Department of Economics
UNIVERSITY OF CANTERBURY
CHRISTCHURCH, NEW ZEALAND

DETERMINANTS OF AGGREGATE DEMAND FOR CIGARETTES IN NEW ZEALAND

ROBIN HARRISON AND JANE CHETWYND

Discussion Paper

No. 9002

Department of Economics, University of Canterbury
Christchurch, New Zealand

Discussion Paper No. 9002

July 1990

DETERMINANTS OF AGGREGATE DEMAND FOR CIGARETTES IN NEW ZEALAND

ROBIN HARRISON
University of Canterbury

and

JANE CHETWYND
Christchurch School of Medicine

DETERMINANTS OF AGGREGATE DEMAND

FOR CIGARETTES IN NEW ZEALAND*

BY

ROBIN HARRISON
UNIVERSITY OF CANTERBURY

AND

JANE CHETWYND
CHRISTCHURCH SCHOOL OF MEDICINE

*This paper was presented to the Seventh World Conference on Tobacco and Health, Perth, Western Australia in April 1990. We wish to acknowledge the assistance provided by Kevin Albertson in extending the database and running the computer analysis, and to note that this research was undertaken without any external funding support.

Address for Correspondence:

Mr Robin Harrison, Department of Economics, University of Canterbury, Christchurch 1, New Zealand.

SUMMARY

This paper extends earlier econometric research Chetwynd et.al. (1988) and Harrison, Chetwynd and Brodie (1989) by updating the database with the last three years' statistics and including an additional variable to examine the influence of the recent anti-smoking advertising campaigns. The results support the conclusions of our earlier work, that:

(i) the industry's advertising does stimulate aggregate consumption (in conflict with the industry's claim that it only redistributes sales between brands);

(ii) cigarettes are not a "luxury" product: sales responsiveness to wage changes is positive but relatively small, with a long run income elasticity of 0.8.

In addition, this study demonstrates that:

(i) the recent anti-smoking advertising campaigns have been effective in reducing cigarette consumption; with sales levels after the campaigns significantly lower than would otherwise have been expected;

(ii) cigarette sales are price responsive but with a relatively low price elasticity. The recent substantial tax increases have reduced levels of cigarette consumption.

(iii) the proposed ban on cigarette advertising would not devastate sales, but could be expected to reduced them by about 30% if the industry did not respond with other promotional activities.

INTRODUCTION

The tobacco industry has consistently argued that their advertising is aimed at brand promotion and does not result in any increase in aggregate demand for their products. They maintain that their advertising is targeted at existing smokers to maintain brand loyalty and encourage brand switching, rather than to attract new smokers or influence existing smokers to smoke more. In contrast, the health professionals argue that tobacco advertising promotes greater use of cigarettes and should be banned.

In recognition of the mounting evidence of the toxicity of tobacco products, most "Western" governments have imposed restrictions on the type of tobacco advertising and promotion, and are contemplating further constraints or total bans. The tobacco companies have been keen to refute any suggestion that their advertising has a positive effect on smoking; hoping to contain or reverse the restrictions. A heated debate[3] has surrounded the validity of research in this area, with the partiality of researchers often brought into question, particularly those funded from the tobacco industry.

Research studies which have sought to resolve the issue empirically has produced some conflicting results. The study by McGuinness and Cowling (1975) of advertising on aggregate cigarette consumption in Britain, demonstrated a positive response. The subsequent METRA report (1979), funded by the tobacco industry, found no evidence of a positive response between changes in quarterly advertising expenditure and quarterly cigarette consumption. However, Redfar (1983) in a study of UK data did find a statistically significant stimulation. In the West German market, Leeflang and Reuijl (1985) found that advertising had a positive effect; but a study of the Australian market by Johnson (1986) failed to find a significant impact. The findings of this paper are therefore the more remarkable for their consistency with the results of the two previous studies of the New Zealand market.

The early study by Chetwynd et al (1988) found that cigarette advertising did have a statistically significant stimulation on aggregate sales, together with a low price effect (elasticity of -.11) and weak income effect (elasticity of +0.5). The econometric methodology of this first study was strongly criticised (Jackson and Ekelund (1989) and in consequence the model was re-evaluated and subjected to stringent statistical tests (Harrison, 1989). The outcome of this re-evaluation was broadly in support of the original model and the conclusions drawn from it; indeed, the revised model displayed a larger stimulation effect for advertising in the long run.

---

[3] The recent issue of the British Journal of Addiction (vol 84, 1989) presents seven articles on the subject together with an editorial review titled Advertising and Smoking - A Smouldering Debate?.

This paper presents results from an econometric investigation of aggregate New Zealand time series data spanning a 17 year period. Inevitably, only non-experimental data are available for this research and this requires particular attention to a number of potential statistical difficulties to ensure that the resulting model is 'congruent' (Hendry, 1989) with the data: a later section of this paper explains the estimation methodology and the battery of diagnostic tests to which the estimated model was subjected. Our examination of the influences on aggregate cigarette sales extends the previous model in two ways. Firstly, by extending the database from which the model is estimated by an additional three years; and, secondly, by including statistics of expenditure on anti-smoking by the New Zealand Health Department and other anti-smoking groups which operated campaigns over the latter part of the study period.

