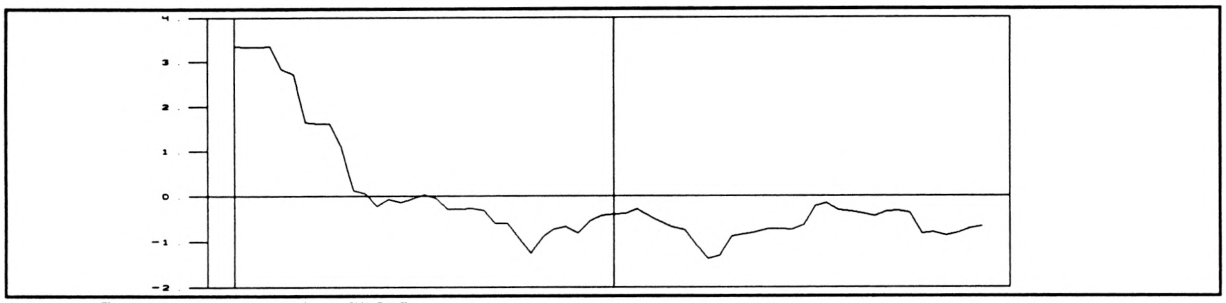

figure 5, SPECTRUM OF P (INFLATION)

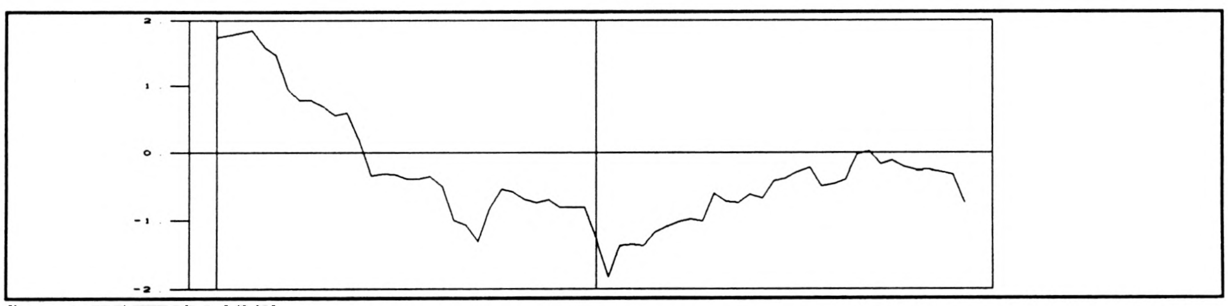

figure 6, SPECTRUM OF W

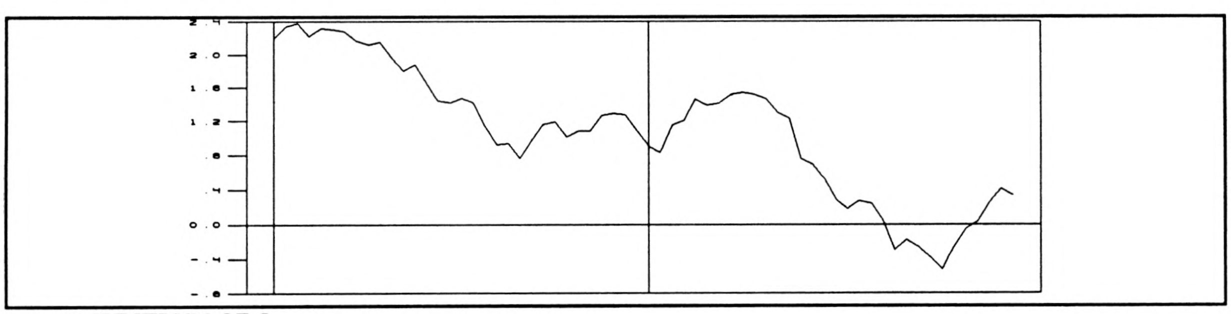

figure 7, SPECTRUM OF Q

TABLES

Table I

EQUATION 1

DEPENDENT VARIABLE 21 W

FROM 69: 1 UNTIL 88: 4
TOTAL OBSERVATIONS 80 SKIPPED/MISSING 0
USABLE OBSERVATIONS 80 DEGREES OF FREEDOM 55
R**2 .45295987 RBAR**2 .21425145
SSR 391.54701 SEE 2.6681523
DURBIN-WATSON 1.98691523
Q(24)= 20.9639 SIGNIFICANCE LEVEL .640857

NO.	LABEL	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	********	***	***********	************	************
1	W	1	.2186341	.1344850	1.625714
2	W	2	.4656405	.1406513	3.310603
3	W	3	.1370908	.1469337	.9330113
4	W	4	-.9550190E-02	.1462079	-.6531926E-01
5	W	5	.3005585E-01	.1561601	.1924681
6	W	6	-.1195949	.1574248	-.7596958
7	W	7	-.3713027E-01	.1472240	-.2522027
8	W	8	.3923015E-01	.1508740	.2600193
9	P	1	.9100116E-01	.1451472	.6269577
10	P	2	.8297943E-02	.1584288	.5237646E-01
11	P	3	.1514556	.1635840	.9258587
12	P	4	-.9903277E-02	.1587339	-.6238918E-01
13	P	5	-.1744347	.1569951	-1.111083
14	P	6	-.2112604	.1570012	-1.345598
15	P	7	.1983459E-02	.1541095	.1287046E-01
16	P	8	.1333898	.1468020	.9086376
17	Q	1	-.3311304E-01	.7341397E-01	-.4510454
18	Q	2	-.1312831	.8046428E-01	-1.631570
19	Q	3	.8274544E-01	.8171636E-01	1.012593
20	Q	4	-.1252437	.8429427E-01	-1.485791
21	Q	5	.9602466E-01	.8431967E-01	1.138817
22	Q	6	-.6119453E-01	.7941965E-01	-.7705212
23	Q	7	-.3316007E-01	.7762935E-01	-.4271589
24	Q	8	.3727483E-01	.6984649E-01	.5336679
25	CONSTANT	0	.4511335E-01	.8200671	.5501178E-01

