Kærgård, Niels, S. B. Krohn, J. Nørregård, T. Vorstrup Rasmussen, E. Skovfoged, N.-H. Topp og S.-K. Topp. 1979. *CLEO – en model for den økonomiske vækst i Danmark 1870-1970*. Københavns Universitet, Økonomisk Institut. Cykelafdelingens memoserie, nr. 60.

Mogensen, Gunnar Viby. 1987. *Historie og økonomi*. København.

Topp, Niels-Henrik. 1992. Ánvendelsen af prisindeks i CLEO. *Institut for Statskundskab, Københavns Universitet*. Arbejdspapir 1992/2.

Modern Econometrics

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The following citation from p. 155 contains the main conclusion from the discussion in chapter 7 of the econometric methods after CLEO:

> Det er hovedsynspunktet, at de senere års debat ikke har bidraget med fundamentalt nye synspunkter. Grundkonflikten er i dag som for ti år siden... spørgsmålet om, hvorvidt man tror, at den økonomiske teori kan give udsagn, der er så simple og præcise, at de sammen med data kan danne fundament for empiriske undersøgelser

Since econometrics became a scientific branch by its own merits the important question of the relationship between economic theory and empirical reality has been extensively discussed and Kærgård provides us with several examples from the historical debate. One can almost say that this question has divided economists into different camps, those believing that empirical econometrics have little to contribute to economic understanding, those believing that economic theory is too abstract to be of any use for practical model building except for the choice of variables and finally those believing that careful econometric modelling can improve the understanding of economic reality and thereby improve the theoretical fundament for macroeconomic modelling. The last group, to which I myself would like to relate, is no doubt the smallest but it is rapidly growing. Based on the discussion in chapter 7 it seems as if Kærgård is more sceptical in this respect and probably belongs to the second group. I will therefore take the oppurtunity here to motivate my more optimistic views about the potentialities of econometric modelling. In particular I will advocate that the econometric debate in particular in the last decade has brought econometric models closer to the complicated empirical reality for instance by allowing for different short-run and long-run dynamic structure, by introducing new causality concepts like Granger noncausality,

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strict exogeneity, weak, strong and super exogeneity (Engle, Hendry and Richard, 1983), new concepts for model comparisons (Hendry, 1988), etc.

Because empirical macroeconomics is a very broad concept covering "schools" of the most diverging principles, it is almost impossible in a short note like this to give a critical appraisal of recent progress in econometric methods without limiting oneself in some respect. I will therefore to a large extent restrict myself to the "schools" discussed by Kærgård, such as traditional econometrics versus time-series analysis, VAR-modeling in the spirit of Sims, new classical economics and rational expectations, but classify them according to whether they assume micro foundations or not, and whether they assume market clearing or not.

The economists basing their macro models on micro foundations (the new classical economics school) usually assume a utility maximizing "representative agent" with a well defined utility function. The weakness of this approach in macroeconomic modelling lies in the many simplifying (and often highly unrealistic) assumptions which have to be made in order to arrive at an estimable empirical model. Within this group there is hardly a need to simplify the theoretical fundament from which the empirical model should be derived. The same can probably be said about those who derive their models on the assumption of instantaneous market clearing. A theory based on instantaneous market clearing is certainly simpler than a theory that has to explain why and how markets do not clear, although the latter must in most cases be considered a better approximation to actual aggregated behaviour. The question whether economic theories should be made more simple or more realistic is therefore far from straightforward. Within the group of recently applied macroeconomic models one can say that the works assuming micro foundations with market clearing has most theory but least empirical content, whereas the combination no micro foundation and adjustment behaviour has least theory and most empirical content. One of the present econometric problems is, in my opinion, that there seems to be so little interaction or feedback between these two groups.

Since the empirical analyses in Kærgård's thesis seem to belong to the latter group, I will restrict myself only to discuss the econometric debate in the eighties relative to the progress within this group. I will concentrate on two separate issues in this context, first on the econometric dispute between the traditional econometricians and the pure time-series analysts and then on the dispute between those assuming backward alternatively forward adjustment behaviour.

One can easily get the impression by reading chapter 7 in Kærgård's thesis that the econometric dispute in the seventies and in the eighties between the proponents of traditional econometrics and time-series analysis has continued without reaching much agreement. In my opinion the debate or competition between the two schools has been quite constructive (in spite of its fieriness) and in general resulted in substantial econometric progress. In figure 1 I have tried to illustrate how the present state of econome-

trics has evolved by the continuous interaction between traditional econometrics, stressing long-run static equilibrium properties of the model in the tradition of Tinbergen (1951) and Klein (1955), and time-series analysis, stressing short-run dynamic properties of the model in the tradition of Wold (1938) and Box and Jenkins (1970). Up to the seventies most empirical econometric models belonged to the first school but with the appearance of the seminal book by Box and Jenkins in 1970 the time-series approach to econometrics got an enormous upswing. The prerequisite for the sudden interest was no doubt the access to electronic computers that made it possible to employ the computationally demanding Box-Jenkins procedure. In figure 1 I have classified the state of econometric versus time-series modelling into three groups in chronological order. In the beginning of the seventies the gap between the two sides was substantial, whereas in the late eighties the difference is more a question of nuances than of substance.

