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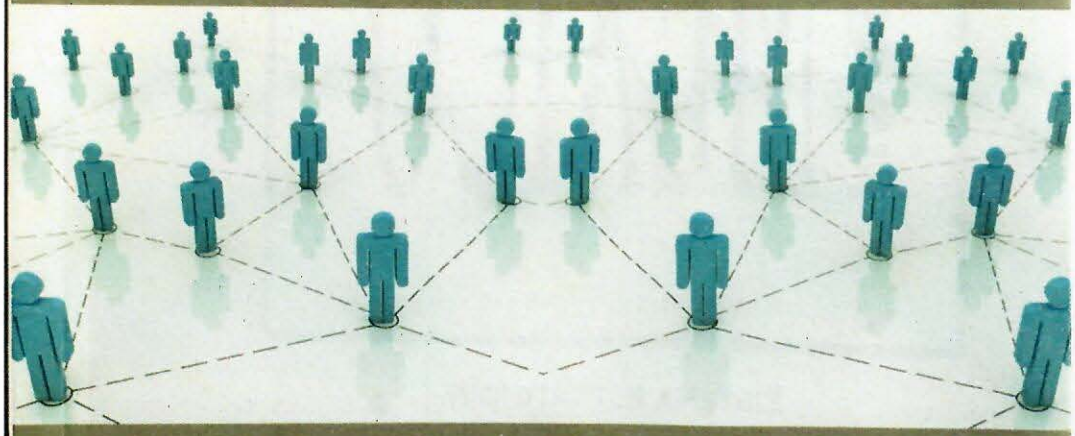

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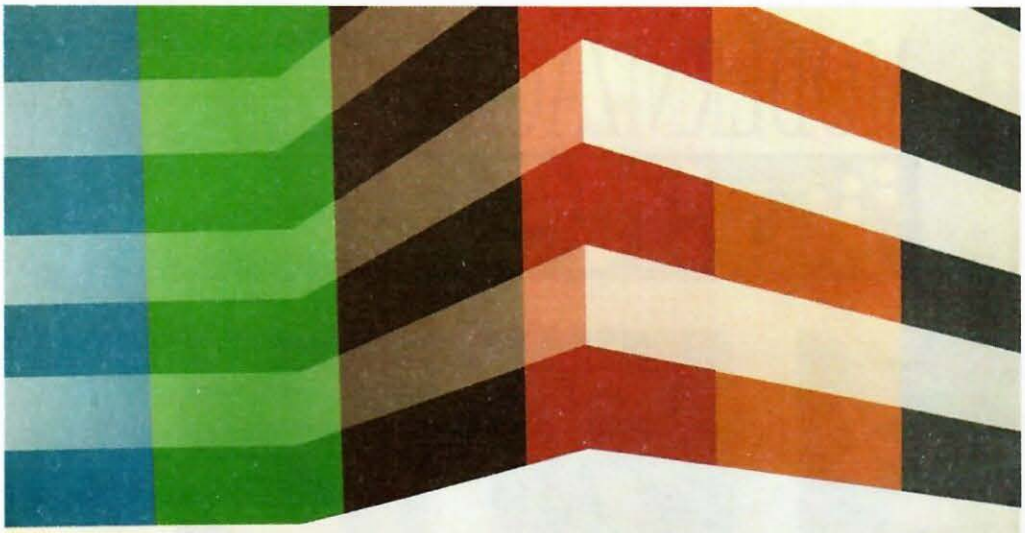

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Sector Strategies for Latin America and the Caribbean

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Y EL PLAN NACIONAL DE DESARROLLO

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MATHEMATICS AND COMPUTERS IN SIMULATION

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Testing for multivariate normality in simultaneous equations models

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Sample Splitting and Applied Econometric Modeling

by

Carlos M. Jarque

Reprinted from
Journal of Business & Economics Statistics, Vol. 5, No. 2, April 1987, pp. 267–27

"México al inicio de la última década del siglo XX"*

*Palabras del Dr. Carlos M. Jarque dirigidas a los mandos medios del Instituto

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SERIE DE DOCUMENTOS DE INVESTIGACION