F-TESTS, DEPENDENT VARIABLE W

VARIABLE	F-STATISTIC	SIGNIF. LEVEL
W	4.48077	.3142981E-03
P	.72038	.6726602
Q	.85549	.5590351

Table II

EQUATION 2

DEPENDENT VARIABLE 19 P

FROM 69: 1 UNTIL 88: 4
TOTAL OBSERVATIONS 80 SKIPPED/MISSING 0
USABLE OBSERVATIONS 80 DEGREES OF FREEDOM 55
R**2 .70358295 RBAR**2 .57423732
SSR 344.65098 SEE 2.5032742
DURBIN-WATSON 1.99187965
Q(24)= 21.6615 SIGNIFICANCE LEVEL .599464

NO.	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	***	***	************	************	************
1	W	1	-.1659045	.1261745	-1.314882
2	W	2	-.8518721E-01	.1319597	-.6455545
3	W	3	-.2759371E-02	.1378539	-.2001663E-01
4	W	4	.1628263	.1371730	1.187014
5	W	5	-.1979091	.1465102	-1.350821
6	W	6	-.4510123E-02	.1476967	-.3053638E-01
7	W	7	.3027388	.1381263	2.191754
8	W	8	-.5843682E-01	.1415507	-.4128331
9	P	1	.4597554	.1361779	3.376139
10	P	2	.3235484	.1486388	2.176743
11	P	3	-.1148655	.1534753	-.7484300
12	P	4	.7831938E-01	.1489249	.5258984
13	P	5	.2922446	.1472937	1.984095
14	P	6	-.7120245E-01	.1472993	-.4833862
15	P	7	-.3569426E-01	.1445863	-.2468717
16	P	8	.4136117E-01	.1377304	.3003054
17	Q	1	.1207647	.6887737E-01	1.753329
18	Q	2	.4699066E-01	.7549200E-01	.6224588
19	Q	3	-.3873340E-01	.7666671E-01	-.5052179
20	Q	4	.4902329E-01	.7908532E-01	.6198786
21	Q	5	.4607261E-01	.7910914E-01	.5823929
22	Q	6	.2759013E-03	.7451193E-01	.3702780E-02
23	Q	7	-.1153258E-01	.7283225E-01	-.1583444
24	Q	8	.3752959E-01	.6553034E-01	.5727056
25	CONSTANT	0	.5445543	.7693912	.7077730

F-TESTS, DEPENDENT VARIABLE P

VARIABLE	F-STATISTIC	SIGNIF. LEVEL
W	1.40993	.2131146
P	13.44811	.1484712E-09
Q	1.06114	.4034386

Table III

EQUATION 3

DEPENDENT VARIABLE 20 Q

FROM 69: 1 UNTIL 88: 4
TOTAL OBSERVATIONS 80 SKIPPED/MISSING 0
USABLE OBSERVATIONS 80 DEGREES OF FREEDOM 55
R**2 .45663221 RBAR**2 .21952626
SSR 1362.8126 SEE 4.9777918
DURBIN-WATSON 2.00708834
Q(24)= 9.24807 SIGNIFICANCE LEVEL .997017

NO.	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	*******	***	************	************	************
1	W	1	.2082250	.2508995	.8299139
2	W	2	.7706702E-01	.2624036	.2936965
3	W	3	-.4154733	.2741243	-1.515639
4	W	4	.1630010E-01	.2727702	.5975763E-01
5	W	5	.3291423	.2913375	1.129763
6	W	6	.3328098	.2936968	1.133175
7	W	7	-.3522221	.2746658	-1.282366
8	W	8	.3197792E-01	.2814754	.1136082
9	P	1	.2245994	.2707914	.8294185
10	P	2	-.2057259	.2955700	-.6960310
11	P	3	.8273105E-01	.3051876	.2710826
12	P	4	-.4923940	.2961391	-1.662712
13	P	5	-.3528939	.2928953	-1.204847
14	P	6	.2531615	.2929065	.8643083
15	P	7	.5867862E-01	.2875117	.2040912
16	P	8	.2767509E-01	.2738785	.1010488
17	Q	1	.4169702	.1369635	3.044389
18	Q	2	-.2649665	.1501168	-1.765069
19	Q	3	.3546451	.1524527	2.326263
20	Q	4	-.1434031	.1572621	-.9118728
21	Q	5	-.1937438	.1573095	-1.231609
22	Q	6	.1796808	.1481679	1.212684
23	Q	7	-.1286252	.1448278	-.8881251
24	Q	8	.9527108E-01	.1303079	.7311229
25	CONSTANT	0	1.570419	1.529944	1.026455

F-TESTS, DEPENDENT VARIABLE Q

VARIABLE	F-STATISTIC	SIGNIF. LEVEL
W	.73396	.6610878
P	1.37121	.2296594
Q	2.13138	.4795170E-01

Table IV

SUMMARY OF SUM OF COEFFICIENTS

EQUATIONS	VARIABLES		
	w	p	q
w	.7243760	-.9470343E-02	-.1679494
T-STATISTIC	4.462323	-.7842938E-01	-1.099808
p	-.4914206E-01	.9734667	.2503908
T-STATISTIC	-.3226655	8.592834	1.747668
q	.2278267	-.4041681	.3158286
T-STATISTIC	.7522731	-1.794110	1.108572

Table V
DECOMPOSITION OF VARIANCE SERIES
W-P-Q ORDER

W

STEP	S.E.	W	P	Q
1	2.21231	100.0000000	.0000000	.0000000
2	2.27449	98.7857011	.8689589	.3453400
3	2.56531	93.3041934	1.4781743	5.2176324
4	2.68956	90.7179622	4.5352546	4.7467832
5	2.83494	85.2042042	7.1675378	7.6282580
6	2.90782	85.7119303	7.0372590	7.2508107
7	2.91672	85.2937107	7.0801480	7.6261413
8	2.94693	84.2727574	6.9370321	8.7902105
9	2.95711	83.7317795	7.5357767	8.7324439
10	2.96147	83.5204752	7.6916270	8.7878978
11	2.96465	83.4442716	7.7592388	8.7964896
12	2.96812	83.3655479	7.8510986	8.7833535
13	2.97233	83.1299656	7.9820473	8.8879871
14	2.97555	82.9500500	8.1545050	8.8954450
15	2.97802	82.8128770	8.2625992	8.9245238
16	2.98130	82.6542335	8.3582804	8.9874861
17	2.98238	82.5961664	8.3761146	9.0277190
18	2.98321	82.5575546	8.3966584	9.0457869
19	2.98501	82.4645457	8.4443781	9.0910762
20	2.98637	82.3988330	8.4895754	9.1115916