DATA

The database used throughout the analyses is quarterly from 1973 first quarter to 1989 second quarter inclusive; a total of 66 observations. The dependant variable C_t is aggregate sales of cigarettes per person (over 14 years). Actual sales figures for tobacco products are unavailable so the monthly statistics on cigarettes "released from bond" have been used and transformed through a four period moving average to adjust for timing differences between bond release and final point of sale. The earlier studies used a five month moving average and although results from this definition match up closely with those from the four month averaging it was dropped because of fears that the longer time span may induce autocorrelation into the residuals of the regression equation. A graph of the quarterly series is given in Figure 1 below; a downward trend is discernable throughout the eighties.

Each of the explanatory variables measured in monetary terms has been deflated by the official quarterly Consumers Price Index for New Zealand (with a 1980 base year) to yield series in real purchasing power. Cigarette advertising real expenditure (A_t) is in $000 at the 1980 price level (Figure 2); the original data comes from the monthly estimates by the Press Research Bureau of A.C.Nielson using a rate card method. Their sampling includes a comprehensive basket of magazines and newspapers with the rate card method incorporating weighting for readership and audited circulation. Unfortunately it has not been possible to include a broader measure covering all promotional activities by the tobacco companies.

Anti-smoking advertising real expenditure (Z_t) is in $000 at the 1980 price level derived from monthly data supplied by the NZ Health Department. Figure 3 reveals the sporadic nature of the Department's campaigns.

The real wage index (Y_t) has been taken form the official Nominal Wage Index deflated onto the 1980 price base. Figure 4 shows the time series of real wages which failed to grow throughout the sample period and suffered a severe drop in the mid-eighties. This variable was selected rather than a broader based average income variable as it appeared more appropriate to the lower income groups who constitute the majority of cigarette consumers.

The real price of cigarettes (P_t) is taken from the official unpublished statistics on the average price of a packet of 20 cigarettes and deflated onto the 1980 price base (Figure 5). After a long period of real price stability through to the mid-eighties sharp rises followed selective tax increases in the latter part of the sample.

A dummy variable for the introduction of the 10% Goods and Services Tax (GST_t) in 1986 has been constructed for the model to allow for the transition in expenditure patterns associated with this new tax regime. GST applied to many items previously exempt from sales tax (eg. food and clothing), while other items previously heavily taxed (eg. consumer durables) were greatly reduced: consumers reacted to these major price changes by advancing or postponing purchases according to the anticipated tax changes. The variable takes a value of one in the third quarter of 1986 and minus one the following quarter.

A constant and three additive seasonal shift dummies ($Q1_t$, $Q2_t$ and $Q3_t$) were constructed to allow for the possibility of seasonal patterns in the data series. These had been found to be of only marginally statistical significance in the earlier study.

MODEL SPECIFICATION AND INTERPRETATION

The equation reported below in Table 1 presents the results of Instrumental Variables estimation of the demand equation for cigarettes in New Zealand using the entire available sample period from 1973 second quarter to 1989 second quarter inclusive. All the non-dummy variables have been transformed into natural logarithms so the resulting coefficients should be interpreted as elasticities (i.e. proportionate effects).

TABLE 1 Regression Results $\log C_t$ dependent

	IV Estimates	t statistics
Advertising ($\log A_t$)	0.05*	2.08
Anti-Smoking Ads ($\log Z_{t-1}$)	-0.03**	-4.53
Price ($\log P_t$)	-0.22*	-2.60
Income ($\log Y_t$)	0.57**	4.23
Consumption in Previous Quarter	0.29**	2.95
Constant, GST, and Seasonals included		
RSS = 0.135 (note: R^2 invalid for IV estimation)		
DW = 1.79		

Note: * : $p < .05$, ** : $p < .01$

All of the coefficients are of <u>a priori</u> correct signs and magnitudes; furthermore the presence of the lagged value of consumption with a positive coefficient implies a "carry over" effect into the longer term, so the long run effects of the variables will be greater than the short run effects captured in the coefficients given above. Table 2 presents the solved out values of these long run coefficients together with their asymptotic standard errors, the commentary below refers to these figures since they offer the appropriate measures of responsiveness in the immediate and subsequent periods.

The advertising variable shows up as statistically positive at the 5% level of significance; furthermore the recursive evolution of its coefficient (Figure 7) reveals reasonable stability over time. The magnitude of its coefficient is not particularly large when viewed as an elasticity, but when transformed back into levels it can be seen that $1,000 (in 1989 prices) of advertising expenditure results on average in an additional $19,000 of sales, producing about $4,700 of extra revenue to the industry[4]. It is tempting to use the model to compute the consequences for sales of the proposed total ban on advertising. Unfortunately, predictions well outside the range of sample variation suffer from statistical imprecision and functional sensitivity. Nevertheless, the model suggests a decline in sales of about 30%. But these forecasts are conditional on the assumption that the industry does not respond by increasing its permissible promotional activities.