LOS FACTORES DE LA PRODUCCION EN MEXICO UN ESTUDIO EMPIRICO

Carlos M. Jarque

México, 1994

Número 2

INSTITUTO NACIONAL DE ESTADISTICA
GEOGRAFIA E INFORMATICA

Journal of Econometrics 36 (1987) 31–53. North-Holland

AN APPLICATION OF LDV MODELS TO HOUSEHOLD EXPENDITURE ANALYSIS IN MEXICO*

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In this paper Mexican household survey data is used to estimate the Extended Linear Expenditure System. The estimation is carried out taking into account the non-negative nature of expenditures through the use of *Limited Dependent Variable* (LDV) models. Substantial differences are found in estimated demand responses between OLS and MLE on the LDV models. If the latter estimation procedure is taken as appropriate the findings show that commonly used OLS results may significantly overestimate the marginal propensity to consume and may considerably underestimate subsistence expenditures.

1. Introduction

In this paper we present a *cross-sectional* study of expenditure behaviour at the household level. This type of study is one of the oldest exercises in applied econometrics [Brown and Deaton (1972)]. However, we concentrate on Mexico for which little work has been done in this area. Moreover, our econometric methodology differs in some respects from traditional approaches. *Firstly*, we apply multivariate clustering algorithms to form groups of households with 'homogeneous' expenditure behavior. *Secondly*, we take into consideration the fact that expenditures are non-negative and therefore use Limited Dependent Variable (LDV) models, carrying out a comprehensive statistical analysis of disturbances, e.g., testing for the normality and homoscedasticity assumptions of disturbances of the LDV models used.

The structure of the paper is as follows. In section 2 we present the model considered and in section 3 the econometric methodology employed. In section 4 we describe the data used for estimation. The main numerical results are presented in section 5. The paper ends with section 6, where we give a summary of our principal findings and make some concluding remarks.

2. The extended linear expenditure system

The model we apply is the *Extended Linear Expenditure System* (ELES). A feature of this system is its linearity, which may not be an appropriate specification for many cases. Also, the utility function from which it is derived is directly additive and, as shown in Deaton (1974, 1975), this is an extremely

*Financial support from a Fulbright Research Scholarship is acknowledged. The author is grateful to the participants of the Harvard/MIT Econometrics Seminar for helpful comments.

A Solution to the Problem of Optimum Stratification in Multivariate Sampling

BY

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Journal of Official Statistics
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Statistics, Democracy and Development[1]

Carlos M. Jarque[2]

Abstract: Systematized information on the physical environment and its inhabitants helps to identify the needs of people and to measure the potential of any society. This is particularly relevant in the current global context where we are witnessing immense changes in the architecture of the world. Countries of all latitudes and organizations of all types have entered into processes of transformation, leading to their modernization. In Mexico, a wide-ranging reform gave rise to new demands for statistical and geographical information. Measures were taken to prepare the national information system to face the traditional and the new challenges. A modernization program for INEGI, Mexico's central statistical, geographical and informatics office was designed and implemented. This program comprises seven areas: decentralization, infrastructure, methodology, training, coordination, new products, and actions to promote a broader statistical culture among the population. The contributions of INEGI's modernization program to the accomplishment of the national goals are briefly noted. A solid and updated information system promotes the extension of democratic participation and practices, helps in the design of policies aimed to promote economic development, and to improve people's living standards. It is concluded that, although statistical activities are technically and scientifically interesting, its fullest nobility may be found in helping nations provide justice and better well-being to their inhabitants.

Key words: Official statistics; world transformation; institutional modernization; National Information system; decentralization; infrastructure; methodology; training; new products, statistical culture; democracy; development; national goals.

1. Introduction

In this paper, I will concentrate on several aspects of Official Statistics and its contributions to democracy and socio-economic development. The objective is to reflect on the purpose of Official Statistics, the resources allocated to it, and the benefits derived from this investment.

As it is known, the consistent reduction of financial resources in some regions, both in Official Statistics and in areas of statistical research and teaching, has become a point of increasing concern to the statistical profession. Hence, it is believed that, among other actions, the promotion of the role of statisticians, highlighting the useful work and positive contributions to modern society will help to motivate further interest in statistics and statisticians. The arguments

[1] This paper is a modified version of a lecture given at the plenary session of the 49th ISI meeting held in Cairo, Egypt, in September 1991. The lecture was dedicated to the memory of Dr. Prasanta Mahalanobis, former President of the Indian Statistical Institute and Honorary President of the ISI.

