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Abstract

This paper is a contribution to the memory of A.W.H. (Bill) Phillips, drawing on the authors' personal recollections of Bill as a teacher and colleague, and also presenting links between Bill's research in econometrics and some more recent econometrics literature. Particular topics mentioned are: models of wage and price determination; control theory; exogeneity; moving average errors in dynamic models; and continuous time econometric models.

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1 Introduction

It is a privilege to contribute to the memory of A.W.H. (Bill) Phillips in this volume. We both knew Bill as a teacher and later colleague, so we commence our section with some personal recollections of our first acquaintanceships. Then we turn to a consideration of the many ways in which Phillips influenced econometrics, focusing on three main aspects (control theory, moving-average errors in dynamic models, and exogeneity). For a recent brief history of the development of dynamic modelling at LSE, including Phillips's role in this, see Mizon (1995); also, Rex Bergstrom relates his work to that of Bill Phillips and notes the stimulus he received in Phillips (1993).

2 Personal recollections

2.1 Initial contacts

GEM first became aware of Bill Phillips when he visited the Economists' Bookshop following an interview at the London School of Economics for admission to the undergraduate BSc(Econ) degree course. Having previously studied economics from a single textbook in school, he was overwhelmed by the vast array of economics books, arranged not only alphabetically but by subdiscipline. Looking for an inexpensive and less daunting purchase, he came across a section containing very short pamphlets and published versions of public lectures. From this section, he found a copy of an inaugural lecture entitled 'Employment, Inflation and Growth' (Phillips, 1962). The combination of subject matter and price attracted him, and so he was soon reading and learning from Bill Phillips. Topics covered in this lecture included: discussion of the role of econometric models in economic policy analysis, emphasis on the value of feedback control mechanisms using proportional, derivative and integral controls in economic analysis, and interpretations and modifications to the 'Phillips curve' of Phillips (1958), which was to play an important role in macroeconomics during the 1960s and 1970s. During his subsequent studies at LSE, GEM began to realise the importance of the material in this lecture. Also GEM has a vivid memory of listening, at the end of the first year of his studies when

Phillips and Bergstrom ran a meeting describing the statistics and econometrics courses that were available to second and third year students, to two quietly spoken, neatly dressed, New Zealanders concisely explain the regulations concerning econometrics-based degrees, and describe without embellishment the content of the courses that they were to teach. They presented the case for following their courses in the way that they knew best, by their quiet enthusiasm. In the years that followed, GEM for one has rarely regretted following that path, and Pravin K. Trivedi (a contemporary of GEM as a student at the School) recently confirmed in personal conversation that Phillips's infectious enthusiasm for econometrics was also an important factor in his career choice.

In addition to having direct contact with Phillips in the econometrics courses, GEM's attention was drawn to his contributions to economics by reading R.G.D. Allen's *Mathematical Economics* (Allen, 1963), a recommended text for mathematical economics courses at the time. Chapter 3 on the acceleration principle contained an exposition of material from Phillips (1954). The importance of dynamics in economic models was highlighted by the discussion of the time form of lagged responses in chapter 8, based on Phillips (1957). Chapter 9 provided an introduction to basic ideas in the theory of economic regulation, the use of control theory – including feedback control via proportional, derivative, and integral control mechanisms – and the characterization of economic systems in flow diagrams, which had their physical counterpart in the Phillips hydraulic machine. Indeed, Frank Paish's lectures, as a part of an applied economics course, were given in a room with the Phillips hydraulic model of the linkages of stocks and flows in the economy hidden under a dust cover. The implicit contrast between the application of control theory to dynamic economic systems patiently awaiting its time, and the less formal intuitive understanding of market interactions, which via a cylindrical slide rule was made more numerically concrete, was striking.

DFH first met Bill Phillips at the LSE in 1966, and had the stimulating experience of being taught by him as an MSc student. The Phillips curve was already a famous concept and that paper (Phillips, 1958) was mandatory reading on the Quantitative Economics course, albeit jointly with Sargan (1964) (Denis ran that option!). DFH had also heard of the Phillips machine, although not witnessed it in action, so Phillips was a decidedly 'big name'.

Notwithstanding his fame, Phillips was a kindly and helpful person, if very private and shy. He was always encouraging one to persevere, despite all the obvious difficulties one could see. The warmth and sympathy that exuded from Phillips in his teaching relationship with students did not override the impression of a mysterious character. Whether the mystery resulted from his reaction to earlier episodes in his life (particularly being held as a prisoner of war by the Japanese) we can only conjecture. Max Steuer suggested to us that it was partly due to Phillips having come to social science through sociology – but never feeling at home there – so he was mainly self-taught in economics. His one real teacher was James Meade (who unfortunately died late last year), who quickly recognized Phillips unusual intelligence. This, combined with Phillips creativity and his oblique view of economics, meant he was somewhat of an outsider. Nevertheless, Phillips played a key role in modernising the economics department at the LSE, winning the support of even Lionel Robbins to introduce mathematics and econometrics.