Table 2 Long Run Equation logC dependent

	Long Run Coefficients	Asymptotic Std Errors
Advertising (logA)	0.07*	0.03
Anti-Smoking Ads (logZ)	-0.04**	-0.01
Price (logP)	-0.32**	-0.10
Income (logY)	0.81**	0.17

Note: (a) * : p < .05, ** : p < .01
(b) The asymptotic standard errors computed using the method proposed by Bardsen (1989).

Anti-smoking campaigns appear to have been very effective in reducing cigarette consumption: the coefficient for the anti-smoking variable is very significantly negative. The relative small coefficient reflects the scale of magnitude of the Health Department's expenditure which has averaged only about 2% of that of the industry's advertising expenditure over the sample period. Transforming back into levels to evaluate the campaigns' cost effectiveness implied by this elasticity, shows that $1,000 (in 1989 prices) of anti-smoking advertising expenditure results in about $135,000 reduction in total cigarette sales, costing the industry about $34,000 in revenue[5]. Thus, the Health Department's expenditure on anti-smoking can be seen to

[4] Based on the 1989 second quarter levels of sales and advertising, using the 1989 retail price of NZ$3.97 and a 20% return to the industry after tax and margins.

[5] Based on the 1989 second quarter levels of sales and anti-smoking expenditure using the 1989 retail price of $3.97 and a 20% return to the industry.

have been on average about 7 times more cost effective in reducing smoking than the industry's campaigns were at stimulating smoking activity[6]. Ironically, it is the government's own coffers which suffer the greater magnitude, from tax losses arising from these anti-smoking campaigns. Clearly a potential conflict of interests between government departments which perhaps helps to explain the very modest scale of the anti-smoking campaigns.

The price elasticity of -0.3 is consistent with estimated magnitudes found in overseas studies. The major price increases produced by big tax rises in the latter part of the sample resulted in greater statistical precision of this regression estimate; earlier New Zealand studies had failed to establish this coefficient as significantly different from zero. The Recursive Instrumental Variables estimates (Figure 8) show dramatically the gains in statistical efficiency arising from the recent years data. While cigarette sales may be highly price responsive between brands, at the aggregate level their price responsiveness is relatively low in comparison with other consumer products, reflecting the strong habit characteristic of cigarette smokers. This price elasticity has important policy implications; firstly, its negative value shows that tax increases do have a deterrent effect on smoking activity and, secondly, its inelastic value shows scope for the government to increase its revenue by raising tax rates on cigarettes still further.[7]

The real wage elasticity of 0.81 is significantly positive indicating cigarettes are normal consumption goods, but less than unity showing they are not in the luxury category of consumer goods. This is consistent with the findings of overseas studies.

---

[6] These cost effectiveness calculations have been based on the 1989 values of the series; However, the double logarithm specification of the model implies diminishing returns to expenditure which suggests that cost effectiveness reduces at the higher levels of industry expenditure. Consequently, these measures should be seen as corresponding to cost effectiveness at the margin; the average cost effectiveness figures are higher.

[7]The critical value for the price elasticity would be less than -1.4 for a tax increases to reduce the government's revenue.

Table 3 has been included only to provide a comparison with the OLS estimates of earlier studies. Although some of the diagnostic tests reported in the next section suggest that Instrumental Variables estimation is more appropriate for the extended sample because the price variable shows evidence of simultaneous feedback.

TABLE 3 Comparison With Previous# Regression Results
$\log C_t$ Dependent

	Original	Revised	New OLS##
Advertising ($\log A_t$)	0.07**	0.08**	0.06*
Anti-Smoking Ads ($\log Z_{t-1}$)			-0.02**
Price (P_t)	-0.11	-0.08	-0.39**
Income (Y_t)	0.50**	0.50**	0.52**
GST			0.14**
Consumption in Last Quarter	0.32*	0.35**	0.18*
Constant	2.11*	1.69*	4.60**
First Qtr (Q1)		0.04**	0.05**
Second Qtr (Q2)		0.03*	-0.02
Third Qtr (Q3)		0.06**	0.01
R^2 =	0.50	0.76	0.90
RSS =			0.12
DW =	2.12	1.90	1.50

Note: * : $p < .05$, ** : $p < .01$
The "original" results are from the Chetwynd (1988) paper and the "revised" are from the Harrison (1989) paper.
OLS ignores the endogeneity of price which can bias the estimates and their test statistics, particularly those of the price variable itself.

ESTIMATION METHODOLOGY DIAGNOSTIC TESTING[8]

The Instrumental Variables estimates reported above were derived after pursuing a strategy of tests designed to determine a data congruent model. In particular, attention was paid to the possibility of:

---

[8] All of the regression estimates and tests were computed using the PC-GIVE package written by Hendry (1989). We wish to acknowledge our appreciation to Professor Hendry for maintaining and promoting this state of the art econometric computer software. As a check on computational robustness all estimation was duplicated on TSP386 version 4.1b.

1. simultaneous feedback from consumption back into the regressor variables, and between the advertising variables,
2. equation misspecification arising from errors of omission or function form, and
3. structural breaks within the sample and parameter instability.