Table VI
DECOMPOSITION OF VARIANCE SERIES
W-P-Q ORDER

		P		
STEP	S.E.	W	P	Q
1	2.07561	.0125611	99.9874389	.0000000
2	2.32439	1.8702913	93.7314482	4.3982606
3	2.63820	2.8769563	87.8380018	9.2850419
4	2.75226	4.8121662	84.0323502	11.1554836
5	2.86651	4.6689409	80.3892312	14.9418279
6	3.14912	8.7820279	71.9094043	19.3085678
7	3.25201	9.5966826	68.7130084	21.6903090
8	3.35654	9.2160346	66.3631233	24.4208422
9	3.44084	8.9529859	64.1359299	26.9110842
10	3.50396	9.3064368	62.3240535	28.3695097
11	3.55857	9.0460576	61.7069501	29.2469923
12	3.60257	9.4958095	61.2541843	29.2500062
13	3.65848	9.9639151	60.2509919	29.7850930
14	3.67692	10.2076261	59.9960996	29.7962744
15	3.70483	11.1713708	59.3142330	29.5143961
16	3.72336	11.4334821	59.1455246	29.4209933
17	3.73884	11.8598301	58.8825145	29.2576554
18	3.75424	12.2749876	58.6413818	29.0836306
19	3.76592	12.6333520	58.4355012	28.9311468
20	3.77652	12.9647821	58.2397969	28.7954210

Table VII
DECOMPOSITION OF VARIANCE SERIES
W-P-Q ORDER

		Q		
STEP	**S.E.**	**W**	**P**	**Q**
1	4.12737	1.4830698	2.8698995	95.6470307
2	4.51007	3.4162590	2.5533819	94.0303591
3	4.53284	3.9613206	2.5520521	93.4866273
4	4.63044	5.1239084	2.4478688	92.4282228
5	4.73305	4.9852195	5.6890948	89.3256856
6	5.07751	6.1297821	11.0173694	82.8528485
7	5.22526	9.0955008	12.1750057	78.7294935
8	5.25751	9.0045652	12.8540553	78.1413795
9	5.38407	9.8226622	12.4893730	77.6879648
10	5.43403	11.0179231	12.2893254	76.6927515
11	5.46141	11.8115024	12.1671854	76.0213122
12	5.49158	11.6861693	12.2381525	76.0756783
13	5.51894	11.5809994	12.2073673	76.2116333
14	5.52541	11.5993871	12.2005569	76.2000560
15	5.54291	11.7798569	12.2292594	75.9908838
16	5.55787	11.7924142	12.4653085	75.7422773
17	5.56612	11.8295082	12.5688688	75.6016230
18	5.57286	11.9027341	12.5989441	75.4983218
19	5.57634	11.9967488	12.5962558	75.4069955
20	5.57850	12.0569004	12.5935027	75.3495969

Table VIII
DECOMPOSITION OF VARIANCE SERIES
Q-P-W ORDER

Q

STEP	S.E.	Q	P	W
1	4.12737	100.0000000	.0000000	.0000000
2	4.51007	97.9147093	1.0576025	1.0276882
3	4.53284	97.2372629	1.0499121	1.7128249
4	4.63044	95.4315503	1.1093933	3.4590564
5	4.73305	92.7381364	3.7782061	3.4836575
6	5.07751	83.3278631	11.1429208	5.5292161
7	5.22526	78.7405752	12.5195279	8.7398969
8	5.25751	77.9599985	13.3646312	8.6753702
9	5.38407	76.6669610	13.3312029	10.0018361
10	5.43403	75.5389966	13.0917060	11.3692974
11	5.46141	74.8167030	12.9656905	12.2176065
12	5.49158	74.6972500	13.1890182	12.1137318
13	5.51894	74.7387246	13.2672206	11.9940548
14	5.52541	74.7241168	13.2831269	11.9927563
15	5.54291	74.5188718	13.3703160	12.1108122
16	5.55787	74.2282106	13.6727810	12.0990083
17	5.56612	74.0718886	13.8095799	12.1185316
18	5.57286	73.9672958	13.8621521	12.1705521
19	5.57634	73.8803829	13.8604395	12.2591776
20	5.57850	73.8255015	13.8578286	12.3166699

Table IX
DECOMPOSITION OF VARIANCE SERIES
Q-P-W

		P		
STEP	**S.E.**	**Q**	**P**	**W**
1	2.07561	2.9159667	97.0840333	.0000000
2	2.32439	3.8902660	93.6535388	2.4561952
3	2.63820	5.4735911	90.5564295	3.9699794
4	2.75226	6.2306092	87.4372042	6.3321865
5	2.86651	8.8498681	84.7908467	6.3592852
6	3.14912	10.9970120	77.5105816	11.4924064
7	3.25201	12.6153356	74.7149815	12.6696829
8	3.35654	15.0637903	72.9938946	11.9423150
9	3.44084	17.0701313	71.1473505	11.7825182
10	3.50396	18.7225854	69.5151902	11.7622244
11	3.55857	19.4008912	69.1951256	11.4039832
12	3.60257	19.4958037	68.8577236	11.6464726
13	3.65848	20.1490870	68.0273678	11.8235452
14	3.67692	20.2129716	67.8108289	11.9761996
15	3.70483	20.1095559	67.0846524	12.8057916
16	3.72336	20.0711262	66.9376935	12.9911803
17	3.73884	19.9857154	66.6581989	13.3560857
18	3.75424	19.8867716	66.3977064	13.7155221
19	3.76592	19.7944861	66.1675193	14.0379946
20	3.77652	19.7140631	65.9499436	14.3359933

Table X
DECOMPOSITION OF VARIANCE SERIES
Q-P-W ORDER

W

STEP	S.E.	Q	P	W
1	2.21231	1.4830698	.0094691	98.5074612
2	2.27449	1.6370693	.7127693	97.6501614
3	2.56531	4.6886898	.8522037	94.4591064
4	2.68956	4.2657860	3.9520819	91.7821321
5	2.83494	7.2976988	5.6275887	87.0747125
6	2.90782	6.9663926	5.5853255	87.4482820
7	2.91672	7.3384618	5.5844103	87.0771279
8	2.94693	8.2421433	5.4932466	86.2646101
9	2.95711	8.2119798	6.0725123	85.7155080
10	2.96147	8.2407142	6.2717355	85.4875503
11	2.96465	8.2526637	6.3263319	85.4210044
12	2.96812	8.2382230	6.4304441	85.3313329
13	2.97233	8.2972024	6.6118412	85.0909564
14	2.97555	8.2864182	6.8062520	84.9073299
15	2.97802	8.2946785	6.9388933	84.7664282
16	2.98130	8.3352163	7.0700852	84.5946985
17	2.98238	8.3616725	7.1005130	84.5378145
18	2.98321	8.3745246	7.1300848	84.4953906
19	2.98501	8.4047837	7.1987557	84.3964606
20	2.98637	8.4164058	7.2579158	84.3256784