2.2 Phillips the teacher

His undergraduate lectures on 'Statistical Methods in Economics' were models of clarity, given by a person sympathetic to the problems experienced by students coming to econometrics for the first time. It was during these lectures that many LSE students gained an understanding of material in the early econometrics textbooks by Johnston and Goldberger, and acquired a better insight into the content of the previous lecture course given by Denis Sargan. As a teacher of graduate courses for the MSc in Mathematical Economics and Econometrics, Phillips was equally brilliant. His lectures on optimal control of linear systems were masterly, and his contributions to the Quantitative Economics seminar always helpful and revealing. In that seminar, Bill and Denis would debate the merits of alternative modelling approaches, whether to use moving-average or autoregressive errors, and how effective economic policy could be, and we listened in awe (see Hendry and Wallis, 1984, for an overview of Sargan's contribution – it was an exciting time to be at LSE). One of these seminars each year was concerned with the modelling of wages and prices, and it was a rewarding experience for the participants to be guided through the existing literature and receive numerous suggestions for further research topics from Phillips and Sargan arguing about money-wage versus real-wage models, on which topic both had published seminal work.

2.3 Phillips the researcher

Coming from an electrical engineering background to economics, Phillips was in the forefront of the researchers seeking to develop formal models of the economic system (also see Tustin, 1953). Bill Phillips and Karl Popper were greatly revered by their young and dynamic colleagues such as Richard Lipsey, Chris Archibald, Maurice Peston, Max Steuer and Ralph Turvey. There was a fervor for a scientific approach to economics, and clamor for increased and improved empirical studies of economic phenomena, exemplified and maintained by the regular meeting of the seminar entitled Methodology, Measurement and Testing.

An invaluable and long-lasting illustration of the fact that research results do not always (perhaps rarely) come quickly or easily, was provided by the prolonged gestation period for the production and eventual publication (Phillips, 1978) of what was to become the Walras–Bowley lecture to the Econometric Society meeting in San Francisco in 1966. Early versions of the paper on the estimation of linear dynamic systems with vector moving-average errors were presented to the Econometrics Doctoral workshop run by Sargan and Phillips. An important feature of this research was the design of estimation methods that were feasible with the then available computing facilities. Had Phillips had access to the computing facilities available today, we can only speculate about his productivity.

3 The legacy of Phillips's contributions

Here, we are concerned with how Phillips's work influenced UK econometricians. We note five main topics:

1. the application of control methods to dynamic econometric models;
2. the estimation of dynamic equations with moving-average errors;

3. the formalization of exogeneity;

4. the estimation of continuous-time econometric systems; and

5. the modelling of wage and price inflation.

Within this already limited set, the first three topics will receive most attention.

A search of the Social Science Citation Index from 1981–1995 reveals that much of his work remains influential: there were approximately 270 citations, relating to all five main topics just listed and involving a wide range of journals. Certainly, the modal cite was to the 'Phillips curve', but 1.–4. also appeared regularly.

3.1 Control methods

Because of his engineering background, and his influential papers on economic policy, Phillips had ensured that control-theoretic ideas were taught at the School. His work showed that the variability of macro-economies could be reduced by appropriately designed feedback stabilisers. When Phillips left the School, DFH had to undertake some of his teaching, particularly the analysis and application of control methods to macro-economic stabilization.

This was based on three components: the techniques for derivative, proportional and integral control servomechanisms which Phillips had helped to introduce to economics (see Phillips, 1954, 1956), the linear least-squares methods lucidly explained by Whittle (1963); and the linear-quadratic model, optimizing a quadratic function of departures from prespecified target trajectories for a linear dynamic system over a finite future horizon (see e.g., Holt, Modigliani, Muth and Simon, 1960). The lecture notes for this part were 'inherited' from Phillips (indirectly), since few contemporaneous textbooks explained the main procedures involved in factorizing lead-lag polynomials in time operators (usually the lag operator, denoted L). While such material is common now, we believe it was unusual in mid-1960s courses.

For example, consider the quadratic cost function $C_{(T)}$ which penalizes the deviations of a variable x_t from a prespecified target trajectory $\{x^*_{t+j}\}$ subject to costs of adjustment represented by changes $\Delta x_{t+j} = x_{t+j} - x_{t+j-1}$ over a T-period horizon:

$$C_{(T)} = \sum_{j=0}^{T} C_t = \sum_{j=0}^{T} \frac{1}{2} \left[\left(x_{t+j} - x^*_{t+j} \right)^2 + \alpha \left(\Delta x_{t+j} \right)^2 \right].$$