EXOGENEITY

The presence of simultaneous feedback can undermine the validity of Ordinary Least Squares, so prior to any estimation, each of the explanatory variables was subjected to Granger's Causality test to examine the null hypothesis of non-causality from consumption in the direction of each of the explanatory variables. The outcomes from these test are presented in Table 4 below; each test was applied using the current and eight lags of the pair of variables. On the basis of these tests only the price variable shows evidence of contemporaneous feedback with consumption. The test on real wages was included for completeness; a significant result would have been most perplexing!

TABLE 4 Granger Causality Tests

Granger test for adding logC to logP,	F(9,39) = 5.09*
Granger test for adding logC to logA,	F(9.39) = 1.45
Granger test for adding logC to logZ,	F(9.39) = 1.63
Granger test for adding logC to logY,	F(9.39) = 1.47
Granger test for adding logA to logZ,	F(9.39) = 0.81
Granger test for adding logZ to logA,	F(9.39) = 1.18

An additional possibility of causality between industry advertising and the anti-smoking variables was suggested (Seldon and Doroodian, 1989), with the industry stimulating its advertising in reaction to the anti-smoking campaigns. However, there was no statistically significant evidence to support this assertion; nor evidence for causality in the other direction, with the anti-smoking campaigns reacting to levels of advertising by the industry.

ESTIMATION

The failure of the price variable to comply with the exogeneity requirement of Ordinary Least Squares, coupled with unsatisfactory diagnostic tests on the OLS residuals, suggested the use of Instrumental Variables estimation which was adopted for all subsequent model building[9]. Throughout the estimation exercise the last four observations were suppressed from the sample to facilitate meaningful post-sample parameter stability testing. Both the levels and the logarithmic forms of the model were estimated throughout the study, although various diagnostic tests pointed consistently towards a preference for the logarithmic. The initial specification utilised all the variables (except GST) together with one lag, the least significant variables were then discarded leaving the core of explanatory variables. Inspection of the diagnostic tests on the residuals revealed unaccepted outliers for the period associated with the introduction of the Goods and Services Tax: this was allowed for in subsequent estimation by including the GST binary variable. The omission of GST did not produce any major changes to the values of the coefficients reported in Table 1.

Clearly, the model is operating at a high level of aggregation and many factors are omitted for lack of available data - the crucial statistical issue is whether such omissions bias the analysis. If their influence is small or uncorrelated with the included variables then valid results are possible. If their influence is neither small nor perfectly correlated with the included variables, then their effects drop into the residuals. It is imperative, therefore, that the residuals should be interrogated for evidence of significant departures from the spherical and normality assumptions. Where an omitted variable is correlated with an included variable part of its influence will be picked up by the included variable, biasing its coefficient (Johnston, 1982). While every attempt has been made to include all likely relevant variables to inhibit such misspecification biases it has been suggested (Boddewyn, 1989) that the coefficient for

[9]Hausman's specification test was applied to examine OLS against IV estimation; the chi(10) = 13.80 failed to reject the exogeneity assumptions of the OLS estimation in contrast with Granger's test: it was decided to persist with Instrumental Variables.

industry's advertising expenditure is upwardly biased by the omission of a measure of industry's other promotional activities. Had such a measured been available, it would have been included: the direction of any induce bias will, however, depend on the sign of the correlation between the two series. In the absence of the data on the other promotions its direction is conjectural; but over this sample period increasing restrictions on advertising may have encouraged the industry to switch into areas of promotion other than print media advertising; this would produce a negative correlation and a downward bias. Thus our model may have underestimated the advertising effectiveness.

While studies such as this can reveal effects at the aggregate level they provide few insights into the distributional effects between segments of society (i.e. differential effects between age groups, the sexes or socio-economic groups). Examination of these features would require detailed cross-sectional data through time.

NON-SPHERICAL DISTURBANCES

The validity of the various test applied to the model is dependent on the distribution of the equation's error terms being spherical and normally distributed (Johnston, 1984). These prerequisites were subjected to rigorous testing for autocorrelation, autoregressive conditional heteroscedastic (ARCH) and normality of the error process. The logarithmic model prove satisfactory on all tests as the following summary shows.

The presence of autocorrelation and partial autocorrelation in the residuals was investigated through the correlogram (Table 5) and by fitting an autoregression (Table 6). No evidence of statistically significant departures from the null of no autocorrelation is apparent.

Table 5 Residual Correlogram

Lag	1	2	3	4	5
Coefficient	0.09	0.03	0.15	0.04	-0.04

Note: Similar results were obtained for longer lag lengths indicating no significant autocorrelation.

Table 6 Residual Autoregressions from lags 1 to 5

Lag	1	2	3	4	5
Coefficient	0.15	0.01	0.13	0.00	-0.08
SE's	0.16	0.16	0.15	0.15	0.15
		chi(5) = 0.055			

Note : Similar results were obtained for longer lag lengths indicating no significant autoregressive errors.

The Lagrange Multiplier test for ARCH errors (Engle, 1982) gave Chi(4) = 2.024 showing no significant autoregressive conditional heteroscedasticity of up to the fourth lag.