Table XI

DEPENDENT VARIABLE 26 P

FROM 69: 1 UNTIL 88: 4
TOTAL OBSERVATIONS 80 SKIPPED/MISSING 0
USABLE OBSERVATIONS 80 DEGREES OF FREEDOM 55
R**2 .67195235 RBAR**2 .52880428
SSR 381.42861 SEE 2.6334513
DURBIN-WATSON 1.98091749
Q(24)= 25.1121 SIGNIFICANCE LEVEL .399688

NO.	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	***	***	************	************	************
1	CONSTANT	0	4.757550	2.751865	1.728846
2	P	1	.4198024	.1397085	3.004845
3	P	2	.3448709	.1506683	2.288941
4	P	3	-.1179760	.1576546	-.7483199
5	P	4	-.8179073E-01	.1565861	-.5223369
6	P	5	.2876429	.1577286	1.823657
7	P	6	-.1033432	.1633369	-.6326998
8	P	7	.2183058E-01	.1591626	.1371590
9	P	8	.3564738E-01	.1512233	.2357267
10	Q	1	.8877428E-01	.1113175	.7974872
11	Q	2	.8692947E-01	.1099719	.7904696
12	Q	3	-.4278219E-01	.1041347	-.4108349
13	Q	4	-.1054751	.1045809	-1.008551
14	Q	5	.1052513E-02	.1062410	.9906839E-02
15	Q	6	-.4615615E-01	.1013161	-.4555659
16	Q	7	-.6131385E-01	.1015200	-.6039583
17	Q	8	-.9432635E-01	.1023527	-.9215819
18	RKL	1	-1.854359	1.354682	-1.368852
19	RKL	2	1.752903	2.594538	.6756127
20	RKL	3	.2268232	2.796958	.8109638E-01
21	RKL	4	-1.817122	2.806825	-.6473942
22	RKL	5	1.357038	2.767993	.4902608
23	RKL	6	.7407969	2.750218	.2693593
24	RKL	7	-2.090896	2.536991	-.8241634
25	RKL	8	1.602603	1.334613	1.200800

F-TESTS, DEPENDENT VARIABLE P

VARIABLE	F-STATISTIC	SIGNIF. LEVEL
P	5.64743	.3079216E-04
RKL	1.14674	.3478233
Q	.40191	.9147179

Table XII

DEPENDENT VARIABLE RKL

FROM 69: 1 UNTIL 88: 4
TOTAL OBSERVATIONS 80 SKIPPED/MISSING 0
USABLE OBSERVATIONS 80 DEGREES OF FREEDOM 55
R**2 .99866865 RBAR**2 .99808770
SSR 3.1447297 SEE .23911692
DURBIN-WATSON 1.94248686
Q(24)= 23.2988 SIGNIFICANCE LEVEL .502219

NO.	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	******	***	************	************	************
1	CONSTANT	0	.8791836E-01	.2498689	.3518580
2	P	1	-.1560549E-01	.1268551E-01	-1.230183
3	P	2	.8110574E-02	.1368066E-01	.5928497
4	P	3	.1173512E-01	.1431501E-01	.8197773
5	P	4	.7020021E-02	.1421800E-01	.4937420
6	P	5	-.5323697E-02	.1432173E-01	-.3717215
7	P	6	.2490539E-01	.1483097E-01	1.679283
8	P	7	-.1133025E-01	.1445193E-01	-.7839957
9	P	8	-.9637933E-02	.1373105E-01	-.7019078
10	Q	1	-.7240430E-02	.1010761E-01	-.7163346
11	Q	2	.1914702E-01	.9985434E-02	1.917495
12	Q	3	-.2315910E-02	.9455416E-02	-.2449294
13	Q	4	-.2186793E-02	.9495925E-02	-.2302875
14	Q	5	.7866993E-02	.9646665E-02	.8155142
15	Q	6	.1578375E-02	.9199482E-02	.1715722
16	Q	7	-.1399323E-01	.9218000E-02	-1.518034
17	Q	8	-.2887418E-01	.9293603E-02	-3.106888
18	RKL	1	1.583557	.1230049	12.87394
19	RKL	2	-.6927361	.2355836	-2.940511
20	RKL	3	.2090329	.2539633	.8230830
21	RKL	4	-.1570453	.2548592	-.6162039
22	RKL	5	.8705976E-01	.2513333	.3463917
23	RKL	6	.1947714E-01	.2497194	.7799610E-01
24	RKL	7	-.2672917	.2303584	-1.160330
25	RKL	8	.2188303	.1211826	1.805790

F-TESTS, DEPENDENT VARIABLE RKL

VARIABLE	F-STATISTIC	SIGNIF. LEVEL
P	.90811	.5166436
RKL	3418.99940	.1110223E-15
Q	2.54995	.1936804E-01

Table XIII

DEPENDENT VARIABLE Q

FROM 69: 1 UNTIL 88: 4
TOTAL OBSERVATIONS 80 SKIPPED/MISSING 0
USABLE OBSERVATIONS 80 DEGREES OF FREEDOM 55
R**2 .41926062 RBAR**2 .16584707
SSR 583.35967 SEE 3.2567683
DURBIN-WATSON 2.08380248
Q(24)= 19.9355 SIGNIFICANCE LEVEL .700437