To minimize $C_{(T)}$ at time $t + j$, differentiate with respect to x_{t+j}, noting that $\Delta x_{t+j+1} = x_{t+j+1} - x_{t+j}$ thereby depends on x_{t+j}, which yields (ignoring the end point for simplicity):

$$\frac{\partial C_{(T)}}{\partial x_{t+j}} = \frac{\partial C_{t+j}}{\partial x_{t+j}} + \frac{\partial C_{t+j+1}}{\partial x_{t+j}} = x_{t+j} - x^*_{t+j} + \alpha \left(\Delta x_{t+j} \right) - \alpha \left(\Delta x_{t+j+1} \right)$$

so equating to zero for a minimum:

$$x_{t+j} - x^*_{t+j} + \alpha \Delta x_{t+j} - \alpha \Delta x_{t+j+1} = 0.$$

This can be re-expressed as a polynomial involving leads and lags in L:

$$x_{t+j} + \alpha x_{t+j} - \alpha L x_{t+j} - \alpha L^{-1} x_{t+j} + \alpha x_{t+j} = x^*_{t+j}$$

or (for $\alpha \neq 0$):

$$\left(L^{-1} - \left(2 + \alpha^{-1} \right) + L \right) x_{t+j} = \left(L^{-1} - \lambda_2 \right) \left(1 - \lambda_1 L \right) x_{t+j} = -\frac{x^*_{t+j}}{\alpha}.$$

The polynomial has roots λ_1 and λ_2 with a product of unity (so are inverses, λ_1 inside, λ_2 outside the unit circle) and a sum of $(2 + \alpha^{-1})$. Inverting the first factor expresses x_{t+j} as a function of lagged x_{t+j} and current and future values of the target x^*_{t+j}:

$$\left(1 - \lambda_1 L \right) x_{t+j} = -\left(L^{-1} - \lambda_2 \right)^{-1} \frac{x^*_{t+j}}{\alpha} = \lambda_1 \left(1 - \lambda_1 L^{-1} \right)^{-1} \frac{x^*_{t+j}}{\alpha}.$$

since $(1/\lambda_2) = \lambda_1$. The last term can be expanded as a power series in L^{-1} as $\lambda_1 < 1$:

$$\left(1 - \lambda_1 L \right) x_{t+j} = \frac{\lambda_1}{\alpha} \left[1 + \lambda_1 L^{-1} + \lambda_1^2 L^{-2} + \cdots \right] x^*_{t+j} = \frac{\lambda_1}{\alpha} \sum_{k=0}^{\infty} \lambda_1^k x^*_{t+j+k}.$$

An operational procedure is obtained by replacing any unknown future targets by their expected values. However, the implication that all future values of the target needed to be known in advance, or correctly anticipated, persuaded DFH that the approach was not very relevant for empirical modelling, although the special case of a 1-period horizon was used in Hendry and Anderson (1977).

That last formulation also contained the germ of the notion of an 'Error Correction Mechanism' (ECM) which was initially based on log-ratios of economic series that might nevertheless be 'equilibria' (see Hendry, 1977). For example, UK Building Societies, which were non-profit organizations, were modelled as striving to maintain constant ratios of lending to borrowing, by adjusting lending margins and growth rates. With hindsight, the ECM was that ratio, and the derived model was one with derivative and proportional control, though that interpretation was not made at the time. Let

$$x_{t+j}^{**} = (1-\lambda_1)\sum_{k=0}^{\infty}\lambda_1^k x_{t+j+k}^{*}$$

denote the 'ultimate' target (scaled so that the weights sum to unity: see e.g., Nickell, 1985), then (other than the end point):

$$x_{t+j} = \lambda_1 x_{t+j-1} + \frac{\lambda_1}{\alpha(1-\lambda_1)} x_{t+j}^{**}$$

so that:

$$\Delta x_{t+j} = -(1-\lambda_1)x_{t+j-1} + (1-\lambda_1)x_{t+j}^{**} = -(1-\lambda_1)\left[x_{t+j-1} - x_{t+j}^{**}\right] \quad (1)$$

noting that from the conditions on the roots:

$$\frac{1-2\lambda_1+\lambda_1^2}{(1-\lambda_1)} = (1-\lambda_1) = \frac{\lambda_1}{\alpha(1-\lambda_1)}.$$

Thus, once one knows where to look for the formulation, ECMs appear readily in transformations of the optimal control problem, although (1) is a restricted specification, involving only proportional control, and excluding derivative (Δx_{t+j}^{**}).

Nevertheless, having the latent idea helped when puzzling over anomalies in UK consumers' expenditure equations, as it led to noticing the 'DHSY' formulation (see Davidson, Hendry, Srba and Yeo, 1978). Although the model in Sargan (1964) was already an ECM, the idea of the class being a general one does not seem to have been perceived before DHSY (see Hendry, 1993, for a general discussion). Together with the realization that it is not necessary to have stationary regressors and regressand in order to have a stationary error (see Hendry and Mizon, 1978), this follow up to Phillips' work helped to precipitate the notion of 'cointegration' (see Granger, 1981).