Normality of the error process was tested using the statistic proposed by Jarques and Bera (1980) on the null of normality Chi(2) = 0.58; also insignificant. Figure 7 presents the interpolated frequency distribution for the IV residuals which clearly displays the principal characteristics of a normal distribution; being symmetric and free from extreme outliers.

PARAMETER STABILITY

A particularly powerful test of a model's validity is its ability to predict beyond the time span used for its estimation. With this test in mind, the last four observations spanning 1988 third quarter to 1989 second quarter, were suppressed from the initial estimation of the model. Table 7 presents the comparison of the forecasts from the model[10] with the actual values of log consumption over the last four quarters; also included are the prediction errors together with their standard errors and t values. None of the four forecast errors was statistically significant from zero and Chow's F test (Chow, 1960) on the four forecasts taken together gave F(4,50) = 1.01, also indicating insignificance from zero. Thus the model performs well on all the post-sample parameter constancy tests.

[10]Forecasts are produced from the reduced form rather than the structural form of the model which would not allow for the simultaneous feedback arising from the endogeneity of price.

Table 7 Post Sample Parameter Stability Tests

	Actual	Forecast	Error	Forecast SE	t-value
1988 3	6.190	6.171	0.019	0.067	0.29
1988 4	6.228	6.278	-0.049	0.063	-0.78
1989 1	6.183	6.254	-0.071	0.062	-1.14
1989 2	6.055	6.159	-0.104	0.070	-1.48

To assess the stability of the regression coefficients through time the model was estimated by Recursive Instrumental Variables (Harvey, 1981). Graphs showing the evolution of the coefficients are given in Figs 7 to 11 below; each indicates acceptable stability in the coefficients, although the price coefficient only shows as significant in the latter part of the sample when prices exhibited greater movement.

CONCLUSIONS

This study demonstrates robust statistical evidence that the industry's advertising has increased cigarette sales in New Zealand over recent years. The proposed legislation to ban all tobacco advertising and other promotions can be expected to reduce overall sales but not to devastate them.

Anti-smoking campaigns have been shown to be cost effective in reducing sales but their absolute effect on sales has been relatively small because of the very modest funding in comparison with the size of the industry's promotional activities.

The significant price elasticity shows that cigarette consumption is reduced by price increases and that tobacco tax rises have had a definite effect. In addition, the price inelasticity suggests that further real tax rate increases would continue to boost government tax revenue.

REFERENCES

Bardsen, G. (1989), The Estimation of Long Run Coefficients from Error correction Models, forthcoming Oxford Bulletin of Economics and Statistics.

Boddewyn, J.J. (1989), There is No Convincing Evidence for a Relationship Between Cigarette Advertising and Consumption. British Journal of Addiction, 84, pp.1255-1263.

Chetwynd, J., Coope,P., Brodie, R.J., and Wells, E. (1988). Impact of Cigarette Advertising on Aggregate Demand for Cigarettes in New Zealand, British Journal of Addiction, 83, pp.409-414.

Chetwynd, J., Brodie, R.J. and Harrison, R.W. (1989). The Influence of Advertising on Tobacco Consumption: a reply to Boddewyn. British Journal of Addiction, 84, pp1263-1266.

Chow, G.C. (1960), Tests of Equality Between Sets of Coefficients in Two Linear Regressions, Econometrica, 28, pp591-605.

Engle, R.F. (1982), Autoregressive Conditional Heteroscedasticity, with Estimates of the Variance of United Kingdom Inflations, Econometrica, 50, pp987-1008.

Granger, C. (1969). Investigating the Causal Relations by Econometric Models and Cross-Spectral Methods, Econometrica, 37, pp.424-438.

Harrison, R.W., Chetwynd, J. and Brodie, R.J. (1989), The Influence of Advertising on Tobacco Consumption: A Reply to Jackson and Ekelund, British Journal of Addiction, 84, pp1251-1254.

Hausman, J.A. (1978), Specification Tests in Econometrics, Econometrica, 50, pp1251-1271.

Harvey, A. (1981), The Econometric Analysis of Time Series, (Oxford, Philip Allan)

Hendry, D.F. (1989), PC-GIVE :An Interactive Econometric Modelling System, (Oxford, Institute of Economics and Statistics).

Jackson, J.D. and Ekelund, R.B. (1989), The Influence of Advertising on Tobacco Consumption: some problems with Chetwynd et al's analysis, British Journal of Addiction, 84, pp1247-1250.

Jarque, C.M. and Bera, A.K. (1980), Efficient Tests of Normality, Homoscedasticity and Serial Independence of Regression Residuals, Economic Letters, 6, pp.255-259.

Johnson, L.W. (1986), Advertising and Aggregate Demand for Cigarettes in Australia. International Journal of Advertising, 5, pp45-58.

Johnston, J. (1984), Econometric Methods, 3rdEd.,(New York, McGraw-Hill

Leeflang, P.S.H. and Reuijl, J.C. (1985), Advertising and Industry Sales: An Empirical Study of the West German Cigarette Market, Journal of Marketing, 49, pp92-98.

McGuinness, T. and Cowling, K. (1975), Advertising and the Aggregate Demand for Cigarettes, European Economic Review, 6, pp311-328.