NO. ***	VAR ***	LAG ***	COEFFICIENT ***********	STAND. ERROR ***********	T-STATISTIC ***********
1	CONSTANT	0	5.177749	3.403209	1.521431
2	P	1	-.2556737	.1727764	-1.479795
3	P	2	.4059348E-01	.1863303	.2178576
4	P	3	.2851908	.1949701	1.462741
5	P	4	-.2699325	.1936488	-1.393928
6	P	5	-.6265056	.1950618	-3.211832
7	P	6	.4247404	.2019975	2.102701
8	P	7	.1945995	.1968351	.9886424
9	P	8	.5731992E-01	.1870167	.3064962
10	Q	1	-.1938803	.1376655	-1.408344
11	Q	2	-.1924071	.1360014	-1.414743
12	Q	3	.1497105	.1287826	1.162505
13	Q	4	-.1274548	.1293343	-.9854678
14	Q	5	-.1536863	.1313874	-1.169718
15	Q	6	.1847434	.1252968	1.474446
16	Q	7	.2008939	.1255490	1.600123
17	Q	8	-.9524235E-01	.1265787	-.7524358
18	RKL	1	-1.047462	1.675324	-.6252295
19	RKL	2	2.146083	3.208645	.6688442
20	RKL	3	-1.502963	3.458975	-.4345110
21	RKL	4	.6282767E-01	3.471178	.1809981E-01
22	RKL	5	1.229931	3.423155	.3592974
23	RKL	6	-.8906345	3.401173	-.2618610
24	RKL	7	1.813887	3.137477	.5781354
25	RKL	8	-1.913080	1.650505	-1.159087

F-TESTS, DEPENDENT VARIABLE Q

VARIABLE	F-STATISTIC	SIGNIF. LEVEL
P	2.33561	.3085741E-01
RKL	.55382	.8105561
Q	2.39677	.2702361E-01

Table XIV
UNIT ROOT TESTS ON VAR VARIABLES

TEST	Statistic			Critical Values (100 obs.) 5% Signif.	1% Signif.
	LOG(PGDP)	LOG(TQ)	LOG(WCPI)		
SB: R.W. & drift	.19461E-02	.14088E-01	.23166E-01	.25900	.37600
ADF: R.W.	-1.5840	-.70046	-3.8012	-2.8900	-3.5100
ADF: R.W. & drift	-.58144	-2.0326	-2.6197	-3.4500	-4.0400
ADF: drift	2.9776	.67511	3.8121	2.5400	3.2200
ADF: trend	.35902	-1.9102	-1.3288	2.7900	3.5300
ADF Diagnostics:					
Drift D.W.	2.5315	1.9024	2.1672		
Q-stat(d.f=24)	51.07	28.97	28.42		
Trend D.W.	2.5549	1.9459	2.1198		
Q-stat(D.F=24)	50.65	30.05	33.76		

RATE OF CHANGE

TEST	P	Q	W	5% Signif.	1% Signif.
SB: R.W. & drift	.55302	1.1638	1.1371	.25900	.37600
ADF: R.W.	-2.2274	-5.0658	-2.9655	-2.8900	-3.5100
ADF: R.W. & drift	-2.5101	-5.0321	-3.6850	-3.4500	-4.0400
ADF: drift	2.0122	-1.4040	.74932	2.5400	3.2200
ADF: trend	-1.2720	-.17270	-2.0952	2.7900	3.5300
ADF Diagnostics:					
Drift D.W.	2.0188	1.9200	2.0395		
Q-stat(d.f=24)	23.64	28.78	27.00		
Trend D.W.	2.0283	1.9209	1.9880		
Q-stat(D.F=24)	27.37	28.71	29.14		

Table XV

DIAGNOSTIC TESTS FOR VAR ORDER

6TH ORDER

F-TESTS, DEPENDENT VARIABLE W

VARIABLE	F-STATISTIC	SIGNIF. LEVEL
W	6.13151	.4683438E-04
P	.87630	.5177892
Q	1.24514	.2965157

F-TESTS, DEPENDENT VARIABLE P

VARIABLE	F-STATISTIC	SIGNIF. LEVEL
W	1.22649	.3055792
P	19.43959	.1911693E-11
Q	1.59020	.1657039

F-TESTS, DEPENDENT VARIABLE Q

VARIABLE	F-STATISTIC	SIGNIF. LEVEL
W	.67348	.6714194
P	1.76028	.1227708
Q	2.62274	.2521660E-01

SIMS' MODIFIED LIKELIHOOD-RATIO TEST OF LAG STRUCTURE:

H0: LAG STRUCTURE OF VAR IS OF 6TH. ORDER
HA: LAG STRUCTURE OF VAR IS OF 8TH. ORDER

CHI-SQUARE(18) = 8.520231 SIGNIFICANCE LEVEL .9698436

RESULT: LAG STRUCTURE OF ORDER 6 CANNOT BE REJECTED.

Table XVI

DIAGNOSTIC TESTS FOR VAR ORDER

4TH ORDER

F-TESTS, DEPENDENT VARIABLE W

VARIABLE	F-STATISTIC	SIGNIF. LEVEL
W	8.11800	.2190370E-04
P	.40363	.8053696
Q	.76095	.5544365

F-TESTS, DEPENDENT VARIABLE P

VARIABLE	F-STATISTIC	SIGNIF. LEVEL
W	1.72009	.1560334
P	28.52674	.8959500E-13
Q	1.89073	.1224440

F-TESTS, DEPENDENT VARIABLE Q

VARIABLE	F-STATISTIC	SIGNIF. LEVEL
W	.41363	.7982129
P	2.88452	.2901244E-01
Q	4.14913	.4653527E-02

SIMS' MODIFIED LIKELIHOOD-RATIO TEST OF LAG STRUCTURE:

H0: LAG STRUCTURE OF VAR IS OF 4TH. ORDER
HA: LAG STRUCTURE OF VAR IS OF 6TH. ORDER

CHI-SQUARE(18) = 16.12349 SIGNIFICANCE LEVEL .5839292

RESULT: LAG STRUCTURE OF ORDER 4 CAN BE REJECTED.

Table XVII
ENGLE AND YOO TESTS OF COINTEGRATING VECTORS

H0: PGDP ,TQ (TOTAL FACTOR PRODUCTIVITY), AND WCPI (CONSUMER REAL WAGE) ARE NOT COINTEGRATED.