The interpretation of DHSY in terms of servo-mechanistic control was post-hoc, as DFH did not see the connection initially. Worse still, he did not even think of using Phillips's famous work on policy control (in Phillips, 1954, 1956) as a basis for empirical specifications despite both knowing his work well, and having studied Sargan (1964) many times. It is surprising how hard it is to cross-link ideas, even such a simple step as using work on controlling dynamic equations when specifying empirical dynamic models. The notion of integral control referred to in Mizon and Hendry (1980) and used in Hendry and von Ungern-Sternberg (1981), however, was directly based on Phillips (1956), once the connections had become clearer.

Since then, other researchers have pursued many related avenues. In particular, Salmon (1982) related the ECM idea to the general control theory literature to show the need for the three 'correctors' that Phillips had proposed (namely integral, derivative and proportional). Engle and Granger (1987) showed that cointegration and proportional ECM were equivalent, linking time-series approaches more closely with econometric modelling. However, recent research on the impact of regime shifts on cointegrated processes has highlighted the need to distinguish equilibrium correction, which includes cointegration and operates successfully only within regimes, from error correction which stabilizes even in the face of other non-stationarities (see Clements and Hendry, 1995b). The assumptions concerning the stationarity or otherwise of the entity to be controlled were rarely explicitly stated, although the notion of 'stabilization' regularly occurred, perhaps suggesting a stationary state or a system centered around a steady-state growth path, but also consistent with preventing an unstable system from diverging. When processes are highly non-stationary, even after differencing and cointegration, it is unclear how well servo-mechanisms will function, and more adaptive methods merit consideration. It is possible that integral control could correct for systematic deviations due to shifts in equilibria, but that idea is hard to reconcile with all variables having coherent numbers of unit roots (preferably none) without introducing multicointegration (see Granger and Lee, 1991), which recreates the regime-shift problem at a higher level.

Other solutions also merit consideration. For example, exponentially weighted moving averages are an error-correction model, adjusting more or less rapidly to wherever the target variable moves; in contrast, cointegrated relations converge on their means, which would be the incorrect target when the mean altered. In essence, either the dynamics must ensure correction, or the target implicit in the econometric model must move when the regime alters. This last result explains why models in differences are not as susceptible to certain forms of structural break as equilibrium-correction systems (see Clements and Hendry, 1995a).

The introduction of moving-average models leads conveniently to the next topic.

3.2 Moving-average errors

Following his development of the theory for the maximum likelihood estimation of linear dynamic models with moving-average errors, described in Phillips (1966), Phillips was assisted in 1966–7 by Trivedi to write a computer program to implement the new method. Much of the difficulty lay in computing the estimator, which did not have an obvious non-iterative numerical solution, and Phillips (1966) was concerned to make the approach operational. Although Phillips presented the Walras–Bowley lecture in 1966, he had lingering doubts about the identification of the autoregressive and moving-average parameters, and as a result publication did not come until 1978, with Phillips (1978) having only a passing mention of identification issues. In fact, the reference to the empirical determination of the orders of the autoregressive and moving-average lag polynomials (Phillips, 1978, page 198) suggests a simple-to-general procedure, no doubt to avoid the lack of identification when the orders are overspecified. Trivedi, who was then one of Phillips's doctoral students, had also been studying inventory behavior based on control-type models following Holt *et al.* (1960) (see Trivedi, 1970). Thus, the first two strands are more closely linked than might appear at first sight.

Considerable research had been undertaken on autoregressive errors (see e.g., Cochrane and Orcutt, 1949, for an early example), but prior to the papers underlying the first edition in 1970 of Box and Jenkins (1976), less attention had been devoted to moving-average errors – though a member of the LSE Statistics Department, M. Quenouille, had provided a detailed study of systems with moving average errors (see Quenouille, 1957). From the time of Slutsky's analysis (see Slutsky, 1937), it was known that moving averages could induce cyclical behavior similar to autoregressions (see Yule, 1927), so they were a promising model for autocorrelated error processes. Consequently, Trivedi undertook a Monte Carlo study of that estimator for dynamic equations with moving-average errors.

DFH was simultaneously investigating the small-sample behaviour of estimators for models with autoregressive errors following Sargan (1964), so he and Trivedi cooperated in a comparative study that estimated both types of assumed error process on data generated by both forms (later published as Hendry and Trivedi, 1972). The outcome primarily showed that getting the correct order for the error autocorrelation was more important than getting the correct form; that estimators could often be quite badly biased in either approximation (even to the same form); and that multiple optima posed convergence problems. The first finding has since been reflected in the idea that (say) the Lagrange-multiplier test for residual autocorrelation has the same power for the two local alternatives (see e.g., Godfrey and Wickens, 1982). DFH and Trivedi also followed up the ideas prevalent at the time in LSE on more efficient methods of conducting Monte Carlo studies as in (e.g.) Sargan and Mikhail (1971) (see Hammersley and Handscomb, 1964).