Radfar, M. (1983), the Effect of Advertising on Total Consumption of Cigarettes in the U.K., Working Paper No. 3, Department of Economics, City of London Polytechnic.

Ramsey, R.J. and Schmidt, P. (1976), Some further results on the use of OLS and BLUS residuals in specification error tests, Journal of the American Statistical Association, 71, pp 389- 90.

Seldon, B.J. and Doroodian, K. (1989), A Simultaneous Model of Cigarette Advertising Effects on Demand and Industry Response to Public Policy, The Review of Economics and Statistics, 71, pp673-677.

Figure 1 C: Consumption of Cigarettes per Adult

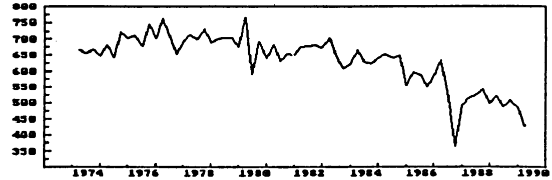


Figure 2 A: Real Expenditure on Advertising

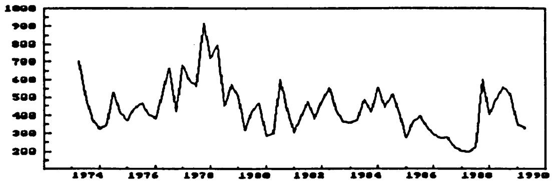


Figure 3 Z: Real Expenditure on Anti-Smoking

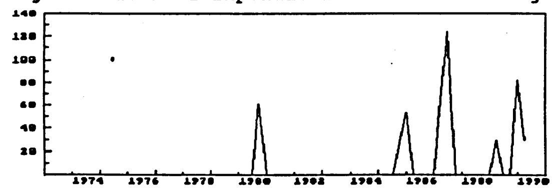


Figure 4 Y: Real Wage Index

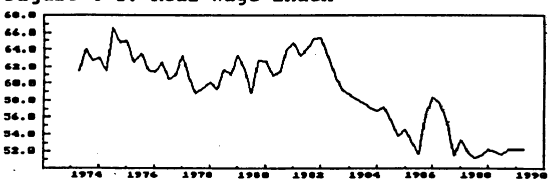


Figure 5 P: Real Price of 20 Cigarettes

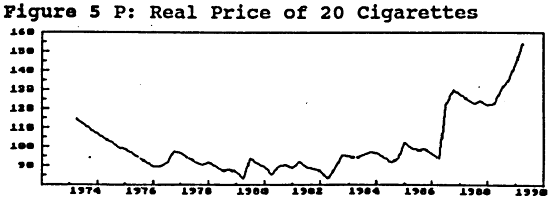


Figure 6 Interpolated Density Function For Instrumental Variables Residuals

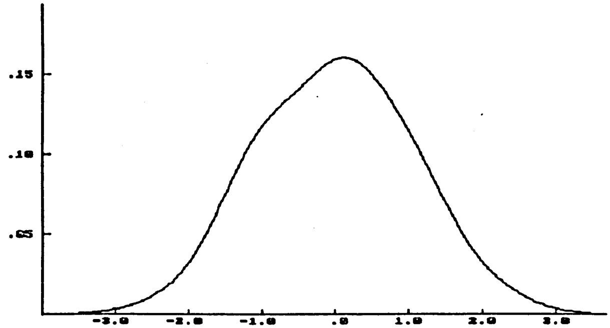


Figure 7 Recursive Instrumental Variables Coefficient for logA

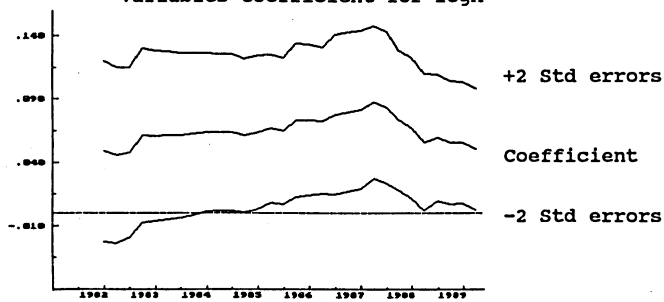


Figure 8 Recursive Instrumental Variables Coefficient for logZ

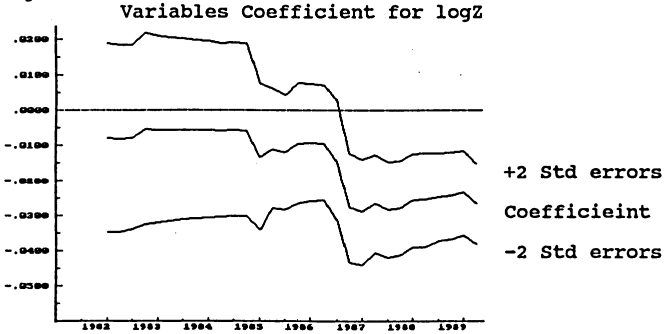


Figure 9 Recursive Instrumental Variables Coefficient for logY

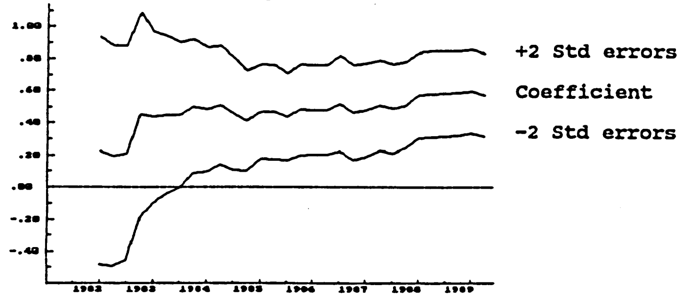


Figure 10 Recursive Instrumental Variables Coefficient for logP

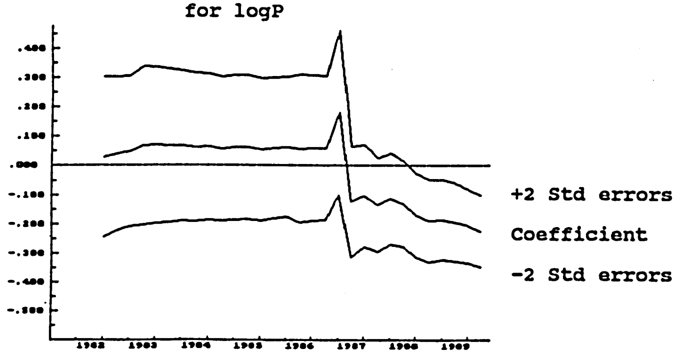
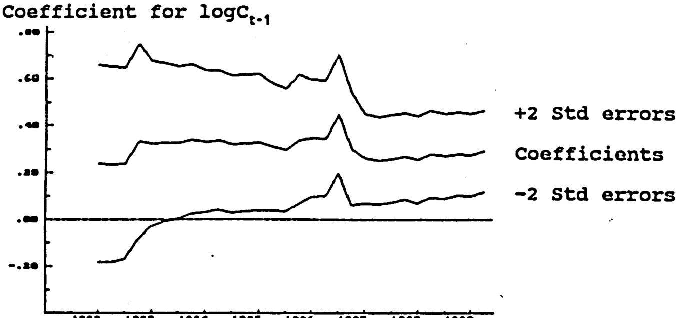


Figure 11
Recursive Instrumental Variables Coefficient for $\log C_{t-1}$



LIST OF DISCUSSION PAPERS*

No. 8401 Optimal Search, by Peter B. Morgan and Richard Manning.

No. 8402 Regional Production Relationships During the Industrialization of New Zealand, 1935-1948, by David E. A. Giles and Peter Hampton.

No. 8403 Pricing Strategies for a Non-Replenishable Item Under Variable Demand and Inflation, by John A. George.