Most of Kærgård's econometric models seem to belong to the first group and therefore the main points of the critique directed toward this kind of econometric modelling should apply to his work as well. The question arises why Kærgård has not analysed his data using the new econometric models and the new improved tools introduced in the last decades. Kærgård meets this critique by advocating that the quality of his data is too poor and that yearly observations are too coarse to allow for more elaborate modelling. Although I have full sympathy for the great difficulties of measuring the main economic determinants of the Danish economy over such a long period, I still do not think that it can be a valid justification for not choosing the best possible econometric procedure to analyse such data. The proposition that measurement errors in the data can justify the use of simple estimation methods has to my knowledge not been proven true nor the proposition that yearly data, if there are enough of them, cannot be efficiently analysed by the new techniques. Kærgård's points of view might be true but they have not been convincingly demonstrated.

The next issue to be discussed, namely the question of whether economic agents adjust in a backward or forward looking manner, is motivated by the fact that many of Kærgård's models are based on the former principle. This issue is closely related to the question of how agents make plans. The adaptive adjustment people usually assume that plans for next period are given by the conditional expectation given present and lagged realizations of important determinants. The forward adjustment people base their models on the assumption of rational expectation implying that the agents use all relevant information available when making plans, inclusive the parameters of the macro models. Since the implications of whether one believes in forward or backward adjustment turned out to be a question of whether one can believe in economic policy or not, the distinction is more important than just a different view on econometric modelling. At first it seemed quite difficult to reject (or accept) one model against the other on empirical evidence alone, and whether one belonged to one camp or another was more

Traditional econometrics	**Time Series Analysis**
Tinbergen (1951), Klein (1955)	Wold (1938), Box and Jenkins (1970)

Characteristic features:

– Variables in levels	– Variables in differences
– Long-run economic properties determine the specification of the model	– The statistical properties of the data determines the final model
– Lagged dependent variable	– Short-run dynamic specification

Critique:

– Stochastically misspecified, and therefore statistical inference invalid	– No economic structure, in particular no long-run structure
– Inferior for short-run forecasting	– Too ad hoc.

Next stage:

Single equation error-correction models	**Vector autoregressive (VAR) models**
Davidson et al. (1979)	Sims (1982), **Bivariate cointegration models in MA form** Granger (1983)

Characteristic features:

– Both short-run and long-run dynamic specification	– System of autoregressive (Sims) or moving average models (Granger)
– Variables in levels and differences	– Variables in differences or levels
– Residual specification correct	– Equivalence between ecm and cointegration; mathematical formulation of nonstationary time-series analysis

Critique:

– Mathematical and statistical formulation ad hoc, because variables in levels are non-stationary	– Only useful for short-run forecasting
	– Difficult to apply MA models
	– No stable parameters
	– Little economic content

Next stage:

System of error-correction models	**Multivariate cointegration models**
Hendry and Mizon (1990)	Engle and Granger (1987), Johansen (1988), Johansen and Juselius (1990)

Characteristic features:

Long-run and short-run structure statistically well-defined; valid inference on economic hypothesis; feedback and interaction effects between system variables can be estimated

Future critique?

Figure 1. A Sketch of the Development of Econometric Modelling in the Last Decades.

a qustion of belief. Recently, as a direct consequence of the well known Lucas (1976) critique, Ericsson and Hendry (1989) and Favero and Hendry (1990) have suggested a possible procedure for empirical testing: If macroeconomic behaviour is best explained by forward (rational) expectations, models based on backward adjustment will suffer from parameter instability when the marginal model of a policy variable changes, for instance if the tax rules are fundamentally changed. The conclusion drawn in the above mentioned works was that if such (large) changes are present in the sample, the Lucas critique can be tested and hence one can actually discriminate between backward and forward adjustment models in terms of stable model parameters. Examples of such testing can in addition to the above mentioned works be found in Brodin and Nymoen (1991), Bårdsen (1992) and Juselius (1992), all of which clearly favoured the backward looking adjustment models in spite of the fact that these postulate less sophisticated agents, or possibly because of that.

The reason why this debate is of relevance for Kærgård's thesis is because Hylleberg (in this volume) shows that the estimated parameters in many of Kærgård's models are far from stable. Therefore, the conclusion must be that either the models are misspecified or Lucas critique applies, or both.

To summarize I think it is very difficult to share Kærgård's rather pessimistic views about the econometric debate in the last decade. In my opinion the econometric debate in the late seventies and especially in the eighties has been more intense and more constructive than ever before and as a consequence, econometric contributions have experienced a growth never parallelled before. The explanation to this boom in econometric research can probably be found in the simple fact that the eighties was the decade when the (personal) computers marched into the office rooms of the academic staff. They made possible computationally demanding analyses that were never thought of before and thereby opened up for some new avenues, some of which are still under construction but hopefully in the future will make the econometric travelling toward a better understanding of the macro economy more enjoyable.

References

Box, G. E. P. and G. M. Jenkins. 1970. *Time Series Analysis, Forecasting and Control.* San Fransisco.