Since Phillips (1966), much other work has been done on moving-average estimation (see, inter alia, Aigner, 1971, Anderson, 1980, Box and Jenkins, 1976, Davidson, 1981, Harvey and Phillips, 1979, Kang, 1973, Nicholls, Pagan and Terrell, 1975, Osborn, 1976, 1977, Pagan and Nicholls, 1976, Reinsel, 1979, and Sargan and Bhargava, 1983).

3.3 Exogeneity

Phillips (1956) focussed on the specification of dynamic models which would sustain least-squares estimation. The relevant notion, now known as 'strict exogeneity', is concerned with regressors being uncorrelated with errors in dynamic systems (see e.g. Koopmans, 1950, Christ, 1966, and Sims, 1972), and was related to the approach in Wold (1949) (who was Peter Whittle's doctoral supervisor). When errors were potentially autocorrelated, a lack of feedback, or absence of Granger (1969) causality, was needed to obtain consistent estimators (see Geweke, 1984). That Phillips was aware of this is apparent from inspection of Phillips (1978) which contains a brief discussion of exogeneity conditions remarkably similar to those required for strong exogeneity (see Engle, Hendry and Richard, 1983). Indeed, a feature of the equations considered in Phillips (1966) and Phillips (1978) was the inclusion of non-modelled variables, which helped in the identification of the autoregressive and moving-average parameters, and also raised the issue of the validity of conditioning on the non-modelled or exogenous variables. Rather than following the standard simultaneous equations literature of the time and asserting that certain variables are exogenous, Phillips considered the joint density for all variables conditional on initial conditions, which he noted could be factored into a conditional and marginal density, and stated explicitly that the marginal density for the exogenous variables did not involve the parameters of interest (see Phillips, 1978, page 185).

The work on weak exogeneity in Engle *et al.* (1983) originally failed to build on Phillips (1957), and it was Christopher Sims who suggested a link. However, the motivation for the concepts was very different. Weak exogeneity did not specify the Granger-causality properties of variables, but focused on when there was no loss of information in a conditional model about the parameters of interest. An example in Engle *et al.* (1983) showed that this could potentially occur even in the presence of autoregressive errors, and conversely, weak exogeneity of a variable for a parameter of interest did not by itself justify least squares.

Taken together with the work noted above on controlling economic systems and moving-average errors, the important theme of dynamic model specification provides a common thread and remains a major preoccupation of econometricians seeking to understand time-series data. That same theme encompasses the next topic, namely continuous time models.

3.4 Continuous time modelling

Another topic on which both Phillips and Sargan made valuable and influential contributions was that of modelling continuous-time processes (see Phillips, 1959, and Sargan, 1974). Indeed, in the Preface to Bergstrom (1990), Bergstrom states that in writing chapters 1 and 3 of that book (originally published as Bergstrom, 1962, and Bergstrom, 1966, respectively), he was much influenced by Phillips's research. Further, though Cliff Wymer and Peter Phillips completed their doctoral theses on aspects of continuous-time modelling under the supervision of Denis Sargan, Wymer at least had previously been jointly supervised by Bill Phillips. With the advent of considerable modelling of large samples of high-frequency financial data, results in these early contributions to continuous time modelling are seeing increasing application. Again, the subsequent literature is large: see Bergstrom (1984) for bibliographic perspective.

3.5 Modelling wage and price inflation

Following the seminal work in Phillips (1958) concerning the inverse relationship between wage inflation and the rate of unemployment, numerous LSE economists have written on the subject, including Desai (1975, 1984), Lipsey (1960), Nickell (1984, 1990), and Sargan (1964, 1980). More generally, the 'Phillips curve' made it into the big time of economics textbooks during the 1960s and 1970s, and modified so as to incorporate inflation expectations, survived for much longer. As noted above, this contribution to both empirical economics and econometrics continues to be cited frequently for both aspects, despite the unconventional initial estimates based on fitting to averages designed to eliminate business-cycle effects (see e.g., Gilbert, 1989: one of the critics of the Phillips curve, Milton Friedman in Friedman, 1977, was in turn criticised for an inappropriate use of phase averaging by Hendry and Ericsson, 1991, and Campos, Ericsson and Hendry, 1990).

A recent replication and evaluation of the Phillips curve using the UK annual data over 1863-1913 by Shadman-Mehta (1995), employing all the modern techniques of multivariate cointegration analysis, recursive system maximum likelihood, and system diagnostic tests concluded that 'the results are remarkably close to his ... if Phillips was conducting his analysis ... with the current developments in econometric theory, his overall conclusions would have been much the same'. Her unique cointegrating vector involves only unemployment and nominal inflation, and does not depend on real wages or productivity. But that cointegrating relation influences unemployment rather than inflation, so the dynamic equation is the reverse of how Phillips wrote his model. Such ease of replication of results first established more than forty years ago, and satisfaction of rigorous testing, is impressive testimony to the quality of Phillips's empirical research. Over the whole period to 1990, however, Shadman–Mehta finds noticeably different results, suggesting a regime shift in the later part of the century that has been the subject of considerable controversy.