No. 8404 Alienation Rights in Traditional Maori Society, by Brent Layton.

No. 8405 An Engel Curve Analysis of Household Expenditure in New Zealand, by David E. A. Giles and Peter Hampton.

No. 8406 Paying for Public Inputs, by Richard Manning, James R. Markusen, and John McMillan.

No. 8501 Perfectly Discriminatory Policies in International Trade, by Richard Manning and Koon-Lam Shea.

No. 8502 Perfectly Discriminatory Policy Towards International Capital Movements in a Dynamic World, by Richard Manning and Koon-Lam Shea.

No. 8503 A Regional Consumer Demand Model for New Zealand, by David E. A. Giles and Peter Hampton.

No. 8504 Optimal Human and Physical Capital Accumulation in a Fixed-Coefficients Economy, by R. Manning.

No. 8601 Estimating the Error Variance in Regression After a Preliminary Test of Restrictions on the Coefficients, by David E. A. Giles, Judith A. Mikolajczyk and T. Dudley Wallace.

No. 8602 Search While Consuming, by Richard Manning.

No. 8603 Implementing Computable General Equilibrium Models: Data Preparation, Calibration, and Replication, by K. R. Henry, R. Manning, E. McCann and A. E. Woodfield.

No. 8604 Credit Rationing: A Further Remark, by John G. Riley.

No. 8605 Preliminary-Test Estimation in Mis-Specified Regressions, by David E. A. Giles.

No. 8606 The Positive-Part Stein-Rule Estimator and Tests of Linear Hypotheses, by Aman Ullah and David E. A. Giles.

No. 8607 Production Functions that are Consistent with an Arbitrary Production-Possibility Frontier, by Richard Manning.

No. 8608 Preliminary-Test Estimation of the Error Variance in Linear Regression, by Judith A. Clarke, David E. A. Giles and T. Dudley Wallace.

No. 8609 Dual Dynamic Programming for Linear Production/Inventory Systems, by E. Grant Read and John A. George.

No. 8610 Ownership Concentration and the Efficiency of Monopoly, by R. Manning.

No. 8701 Stochastic Simulation of the Reserve Bank's Model of the New Zealand Economy, by J. N. Lye.

No. 8702 Urban Expenditure Patterns in New Zealand, by Peter Hampton and David E. A. Giles.