Brodin, P. A. and R. Nymoen. 1991. Wealth Effects and Exogeneity: The Norwegian Consumption Function 1966 (1) – 1989 (4). Discussion Paper, Bank of Norway.

Bårdsen, G. 1992. Dynamic Modelling of the Demand for Narrow Money in Norway. Forthcoming in *Journal of Policy Modeling*.

Davidson, J. E. H., D. F. Hendry, F. Srba and S. Yeo. 1978. Econometric Modelling of the Aggregate Time-series Relationship between Consumers' Expenditure and Income in the United Kingdom, *Economic Journal,* 88, 352, pp. 661-692.

Engle, R. F. and C. W. J. Granger. 1987. Cointegration and Error Correction: Representation, Estimation and Testing. *Econometrica,* 55, pp. 251-276.

Engle, R. F., D. F. Hendry and J-F. Richard. 1983. Exogeneity. *Econometrica* 51, 2, pp. 277-304.

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References

Box, G. E. P. and G. M. Jenkins. 1970. *Time Series Analysis, Forecasting and Control.* San Fransisco.

Brodin, P. A. and R. Nymoen. 1991. Wealth Effects and Exogeneity: The Norwegian Consumption Function 1966 (1) – 1989 (4). Discussion Paper, Bank of Norway.

Bårdsen, G. 1992. Dynamic Modelling of the Demand for Narrow Money in Norway. Forthcoming in *Journal of Policy Modeling.*

Davidson, J. E. H., D. F. Hendry, F. Srba and S. Yeo. 1978. Econometric Modelling of the Aggregate Time-series Relationship between Consumers' Expenditure and Income in the United Kingdom, *Economic Journal,* 88, 352, pp. 661-692.

Engle, R. F. and C. W. J. Granger. 1987. Cointegration and Error Correction: Representation, Estimation and Testing. *Econometrica,* 55, pp. 251-276.

Engle, R. F., D. F. Hendry and J-F. Richard. 1983. Exogeneity. *Econometrica* 51, 2, pp. 277-304.

Ericsson, N. R. and D. F. Hendry. 1989. Encompassing and Rational Expectations: How Sequential Corroboration Can Imply Refutation. International Finance Discussion Paper No. 354, Board of Governors of the Federal Reserve System, Washington D. C.

Favero, C. and D. F. Hendry. 1990. Testing the Lucas Critique: A Review. Discussion Paper No. 212, University of London.

Granger, C. W. J. 1983. Cointegrated Variables and Error Correcting Models. UCSD Discussion Paper.

Hendry, D. F. 1988. Encompassing: *National Institute Economic Review,* Vol. 125, pp. 88-92.

Hendry, D. F. and G.E. Mizon. 1990. Evaluating Econometric Models by Encompassing the VAR. Applied Economics Discussion Paper, No. 102, University of Oxford.

Johansen, S. 1988. Statistical Analysis of Cointegration Vectors. *Journal of Economic Dynamics and Control,* Vol. 12., 231-254.

Johansen, S. and Juselius, K. 1990. Maximum Likelihood Estimation and Inference on Cointegration – With Applications to the Demand for Money. *Oxford Bulletin of Economics and Statistics,* Vol. 52, No. 2, 169-210.

Juselius, K. 1992. Domestic and Foreign Effects on Prices in an Open Economy. The case of Denmark. Forthcoming in *Journal of Policy Modeling.*

Klein, L. R. and Goldberger, A. S. 1955. *An Econometric Model of the United States 1929-1952.* Amsterdam.

Lucas, Jr. R. E. 1976. Econometric Policy Evaluation: A Critique. In K. Brunner and A. H. Meltzer (eds.) *Carnegie-Rochester Conferences on Public Policy,* Vol. 1, *Journal of Monetary Economics,* 19-46.

Sims, C. 1982. Policy Analysis with Econometric Models. *Brookings Papers of Economic Activity,* 2, 107-132.

Tinbergen, J. 1951. *Business Cycles in the United Kingdom 1870-1914.* Amsterdam.

Wold, H. 1938. *A Study in the Analysis of Stationary Time Series.* Uppsala.

Økonometri og tidsrækkeanalyse

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Jeg har læst disputatsen ud fra min baggrund som statistiker, der arbejder indenfor økonometri. Med det udgangspunkt er den store værdi af Kærgårds arbejde, at disputatsen giver en tilsyneladende uudtømmelig kilde til relevante eksempler på økonometriske problemstillinger. Værdien ligger i, at Kærgård rundt omkring i bogen anvender snart sagt alle klassiske og moderne modeller, estimatorer og tests.

Derved får Kærgård mulighed for at afprøve den praktiske relevans af alt det, der optager teoretisk orienterede økonometrikere. Det fører iblandt til tankevækkende konklusioner, som f.eks. at mange forskellige estimationsmetoder i de fleste tilfælde giver stort set identiske resultater.

Det er imidlertid også muligt at dreje denne ros for bredden i mere kritisk retning: I disputatsen arbejdes med mange enkeltproblemer, f.eks. autokorrelation, heteroskedasticitet og indflydelsesrige observationer. Problemet er, at disse emner behandles hver