DEPENDENT VARIABLE LOG(PGDP)
FROM 69: 1 UNTIL 88: 4
TOTAL OBSERVATIONS 80 SKIPPED/MISSING 0
USABLE OBSERVATIONS 80 DEGREES OF FREEDOM 77
R**2 .92379975 RBAR**2 .92182052
SSR 1.0797103 SEE .11841542
DURBIN-WATSON .11374471
Q(24)= 347.217 SIGNIFICANCE LEVEL .000000

NO.	LABEL	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	*******	***	***********	************	***********
1	CONSTANT	0	3.420319	2.104565	1.625191
2	LTQ	0	-2.592476	.1173209	-22.09730
3	LWCPI	0	2.578434	.2788664	9.246125

Augmented Dickey-Fuller Test

DEPENDENT VARIABLE DIFFRESP(DIFFERENCE OF RESIDUAL)
FROM 69: 4 UNTIL 88: 4
TOTAL OBSERVATIONS 77 SKIPPED/MISSING 0
USABLE OBSERVATIONS 77 DEGREES OF FREEDOM 74
R**2 .27978930 RBAR**2 .26032415
SSR .86849030E-01 SEE .34258365E-01
DURBIN-WATSON 2.02797532
Q(24)= 35.4687 SIGNIFICANCE LEVEL .617472E-01

NO.	LABEL	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	*******	***	***********	************	***********
1	CONSTANT	0	.3638877E-03	.3909385E-02	.9308053E-01
2	RESP	1	-.8324139E-01	.3447097E-01	-2.414826
3	DIFFRESP	1	.5182412	.1001258	5.175903

	E.Y. Critical Values (100 obs.)		E.Y. Critical Values (50 obs.)	
TEST Statistic	5% Signif.	1% Signif.	5% Signif	.1% Signif.
ADF -2.4148	-4.22	-4.75	-4.35	-4.94

RESULT: H0 CANNOT BE REJECTED

Table XVIII, ENGLE AND YOO TEST OF COINTEGRATION

H0: P (INFLATION), TQ (TOTAL FACTOR PRODUCTIVITY), AND WCPI (CONSUMER REAL WAGE) ARE NOT COINTEGRATED.

DEPENDENT VARIABLE LOG(P)
FROM 69: 1 UNTIL 88: 4
TOTAL OBSERVATIONS 80 SKIPPED/MISSING 0
USABLE OBSERVATIONS 80 DEGREES OF FREEDOM 77
R**2 .29667137 RBAR**2 .27840309
SSR 24.295887 SEE .56172146
DURBIN-WATSON .96486324
Q(24)= 157.898 SIGNIFICANCE LEVEL .000000

NO.	LABEL	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	*******	***	************	************	************
1	CONSTANT	0	-45.13206	9.983321	-4.520746
2	LTQ	0	3.137118	.5565295	5.636930
3	LWCPI	0	4.273456	1.322845	3.230504

Augmented Dickey-Fuller Test

DEPENDENT VARIABLE DIFFRESP (FIRST DIFFERENCE OF RESIDUALS)
FROM 69: 4 UNTIL 88: 4
TOTAL OBSERVATIONS 77 SKIPPED/MISSING 0
USABLE OBSERVATIONS 77 DEGREES OF FREEDOM 74
R**2 .27642121 RBAR**2 .25686503
SSR 16.330270 SEE .46976518
DURBIN-WATSON 2.02316744
Q(24)= 27.4087 SIGNIFICANCE LEVEL .285767

NO.	LABEL	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	******	***	************	************	************
1	CONSTANT	0	.7510496E-02	.5355924E-01	.1402278
2	RESP	1	-.3743465	.1107334	-3.380609
3	DIFFRESP	1	-.2104328	.1119027	-1.880498

TEST	Statistic	E.Y. Critical Values (100 obs.) 5% Signif.	1% Signif.	E.Y. Critical Values (50 obs.) 5% Signif.	1% Signif.
ADF	-3.3806	-4.22	-4.75	-4.35	-4.94

<u>**RESULT:**</u> **H0 CANNOT BE REJECTED.**

Table XIX, ENGLE AND YOO TEST OF COINTEGRATION

H0: P (INFLATION), Q (RATE OF CHANGE OF TOTAL FACTOR PRODUCTIVITY), AND W (RATE OF GROWTH OF CONSUMER REAL WAGE) ARE NOT COINTEGRATED.

DEPENDENT VARIABLE 26 Q
FROM 66: 2 UNTIL 88: 4
TOTAL OBSERVATIONS 91 SKIPPED/MISSING 0
USABLE OBSERVATIONS 91 DEGREES OF FREEDOM 88
R**2 .07848627 RBAR**2 .05754277
SSR 2519.8869 SEE 5.3511755
DURBIN-WATSON 1.18424499
Q(27)= 38.0865 SIGNIFICANCE LEVEL .765045E-01

NO.	LABEL	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	*******	***	***********	***********	**********
1	CONSTANT	0	.9977927	1.168674	.8537821
2	P	0	-.4008751	.1517550	-2.641594
3	W	0	.6468297E-01	.1930830	.3350009

Augmented Dickey-Fuller Test

DEPENDENT VARIABLE DIFFRESQ
FROM 67: 1 UNTIL 88: 4
TOTAL OBSERVATIONS 88 SKIPPED/MISSING 0
USABLE OBSERVATIONS 88 DEGREES OF FREEDOM 85
R**2 .29882317 RBAR**2 .28232489
SSR 2038.1053 SEE 4.8967039
DURBIN-WATSON 1.94474005
Q(27)= 36.7638 SIGNIFICANCE LEVEL .995609E-01

NO.	LABEL	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	*******	***	***********	***********	***********
1	CONSTANT	0	.5785690E-01	.5221385	.1108076
2	RESQ	1	-.6359761	.1171522	-5.428630
3	DIFFRESQ	1	.7651620E-01	.1073683	.7126520

TEST	Statistic	E.Y. Critical Values (100 obs.) 5% Signif.	E.Y. Critical Values (100 obs.) 1% Signif.	E.Y. Critical Values (50 obs.) 5% Signif.	E.Y. Critical Values (50 obs.) 1% Signif.
ADF	-5.4286	-4.22	-4.75	-4.35	-4.94

<u>RESULT:</u> **H0 IS REJECTED. P, Q, AND W ARE COINTEGRATED.**

Table XX. SIMS' MODIFIED LIKELIHOOD TEST FOR BLOCK EXOGENEITY

H0: P IS EXOGENOUS IN THE VAR SYSTEM.

CHI-SQUARE(17) = 19.95614 SIGNIFICANCE LEVEL .2764788

RESULT: H0 IS REJECTED.

H0: W IS EXOGENOUS IN THE VAR SYSTEM.

CHI-SQUARE(17) = 19.29475 SIGNIFICANCE LEVEL .3118782

RESULT: H0 IS REJECTED.

H0: Q IS EXOGENOUS IN THE VAR SYSTEM.

CHI-SQUARE(17) = 18.10713 SIGNIFICANCE LEVEL .3821129

RESULT: H0 IS REJECTED.