4 Conclusion

This section is not aptly titled, since as yet there is no conclusion to the legacy of Bill Phillips's contributions to econometrics. Later researchers were probably often unaware of the extent to which they were building on his contributions, or even how useful his ideas could be in related contexts. We hope this short retrospective has highlighted some of the developments in the main areas of his work.

References

Aigner, D. J. (1971). A compendium on estimation of the autoregressive moving average model from time series data. *International Economic Review*, **12**, 348–369.

Allen, R. G. D. (1963). *Mathematical Economics* 2nd edn. London: Macmillan.

Anderson, T. W. (1980). Maximum likelihood estimation for vector autoregressive moving average models. In Brillinger, D. R., and Tiao, G. C. (eds.), *New Directions in Time Series*, pp. 45–59: Institute of Mathematical Statistics.

Bergstrom, A. R. (1962). A model of technical progress, the production function and cyclical growth. *Economica*, **29**, 357–370. Reprinted as chapter 1, pages 23-37 of Bergstrom, A. R., Continuous Time Modelling, Oxford: Oxford University Press, 1990.

Bergstrom, A. R. (1966). Nonrecursive models as discrete approximations to systems of stochastic differential equations. *Econometrica*, **34**, 173–182. Reprinted as chapter 3, pages 51-61 of Bergstrom, A. R., Continuous Time Modelling, Oxford: Oxford University Press, 1990.

Bergstrom, A. R. (1984). Continuous time stochastic models and issues of aggregation over time. in Griliches, and Intriligator (1984), Ch. 20.

Bergstrom, A. R. (1990). *Continuous Time Econometric Modelling*. Oxford: Oxford University Press.

Box, G. E. P., and Jenkins, G. M. (1976). *Time Series Analysis, Forecasting and Control*. San Francisco: Holden-Day.

Campos, J., Ericsson, N. R., and Hendry, D. F. (1990). An analogue model of phase-averaging procedures. *Journal of Econometrics*, **43**, 275–292.

Christ, C. F. (1966). *Econometric Models and Methods*. New York: John Wiley.

Clements, M. P., and Hendry, D. F. (1995a). Forecasting in macroeconomics. In Cox, D., Hinkley, D., and Barndorff-Nielsen, O. (eds.), *Time Series Models in Econometrics, Finance and Other Fields*, pp. 99–138. London: Chapman and Hall.

Clements, M. P., and Hendry, D. F. (1995b). Macro-economic forecasting and modelling. *Economic Journal*, **105**, 1001–1013.

Cochrane, D., and Orcutt, G. H. (1949). Application of least squares regression to relationships containing auto-correlated error terms. *Journal of the American Statistical Association*, **44**, 32–61.

Davidson, J. E. H. (1981). Problems with the estimation of moving average processes. *Journal of Econometrics*, **16**, 295–310.

Davidson, J. E. H., Hendry, D. F., Srba, F., and Yeo, S. (1978). Econometric modelling of the aggregate time-series relationship between consumers' expenditure and income in the United Kingdom. *Economic Journal*, **88**, 661–692. Reprinted in Hendry D. F. (1993), *Econometrics: Alchemy or*

Science? Oxford: Blackwell Publishers.

Desai, M. J. (1975). The Phillips curve: A revisionist interpretation. *Economica*, **42**, 1–19.

Desai, M. J. (1984). Wages, prices and unemployment a quarter of a century after the Phillips curve. in Hendry, and Wallis (1984), pp. 251–273.

Engle, R. F., and Granger, C. W. J. (1987). Cointegration and error correction: Representation, estimation and testing. *Econometrica*, **55**, 251–276.

Engle, R. F., Hendry, D. F., and Richard, J.-F. (1983). Exogeneity. *Econometrica*, **51**, 277–304. Reprinted in Hendry D. F. (1993), *Econometrics: Alchemy or Science?* Oxford: Blackwell Publishers.

Friedman, M. (1977). Nobel lecture: Inflation and unemployment. *Journal of Political Economy*, **85**, 451–472.

Geweke, J. B. (1984). Inference and causality in economic time series models. in Griliches, and Intriligator (1984), Ch. 19.

Gilbert, C. L. (1989). LSE and the British approach to time-series econometrics. *Oxford Economic Papers*, **41**, 108–128.

Godfrey, L. G., and Wickens, M. R. (1982). Tests of misspecification using locally equivalent alternative models. In Chow, G. C., and Corsi, P. (eds.), *Evaluating the Reliability of Macro-Economic Models*, Ch. 6. New York: John Wiley.

Granger, C. W. J. (1969). Investigating causal relations by econometric models and cross-spectral methods. *Econometrica*, **37**, 424–438.