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Austral. J. Statist., **23** (2), 1981, 159–163

A TEST FOR HETEROSCEDASTICITY IN A LIMITED DEPENDENT VARIABLE MODEL[1]

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Summary

Limited Dependent Variable models arise, for example, when the dependent variable is necessarily non-negative. When these models are estimated under the incorrect assumption of homoscedasticity, serious consequences have been found. It is therefore important to test for its existence. In this paper, we make use of the Lagrange multiplier procedure to derive a test for heteroscedasticity in the Tobit model.

1. Introduction

The Tobit model was originated by Tobin (1958) in the study of household durable expenditure. After being in, as noted by Dhrymes (1979), "(nearly) splendid isolation for over a decade" it has recently been applied in many other areas of socioeconomic research (e.g. see Fair, 1978). This current popularity extends to other models in which the dependent variable is restricted to lie in a particular interval or to take a finite number of values (e.g. see the Fall 1976 issue of the *Annals of Economic and Social Measurement*). Models of this sort have come to be known as Limited Dependent Variable (LDV) models.

In the various applications of LDV models, constant error variance has been specified. The consequences of incorrectly assuming homoscedasticity have been pointed out by various authors. For example, Hurd (1979) showed (for a simple model) that the maximum likelihood estimators of the parameters, computed under the incorrect assumption of homoscedasticity, were not consistent. He also found that the size of the asymptotic bias could be substantial and concluded that "heteroscedasticity may be a serious empirical problem in truncated sample models". A similar result was obtained by Maddala & Nelson (1975) who considered the Tobit estimator and noted this was not consistent when a specified form of heteroscedasticity was present. An additional finding is that of Warner (1976) who carried out a Monte Carlo Experiment to study the sensitivity of three estimators of

[1] Manuscript received July 14, 1980; revised September 10, 1980.

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A Test for Normality of Observations and Regression Residuals

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Summary

Using the Lagrange multiplier procedure or score test on the Pearson family of distributions we obtain tests for normality of observations and regression disturbances. The tests suggested have optimum asymptotic power properties and good finite sample performance. Due to their simplicity they should prove to be useful tools in statistical analysis.

Key words: Lagrange multiplier test; Normality test; Regression model; Score test.

1 Introduction

Statisticians' interest in fitting curves to data goes a long way back. As noted by Ord (1972, p. 1), although towards the end of the nineteenth century 'not all were convinced of the need for curves other than the normal' (K. Pearson, 1905), 'by the turn of the century most informed opinion had accepted that populations might be non-normal'; some historical accounts are given by E. S. Pearson (1965). This naturally led to the development of tests for the *normality of observations*. Interest in this area is still very much alive, and recent contributions to the literature are the skewness, kurtosis and omnibus tests proposed by D'Agostino & Pearson (1973), Bowman & Shenton (1975) and Pearson, D'Agostino & Bowman (1977), the analysis of variance tests of Shapiro & Wilk (1965) and Shapiro & Francia (1972), and the coordinate-dependent and invariant procedures described by Cox & Small (1978).

There has also been considerable recent interest in testing the *normality of (unobserved) regression disturbances*. This is noted below, but first we introduce necessary notation. We consider the linear regression model, $y_i = x_i'\beta + u_i$, for $i = 1, \ldots, N$, where x_i' is a 1 by K vector of observations on K fixed regressors, β is a K by 1 vector of unknown parameters, and u_i is the ith unobservable disturbance assumed to have zero mean and to be homoscedastic, identically distributed and serially independent. An additional assumption frequently made in this model is that the probability density function of u_i, $f(u_i)$, is the normal probability density function.