Table XXI. JOHANSEN-JUSELIUS CANONICAL CORRELATION TESTS FOR THE NUMBER OF COINTEGRATING VECTORS

Sample 66: 2 to 88: 4 with 2 lags for series:
P Q W

ORDERED EIGENVALUES:

.2080488	.1089646	.9362544E-01

AND THEIR CORRESPONDING EIGENVECTORS IN EACH COLUMN:

-.3896361	.4285771	.8834499
-1.018761	-.2170588	-.1323254E-02
.1670241	-.7647644	.6471181

# COINT. VECTORS UNDER HO	Trace Test	Critical values(95%)
< 1	39.330*	31.256
< 2	18.803*	17.844
< 3	8.651*	8.083
# COINT. VECTORS UNDER HO	Lambda-max	
< 1	20.526	21.279
< 2	10.153	14.595
< 3	8.651	8.083

Table XXII. PHILLIPS-OULIARIS PRINCIPAL COMPONENTS TEST FOR THE NUMBER OF COINTEGRATING VECTORS

Sample 66: 2 to 88: 4 using lags= 2 , % SIGNIF= 5.0

# COINTEGRATING VECTORS UNDER H0	UPPER BOUND H0: NO COINTEGRATION	TEST RESULT
< 1	.030	H0 IS REJECTED
< 2	.487	H0 CANNOT BE REJECTED
< 3	1.039	H0 CANNOT BE REJECTED
VECTORS UNDER H0	LOWER BOUND H0: COINTEGRATION	
< 1	-.399	CANNOT BE REJECTED
< 2	-.294	CANNOT BE REJECTED
< 3	-.115	CANNOT BE REJECTED

APPENDIX 1

Data: Definitions and Sources

WNIC - average weekly earnings in the commercial sector, dollars per week, seasonally adjusted, from Statistics Canada's Survey of Employment, Payrolls and Hours

RKL - ratio of business capital to total of employed persons

UGDP - Gross Domestic Product, millions of 1981 dollars, seasonally adjusted at annual rates, National Income and Expenditure Accounts

PGDP - GDP price deflator, generated in the Bank of Canada from the National Income and Expenditure Accounts, 1981 = 1.00, seasonally adjusted at annual rates

PCPI - consumer price index, Statistics Canada's Prices Division, 1981 = 1.00, seasonally adjusted

NE - total employed persons excluding armed services. millions of persons, seasonally adjusted, Statistics Canada's Labour Division.

TQ - total factor productivity, defined as:

TQ = (UGDP(T)/NE(T)) * (1/RKL(T)**(1 - (WNIC(T) * NE(T))/ (PGDP(T) * UGDP(T))))

ENTRY	WNIC	RKL	UGDP	PGDP
69: 1	102.952	19.2701	210604.	.381645
69: 2	104.350	19.2798	211748.	.387291
69: 3	106.500	19.7561	214584.	.389666
69: 4	107.790	19.9596	218848.	.393442
70: 1	110.625	20.2967	218504.	.401073
70: 2	112.544	20.5355	217400.	.404710
70: 3	114.231	20.9101	221176.	.407006
70: 4	116.235	21.1116	220912.	.411132
71: 1	118.727	21.4740	222884.	.413560
71: 2	121.746	21.6065	229796.	.417414
71: 3	124.545	21.4446	236684.	.419547

ENTRY	WNIC	RKL	UGDP	PGDP
71: 4	127.501	21.4915	239184.	.425463
72: 1	129.524	21.4910	238420.	.434209
72: 2	132.069	21.5868	244928.	.438611
72: 3	134.738	21.6687	245864.	.444571
72: 4	137.624	21.7754	252552.	.452422
73: 1	140.118	21.3462	260360.	.459472
73: 2	142.156	21.1968	262716.	.473987
73: 3	144.137	21.4069	263604.	.488506
73: 4	147.750	21.2891	270796.	.504306
74: 1	151.496	21.3586	273488.	.524337
74: 2	155.946	21.5540	275072.	.544861
74: 3	162.445	21.6238	276736.	.561329
74: 4	167.393	21.9324	278728.	.573419
75: 1	173.566	22.5293	278432.	.583755
75: 2	178.708	22.7355	281048.	.596638
75: 3	184.571	23.2264	285228.	.613446
75: 4	190.807	23.4602	288040.	.628274
76: 1	196.510	23.5150	294624.	.639826
76: 2	201.927	23.8479	301344.	.657017
76: 3	206.088	24.2926	303416.	.660585
76: 4	211.535	24.7188	303168.	.675428
77: 1	216.746	24.9122	308204.	.683443
77: 2	221.814	24.9645	309360.	.696043
77: 3	226.029	25.0625	311344.	.705702
77: 4	229.919	25.5918	317108.	.712161
78: 1	230.696	25.4634	320172.	.721137
78: 2	235.262	25.3536	324836.	.732222
78: 3	239.420	25.5901	327040.	.748043
78: 4	244.257	25.5183	330956.	.764561
79: 1	248.714	25.3879	334800.	.779474
79: 2	255.285	25.7480	336708.	.808606
79: 3	261.918	25.6700	340096.	.826390
79: 4	265.913	25.5961	341844.	.848633
80: 1	274.184	26.0057	342776.	.866934
80: 2	279.347	26.4893	342264.	.889501
80: 3	286.884	26.7859	340716.	.915531

ENTRY	WNIC	RKL	UGDP	PGDP
80: 4	295.450	26.9321	347780.	.937432
81: 1	304.942	26.8492	354836.	.965235
81: 2	314.275	27.3150	359352.	.987745
81: 3	322.173	28.0412	356152.	1.01314
81: 4	329.963	29.1520	353636.	1.03410
82: 1	340.271	30.0513	349568.	1.05743
82: 2	346.749	31.2782	345284.	1.07748
82: 3	352.096	32.6553	343028.	1.09666
82: 4	359.178	33.5988	340292.	1.11641
83: 1	364.008	33.7137	346072.	1.12303
83: 2	370.817	33.4995	353860.	1.13395
83: 3	376.995	33.4727	359544.	1.14721
83: 4	380.614	33.7811	362304.	1.16059
84: 1	383.997	33.9718	368280.	1.17117
84: 2	386.639	33.8787	376768.	1.17406
84: 3	390.499	33.9134	381016.	1.17795
84: 4	394.199	33.9250	385396.	1.18438
85: 1	396.174	34.0789	390240.	1.18990
85: 2	401.761	33.8864	391580.	1.20625
85: 3	407.151	34.0069	396384.	1.21492
85: 4	410.466	33.9610	405308.	1.21805
86: 1	412.669	33.8083	405680.	1.22408
86: 2	412.524	34.2129	408116.	1.22856
86: 3	414.663	34.4252	409160.	1.23916
86: 4	417.278	34.4988	409616.	1.25368
87: 1	420.477	34.3564	416484.	1.27118
87: 2	423.664	34.3126	422916.	1.28429
87: 3	426.878	34.4968	429980.	1.29600
87: 4	436.557	34.5343	436264.	1.31001
88: 1	439.805	34.8139	440592.	1.32325
88: 2	446.711	34.8676	446680.	1.33219
88: 3	449.653	35.2317	450328.	1.35065
88: 4	452.517	35.7456	453516.	1.36648