Granger, C. W. J. (1981). Some properties of time series data and their use in econometric model specification. *Journal of Econometrics*, **16**, 121–130.

Granger, C. W. J., and Lee, T.-H. (1991). Multicointegration. In Engle, R. F., and Granger, C. W. J. (eds.), *Long-Run Economic Relationships*, pp. 179–190. Oxford: Oxford University Press.

Griliches, Z., and Intriligator, M. D. (eds.)(1984). *Handbook of Econometrics*, Vol. 2–3. Amsterdam: North-Holland.

Hammersley, J. M., and Handscomb, D. C. (1964). *Monte Carlo Methods.* London: Chapman and Hall.

Harvey, A. C., and Phillips, G. D. A. (1979). The estimation of regression models with autoregressive-moving average disturbances. *Biometrika*, **66**, 49–58.

Hendry, D. F. (1977). On the time series approach to econometric model building. In Sims, C. A. (ed.), *New Methods in Business Cycle Research*, pp. 183–202. Minneapolis: Federal Reserve Bank of Minneapolis. Reprinted in Hendry D. F. (1993), *Econometrics: Alchemy or Science?* Oxford: Blackwell Publishers.

Hendry, D. F. (1993). *Econometrics: Alchemy or Science?* Oxford: Blackwell Publishers.

Hendry, D. F., and Anderson, G. J. (1977). Testing dynamic specification in small simultaneous systems: An application to a model of building society behaviour in the United Kingdom. In Intriligator, M. D. (ed.), *Frontiers in Quantitative Economics*, Vol. 3, pp. 361–383. Amsterdam: North Holland Publishing Company. Reprinted in Hendry D. F. (1993), *Econometrics: Alchemy or Science?* Oxford: Blackwell Publishers.

Hendry, D. F., and Ericsson, N. R. (1991). An econometric analysis of UK money demand in monetary trends in the United States and the United Kingdom by Milton Friedman and Anna J. Schwartz. *American Economic Review*, **81**, 8–38.

Hendry, D. F., and Mizon, G. E. (1978). Serial correlation as a convenient simplification, not a nuisance: A comment on a study of the demand for money by the Bank of England. *Economic Journal*, **88**, 549–563. Reprinted in Hendry D. F. (1993), *Econometrics: Alchemy or Science?* Oxford: Blackwell Publishers.

Hendry, D. F., and Trivedi, P. K. (1972). Maximum likelihood estimation of difference equations with moving-average errors: A simulation study. *Review of Economic Studies*, **32**, 117–145.

Hendry, D. F., and von Ungern-Sternberg, T. (1981). Liquidity and inflation effects on consumers' expenditure. In Deaton, A. S. (ed.), *Essays in the Theory and Measurement of Consumers' Behaviour*, pp. 237–261. Cambridge: Cambridge University Press. Reprinted in Hendry D. F. (1993), *Econometrics: Alchemy or Science?* Oxford: Blackwell Publishers.

Hendry, D. F., and Wallis, K. F. (eds.)(1984). *Econometrics and Quantitative Economics*. Oxford: Basil Blackwell.

Holt, C., Modigliani, F., Muth, J. F., and Simon, H. (1960). *Planning Production, Inventories and Work Force*. Englewood Cliffs: Prentice-Hall.

Kang, K. M. (1973). A comparison of estimators for moving average processes. Report, Australian National Bureau of Statistics, Canberra.

Koopmans, T. C. (1950). When is an equation system complete for statistical purposes?. In Koopmans, T. C. (ed.), *Statistical Inference in Dynamic Economic Models*, No. 10 in Cowles Commission Monograph, Ch. 17. New York: John Wiley & Sons.

Lipsey, R. G. (1960). The relationship between unemployment and the rate of change of money wage rates in the United Kingdom 1862-1957: A further analysis. *Economica*, **27**, 1–31.

Mizon, G. E. (1995). Progressive modelling of macroeconomic time series: the LSE methodology. In Hoover, K. D. (ed.), *Macroeconometrics: Developments, Tensions and Prospects*, pp. 107–169. Dordrecht: Kluwer Academic Press.

Mizon, G. E., and Hendry, D. F. (1980). An empirical application and Monte Carlo analysis of tests of dynamic specification. *Review of Economic Studies*, **49**, 21–45. Reprinted in Hendry D. F. (1993), *Econometrics: Alchemy or Science?* Oxford: Blackwell Publishers.

Nicholls, D. F., Pagan, A. R., and Terrell, R. D. (1975). The estimation and use of models with moving average disturbance terms: A survey. *International Economic Review*, **16**, 113–134.

Nickell, S. J. (1984). The modelling of wages and unemployment. in Hendry, and Wallis (1984), pp. 13–35.

Nickell, S. J. (1985). Error correction, partial adjustment and all that: An expository note. *Oxford Bulletin of Economics and Statistics*, **47**, 119–130.

Nickell, S. J. (1990). Inflation and the UK labour market. *Oxford Review of Economic Policy*, **6**, 26–35.