No. 8703 Preliminary-Test Estimation of Mis-Specified Regression Models, by David E. A. Giles.

No. 8704 Instrumental Variables Regression Without an Intercept, by David E. A. Giles and Robin W. Harrison.

No. 8705 Household Expenditure in Sri Lanka: An Engel Curve Analysis, by Mallika Dissanayake and David E. A Giles.

No. 8706 Preliminary-Test Estimation of the Standard Error of Estimate in Linear Regression, by Judith A. Clarke.

No. 8707 Invariance Results for FIML Estimation of an Integrated Model of Expenditure and Portfolio Behaviour, by P. Dorian Owen.

No. 8708 Social Cost and Benefit as a Basis for Industry Regulation with Special Reference to the Tobacco Industry, by Alan E. Woodfield.

No. 8709 The Estimation of Allocation Models With Autocorrelated Disturbances, by David E. A. Giles.

No. 8710 Aggregate Demand Curves in General-Equilibrium Macroeconomic Models: Comparisons with Partial-Equilibrium Microeconomic Demand Curves, by P. Dorian Owen.

No. 8711 Alternative Aggregate Demand Functions in Macro-economics: A Comment, by P. Dorian Owen.

No. 8712 Evaluation of the Two-Stage Least Squares Distribution Function by Imhof's Procedure by P. Cribbett, J. N. Lye and A. Ullah.

No. 8713 The Size of the Underground Economy: Problems and Evidence, by Michael Carter.

(Continued on back cover)

No. 8714 A Computable General Equilibrium Model of a Fisherine Method to Close the Foreign Sector, by Ewen McCann and Keith Mclaren.

No. 8715 Preliminary-Test Estimation of the Scale Parameter in a Mis-Specified Regression Model, by David E. A. Giles and Judith A. Clarke.

No. 8716 A Simple Graphical Proof of Arrow's Impossibility Theorem, by John Fountain.

No. 8717 Rational Choice and Implementation of Social Decision Functions, by Manimay Sen.

No. 8718 Divisia Monetary Aggregates for New Zealand, by Ewen McCann and David E. A. Giles.

No. 8719 Telecommunications in New Zealand: The Case for Reform, by John Fountain.

No. 8801 Workers' Compensation Rates and the Demand for Apprentices and Non-Apprentices in Victoria, by Pasquale M. Sgro and David E. A. Giles.

No. 8802 The Adventures of Sherlock Holmes, the 48% Solution, by Michael Carter.

No. 8803 The Exact Distribution of a Simple Pre-Test Estimator, by David E. A. Giles.

No. 8804 Pre-testing for Linear Restrictions in a Regression Model With Student-t Errors, by Judith A. Clarke.

No. 8805 Divisia Monetary Aggregates and the Real User Cost of Money, by Ewen McCann and David Giles.

No. 8806 The Management of New Zealand's Lobster Fishery, by Alan Woodfield and Pim Borren.

No. 8807 Poverty Measurement: A Generalization of Sen's Result, by Prasanta K. Pattanaik and Manimay Sen.

No. 8808 A Note on Sen's Normalization Axiom for a Poverty Measure, by Prasanta K. Pattanaik and Manimay Sen.

No. 8809 Budget Deficits and Asset Sales, by Ewen McCann.

No. 8810 Unorganized Money Markets and 'Unproductive' Assets in the New Structuralist Critique of Financial Liberalization, by P. Dorian Owen and Otton Solis-Fallas.

No. 8901 Testing for Financial Buffer Stocks in Sectoral Portfolio Models, by P. Dorian Owen.

No. 8902 Provisional Data and Unbiased Prediction of Economic Time Series by Karen Browning and David Giles.

No. 8903 Coefficient Sign Changes When Restricting Regression Models Under Instrumental Variables Estimation, by David E. A. Giles.

No. 8904 Economies of Scale in the New Zealand Electricity Distribution Industry, by David E. A. Giles and Nicolas S. Wyatt.

No. 8905 Some Recent Developments in Econometrics: Lessons for Applied Economists, by David E. A. Giles.

No. 8906 Asymptotic Properties of the Ordinary Least Squares Estimator in Simultaneous Equations Models, by V. K. Srivastava and D. E. A. Giles.

No. 8907 Unbiased Estimation of the Mean Squared Error of the Feasible Generalised Ridge Regression Estimator, by V. K. Srivasatva and D. E. A. Giles.

No. 8908 An Unbiased Estimator of the Covariance Matrix of the Mixed Regression Estimator, by D. E. A. Giles and V. K. Srivastava.

No. 8909 Pre-testing for Linear Restrictions in a Regression Model with Spherically Symmetric Disturbances, by Judith A. Giles.

No. 9001 The Durbin-Watson Test for Autocorrelation in Nonlinear Models, by Kenneth J. White.

No. 9002 Determinants of Aggregate Demand for Cigarettes in New Zealand, by Robin Harrison and Jane Chetwyd.

* Copies of these Discussion Papers may be obtained for $4 (including postage, price changes occasionally) each by writing to the Secretary, Department of Economics, University of Canterbury, Christchurch, New Zealand.