The consequences of violation of this normality assumption have been studied by various authors. In estimation, for instance, the ordinary least-squares estimator $b = (X'X)^{-1}X'y$, which is known to be efficient under normality, may be very sensitive to long-tailed distributions; for example, see Hogg (1979). Regarding inferential procedures, Box & Watson (1962) consider the usual t and F-tests, and demonstrate that sensitivity to nonnormality is determined by the numerical values of the regressors. They also show that, to obtain the desired significance level, some adjustment in the degrees of freedom of these tests may be required. Similarly, Arnold (1980) studies the distribution of

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MODEL SPECIFICATION TESTS

A Simultaneous Approach*

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Secretaria de Programacion y Presupuesto, Mexico

In econometrics, specification tests have been constructed to verify the validity of one specification at a time. It is argued that most of these tests are not, in general, robust in the presence of other misspecifications, so their application may result in misleading conclusions. Using the Lagrange Multiplier principle we develop efficient test procedures that are capable of testing a number of specifications simultaneously. These tests will 'confirm' the validity (or invalidity) of a general model requiring the estimates of the restricted model only. Through an extensive Monte Carlo experiment we study the performance of these tests and some commonly used one-directional tests. We also suggest a Multiple Comparison Procedure, to identify different sources of errors. This, we hope, will lead to a better specification of econometric models.

> *At the moment, the set of specification error tests is a ragbag of miscellaneous procedures. The chief difficulty occurs with the presence of more than one error and with the resulting problem of how to isolate and identify the separate effects.*
> Kmenta and Ramsey (1980, p. 11)

1. Introduction

One of the most important components of econometric model-building is tests for specification errors. A model can be misspecified in a number of ways. Two *major* sources are incorrect functional form and invalid assumptions on the distribution of the disturbance term. Regarding the functional form, linearity is often assumed for simplicity when a nonlinear function would be more appropriate, and this may be accompanied by

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EFFICIENT SPECIFICATION TESTS FOR LIMITED DEPENDENT VARIABLE MODELS

Carlos M. JARQUE and Anil K. BERA

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The procedure of Jarque and Bera (1980a, b), consisting of the application of the Lagrange Multiplier (*LM*) test to the Pearson Family of distributions, is used to derive efficient normality and/or homoscedasticity tests for limited dependent variable (*LDV*) models.

1. Introduction

LDV models arise when the dependent variable is restricted in some way (e.g., to non-negative values – like supply of and demand for given goods). These models are now being increasingly used in economic modelling, and methods for their efficient estimation – given a set of assumptions – are presently available (e.g., see the Fall 1976 issue of the *Annals of Economic and Social Measurement*). In comparison, few results exist regarding inferential problems. In previous papers we have suggested the use of the *LM* test on a general Family of distributions – the Pearson Family [1] – to derive simple diagnostic tests which have maximum asymptotic local power and are therefore efficient [see Jarque and Bera (1980a, b) and Bera and Jarque (1981)]. In this paper, using the same approach, we derive tests for residual specification in *LDV* models. Here the presentation is made for the Tobit model (section 2) and the Truncated model (section 3), but our approach has more general applicability.

[1] We have also used other families such as Gram–Charlier (type A), and obtained the same test statistics as with the Pearson Family. This makes our tests more appealing.

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Assisting victims in natural disasters:

THE MEXICAN APPROACH

Carlos M. Jarque

Información, Desarrollo Sustentable y Hábitat

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CARLOS M. JARQUE
y LUIS TELLEZ K.

EL COMBATE A LA INFLACIÓN

Presentación
de
Rudiger
Dornbusch

EL ÉXITO DE LA FÓRMULA MEXICANA

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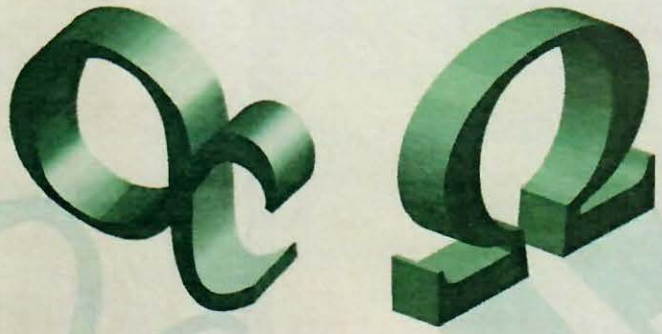
Urbanización, Transporte y Población en el Area Metropolitana de la Ciudad de México