Osborn, D. R. (1976). Maximum likelihood estimation of moving average processes. *Annals of Economic and Social Measurement*, **5**, 75–87.

Osborn, D. R. (1977). Exact and approximate maximum likelihood estimators for vector moving average processes. *Journal of the Royal Statistical Society B*, **39**, 114–118.

Pagan, A. R., and Nicholls, D. F. (1976). Exact maximum likelihood estimation of regression models with finite order moving average errors. *Review of Economic Studies*, **43**, 383–387.

Phillips, A. W. H. (1954). Stabilization policy in a closed economy. *Economic Journal*, **64**, 290–333.

Phillips, A. W. H. (1956). Some notes on the estimation of time-forms of reactions in interdependent dynamic systems. *Economica*, **23**, 99–113.

Phillips, A. W. H. (1957). Stabilization policy and the time form of lagged response. *Economic Journal*, **67**, 265–277.

Phillips, A. W. H. (1958). The relation between unemployment and the rate of change of money wage rates in the United Kingdom, 1861–1957. *Economica*, **25**, 283–299.

Phillips, A. W. H. (1959). The estimation of parameters in systems of stochastic differential equations. *Biometrika*, **46**, 67–76.

Phillips, A. W. H. (1962). *Employment, Inflation and Growth. An Inaugural Lecture.* London: G. Bell and Sons Ltd.

Phillips, A. W. H. (1966). Estimation of stochastic difference equations with moving average disturbances. Walras- bowley lecture, Econometric Society, San Francisco.

Phillips, A. W. H. (1978). The estimation of systems of difference equations with moving average errors. In Bergstrom, A. R., Catt, A. J. L., Peston, M. H., and Silverstone, B. D. J. (eds.), *Stability and Inflation*, pp. 181–199. New York: Wiley.

Phillips, P. C. B. (ed.)(1993). *Models, Methods and Applications of Econometrics*. Oxford: Basil Blackwell.

Quenouille, M. H. (1957). *The Analysis of Multiple Time Series*. London: Griffin.

Reinsel, G. (1979). Maximum likelihood estimation of stochastic linear difference equations with autoregressive moving average errors. *Econometrica*, **47**, 129–152.

Salmon, M. (1982). Error correction mechanisms. *Economic Journal*, **92**, 615–629.

Sargan, J. D. (1964). Wages and prices in the United Kingdom: A study in econometric methodology (with discussion). In Hart, P. E., Mills, G., and Whitaker, J. K. (eds.), *Econometric Analysis for National Economic Planning*, Vol. 16 of *Colston Papers*, pp. 25–63. London: Butterworth Co. Reprinted as pp. 275–314 in Hendry D. F. and Wallis K. F. (eds.) (1984). *Econometrics and Quantitative Economics*. Oxford: Basil Blackwell, and as pp. 124–169 in Sargan J. D. (1988), *Contributions to Econometrics*, Vol. 1, Cambridge: Cambridge University Press.

Sargan, J. D. (1974). Some discrete approximations to continuous time stochastic models. *Journal of the Royal Statistical Society B*, **36**, 74–90.

Sargan, J. D. (1980). A model of wage-price inflation. *Review of Economic Studies*, **47**, 979–1012. Reprinted as pp. 170–190 in Sargan J. D. (1988), *Contributions to Econometrics*, Vol. 1, Cambridge: Cambridge University Press.

Sargan, J. D., and Bhargava, A. (1983). Maximum likelihood estimation of regression models with first order moving average errors when the root lies on the unit circle. *Econometrica*, **51**, 799–820.

Sargan, J. D., and Mikhail, M. H. (1971). A general approximation to the distribution of instrumental variable estimators. *Econometrica*, **39**, 131–169.

Shadman-Mehta, F. (1995). An empirical study of the determinants of real wages and employment: the Phillips curve revisited. Unpublished thesis, Universite Catholique de Louvain, Belgium.

Sims, C. A. (1972). Money, income and causality. *American Economic Review*, **62**, 540–552.

Slutsky, E. (1937). The summation of random causes as the source of cyclic processes. *Econometrica*, **5**, 105–146. (Translation from the Russian version of 1927.).

Trivedi, P. K. (1970). Inventory behaviour in U.K. manufacturing 1956–67. *Review of Economic Studies*, **37**, 517–536.

Tustin, A. (1953). *The Mechanism of Economic Systems*. London: Heinemann.

Whittle, P. (1963). *Prediction and Regulation by Linear Least-Square Methods*. Princeton: D. Van Nostrand.

Wold, H. O. A. (1949). Statistical estimation of economic relationships. *Econometrica*, **17**, 1–21. Supplement.

Yule, G. U. (1927). On a method of investigating periodicities in disturbed series, with special reference to Wolfer's sunspot numbers. *Philosophical Transactions of the Royal Society, A*, **226**, 267–298.

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