ENTRY	PCPI	NE	TQ
69: 1	.389421	7.81533	1440.45
69: 2	.395750	7.85133	1440.83
69: 3	.399595	7.82200	1430.50
69: 4	.403634	7.84400	1439.53
70: 1	.407765	7.86067	1411.07
70: 2	.410423	7.91600	1378.92
70: 3	.411337	7.93267	1374.85
70: 4	.412350	7.97200	1354.08
71: 1	.414000	8.00800	1337.77
71: 2	.419667	8.02333	1367.71
71: 3	.424667	8.14633	1397.95
71: 4	.429333	8.23367	1395.13
72: 1	.434333	8.27733	1383.54
72: 2	.437667	8.30033	1410.49
72: 3	.445667	8.36800	1399.65
72: 4	.451000	8.42867	1419.74
73: 1	.459667	8.61167	1460.75
73: 2	.470000	8.77433	1456.42
73: 3	.481667	8.76033	1448.52
73: 4	.492000	8.89000	1473.52
74: 1	.504667	9.01933	1461.71
74: 2	.520667	9.08167	1446.62
74: 3	.535000	9.16933	1437.46
74: 4	.551000	9.22767	1418.94
75: 1	.563667	9.15533	1391.62
75: 2	.575000	9.26200	1376.46
75: 3	.593000	9.29967	1361.89
75: 4	.606333	9.41300	1345.84
76: 1	.616000	9.45000	1367.73
76: 2	.624667	9.45100	1378.51
76: 3	.631667	9.50133	1356.17
76: 4	.642333	9.51167	1330.72
77: 1	.657333	9.54233	1338.08
77: 2	.672000	9.62600	1329.08
77: 3	.685000	9.68400	1324.64

ENTRY	PCPI	NE	TQ
77: 4	.701667	9.75267	1312.09
78: 1	.715333	9.81167	1322.84
78: 2	.731333	9.94267	1330.24
78: 3	.749000	10.0487	1313.01
78: 4	.761667	10.1393	1320.32
79: 1	.780000	10.2470	1328.25
79: 2	.799333	10.3153	1308.19
79: 3	.814667	10.4370	1310.11
79: 4	.834000	10.5800	1302.64
80: 1	.853333	10.6453	1278.44
80: 2	.876000	10.6423	1253.57
80: 3	.900333	10.6993	1227.95
80: 4	.927000	10.8483	1229.51
81: 1	.957667	10.9770	1243.30
81: 2	.986333	11.0387	1230.95
81: 3	1.01467	11.0360	1189.30
81: 4	1.04100	10.9563	1144.73
82: 1	1.06767	10.8310	1111.05
82: 2	1.09767	10.6727	1070.37
82: 3	1.12100	10.5153	1033.84
82: 4	1.14100	10.4643	1002.11
83: 1	1.14933	10.5163	1010.52
83: 2	1.16300	10.6373	1027.90
83: 3	1.18133	10.7510	1034.18
83: 4	1.19267	10.7957	1028.22
84: 1	1.20833	10.8197	1036.56
84: 2	1.21633	10.8667	1058.23
84: 3	1.22733	10.9997	1056.42
84: 4	1.23733	11.0440	1063.80
85: 1	1.25333	11.0453	1071.79
85: 2	1.26467	11.1880	1068.08
85: 3	1.27633	11.2723	1069.38
85: 4	1.28900	11.3793	1084.36
86: 1	1.30567	11.4917	1079.89
86: 2	1.31400	11.5217	1070.59
86: 3	1.33000	11.5260	1066.17

ENTRY	PCPI	NE	TQ
86: 4	1.34500	11.5920	1059.01
87: 1	1.35867	11.6710	1073.30
87: 2	1.37467	11.8180	1077.48
87: 3	1.39100	11.9050	1081.34
87: 4	1.40200	12.0530	1082.85
88: 1	1.41467	12.1650	1074.78
88: 2	1.42967	12.2300	1082.20
88: 3	1.44633	12.2610	1076.69
88: 4	1.45933	12.3260	1062.99

APPENDIX 2

Consider a moving-average representation of a VAR model

$$MA(q): \quad y_t = X(B)e_t, \; E(e_t e_t^T) = \Sigma,$$

where B is a backward-shift operator. For an appropriate non-singular matrix G, X(B) can be replaced by G X(B) and e by $v = G^{-1} e$. If X(0) is normalized to be the identity matrix, each component of e_t would be the one-step-ahead forecast of the corresponding component of y_t. This representation, however, does not provide an uncontaminated tracing of the effects of a shock to, for example, the inflation rate. The reason is that the covariance matrix Σ is not diagonal, and therefore

$$E(v_t v_t^T)=E(G^{-1}ee^T G^{-1\,T})=E(G^{-1}\Sigma G^{-1\,T}),$$

which implies the innovations v are non-orthogonal. If contemporaneous correlations of innovations were negligible, one could ignore this problem. However, it is often necessary to look at the moving-average representation with orthogonalized innovations. If the matrix G above is chosen so that

$$G^{-1}\Sigma G^{-1\,T} = I$$

then the new innovations v_t satisfy $Ev_t v_t^T = I$. Choleski factorization to orthogonalize innovations chooses a lower triangular G. The problem is that there is a different factorization for each different ordering of the model. As Gordon and King[12] point out, a choice of ordering is equivalent to a choice of a structure for the model. Therefore, conclusions derived from the estimated system depend on an arbitrary choice by the user, unless the choice of ordering proves to be of no significant consequence.

[12] See Gordon and King (1982).

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