Palabras del Dr. Carlos M. Jarque, Presidente del INEGI, Pronunciadas Durante el Acto de Presentación de los Resultados de la Encuesta de Urbanización, Transporte y Población en el Area Metropolitana de la Ciudad de México

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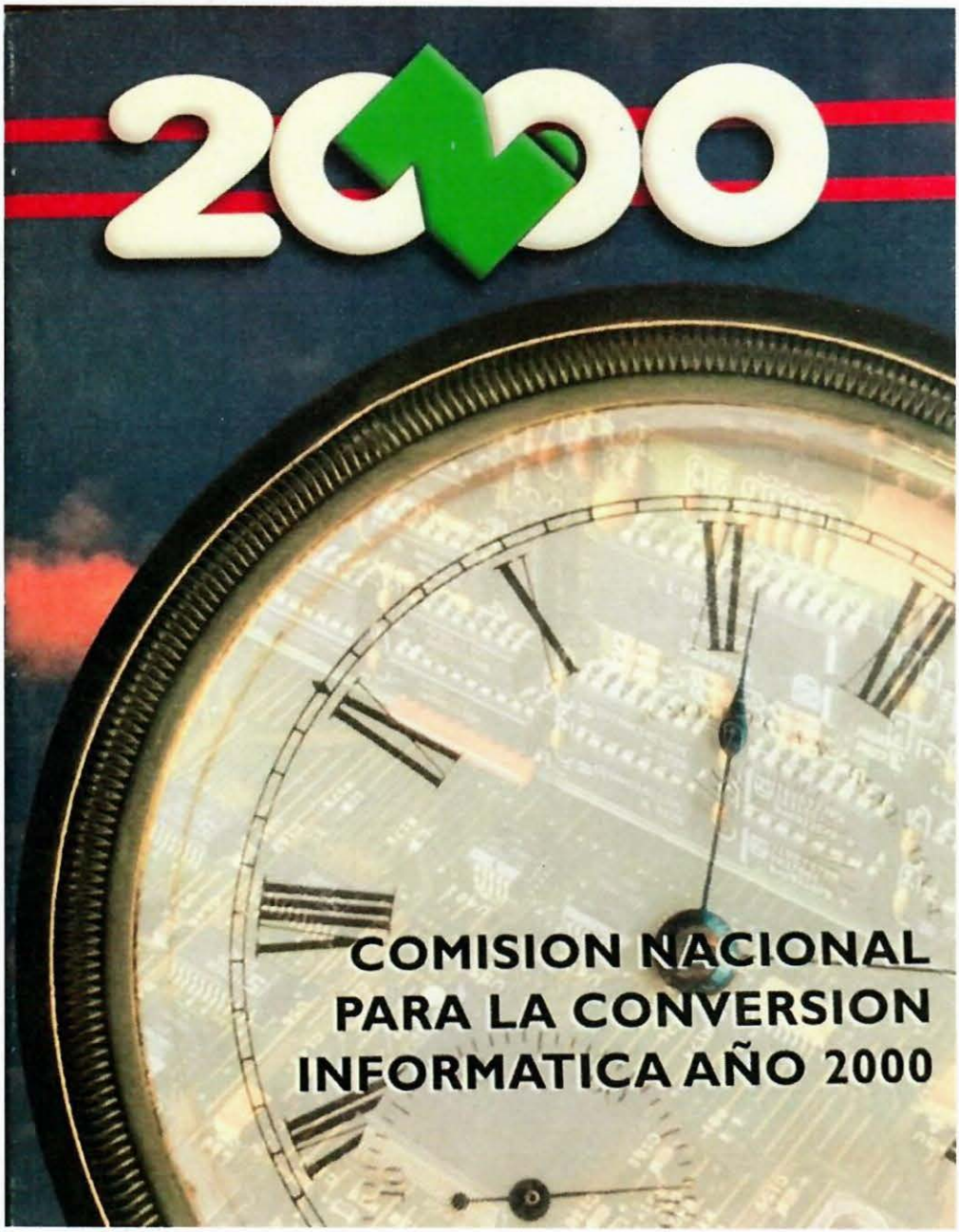
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