23

0-315-18046-0

65951

NAME OF AUTHOR/*NOM DE L'AUTEUR* Bernardus Heijdra

TITLE OF THESIS/*TITRE DE LA THÈSE* Empirical and Theoretical Aspects of Non-Walrasian Economics

UNIVERSITY/*UNIVERSITÉ* Simon Fraser University

DEGREE FOR WHICH THESIS WAS PRESENTED/ *GRADE POUR LEQUEL CETTE THÈSE FUT PRÉSENTÉE* Ph.D.

YEAR THIS DEGREE CONFERRED/*ANNÉE D'OBTENTION DE CE GRADE* 1984

NAME OF SUPERVISOR/*NOM DU DIRECTEUR DE THÈSE* John Chant

DATED/*DATÉ* May 22, 1984 SIGNED/*SIGNÉ*

PERMANENT ADDRESS/*RÉSIDENCE FIXÉ* [redacted]

EMPIRICAL AND THEORETICAL ASPECTS OF NON-WALRASIAN ECONOMICS

by

Bernardus Johannes Heijdra

Kandidaats, Erasmus Universiteit (The Netherlands), 1977

Doctoraal, Erasmus Universiteit (The Netherlands), 1980

THESIS SUBMITTED IN PARTIAL FULFILLMENT OF

THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

in the Department

of

Economics

SIMON FRASER UNIVERSITY

May 1984

APPROVAL

Name: Bernardus J. Heijdra

Degree: Doctor of Philosophy

Title of Thesis: Empirical and Theoretical Aspects of Non-Walrasian Economics

Examining Committee:

Chairman: Stephen T. Easton

John F. Chant
Senior Supervisor

Peter E. Kennedy

Terence Heaps

Dennis R. Maki

Brian L. Scarte
External Examiner
Professor
Department of Economics
University of Alberta

Date Approved: 7 March 1984

PARTIAL COPYRIGHT LICENSE

I hereby grant to Simon Fraser University the right to lend my thesis, project or extended essay (the title of which is shown below) to users of the Simon Fraser University Library, and to make partial or single copies only for such users or in response to a request from the library of any other university, or other educational institution, on its own behalf or for one of its users. I further agree that permission for multiple copying of this work for scholarly purposes may be granted by me or the Dean of Graduate Studies. It is understood that copying or publication of this work for financial gain shall not be allowed without my written permission.

Title of Thesis/Project/Extended Essay

Empirical and Theoretical Aspects of Non-Walrasian

Economics

Author: ______________________

(signature)

Bernardus Heijdra

(name)

May 22, 1984

(date)

ABSTRACT

This thesis examines the potential theoretical and empirical merits of disequilibrium theory or non-Walrasian economics. The different stages in the development of non-Walrasian theory over the last two decades are critically examined in an extensive literature survey, which illustrates the advantages of replacing arbitrarily fixed prices with explicit price setting behaviour. This is followed by an empirical chapter in which a simple two market non-Walrasian model of the Barro-Grossman variety is developed and estimated, using, among others, a new iterative procedure which reduces the computational burden relative to the traditional Maximum Likelihood estimator. The small sample properties of the estimator are analyzed in a Monte Carlo study, presented in an appendix. For comparative purposes, the corresponding pure equilibrium version of the model, as well as an equilibrium model with imposed ad hoc adjustment mechanisms, is also estimated in the empirical chapter. It is shown that both the disequilibrium and the equilibrium-cum-adjustment hypotheses dominate the pure equilibrium formulation in terms of post sample predictive performance, but that neither one of the two dominates the other uniformly.

The theoretical section combines Hahn's notion of conjectural equilibria with formal Bayesian decision theory. Agents are assumed to formulate optimal plans on the basis of simple conjectures or "theories" about the economic process. Bayesian learning occurs through the reformulation of these

conjectures in the light of sequential information. In short-run equilibrium, prices and wages are set by firms and unions respectively, and the fixed price disequilibrium model is then relevant. Profit opportunities may remain unexploited because they are not perceived in the short-run. In long-run equilibrium, agents may find themselves in a "bootstrap" equilibrium, in which "they are right, but for the wrong reasons".

The main conclusion to be drawn from the thesis is that disequilibrium or non-Walrasian economics is an attractive progressive research programme, both from an empirical and from a theoretical point of view. Therefore, some suggestions for further research are also presented.

ACKNOWLEDGEMENTS

I wish to thank my senior supervisor, Professor John F. Chant, for his invaluable support and advice during all stages of this work. Thanks are also due to the other members of my supervisory committee, Professors Peter E. Kennedy and Terry Heaps. In addition to this I would like to express my gratitude to Dr. Terry Jones, without whose expertise I could not have performed the necessary computations in appendix B, and to Anton D. Lowenberg, who has helped me with my English as well as with my economics during all stages of development of the thesis. In addition to this, I would like to thank Professors Carel van der Weijden and Jan Siebrand as well as Dr. Frans van den Bosch, all of Erasmus University, for introducing me to the fascinating world of non-Walrasian economics, both in an empirical and a theoretical sense. Furthermore, thanks are due to my "collegae proximae" David T. Griffiths and Alan P. Williams for their insightful comments. Any remaining errors are, of course, solely attributable to me. Last but not least, I would like to express my gratitude to the Canadian taxpayers for providing me with financial support over the period 1980-1984 in the form of the Government of Canada Award to Foreign Nationals, administered by the World University Service of Canada, on behalf of the Department of External Affairs.

TABLE OF CONTENTS

Approval ii

Abstract iii

Acknowledgements v

List of Tables viii

List of Figures x

Note on Cross References and Notation xi

I. INTRODUCTION 1

II. A SURVEY OF NON-WALRASIAN ECONOMICS. 7

1:INTRODUCTION 7

2:FIX PRICE MODELS 9

3:CRITICISM OF FIX PRICE MODELS. 29

4:MODELS WITH ENDOGENOUS PRICE SETTING. 32

5:CONCLUDING REMARKS. 37

III. TESTING A NON-WALRASIAN MODEL FOR CANADA. 39

1:INTRODUCTION. 39

2:METHODOLOGY, TESTING, AND ECONOMETRICS. 41

3:OVERVIEW OF PREVIOUS EMPIRICAL RESEARCH. 53

4:THE EMPIRICAL SPECIFICATIONS AND RESULTS 70

5:THE RELATIVE FORECASTING PERFORMANCE OF THE EQUILIBRIUM AND DISEQUILIBRIUM FORMULATIONS 103

6:CONCLUDING REMARKS 106

IV. TOWARDS A MORE SATISFYING NON-WALRASIAN MODEL WITH CONJECTURES AND BAYESIAN LEARNING. 111

1:INTRODUCTION 111

2:CONJECTURES AND ADAPTIVE LEARNING 114

3:THE SINGLE MONOPOLIST 123

4:TOWARDS A MORE GENERAL MODEL WITH PRODUCTION AND CONSUMPTION 129

5:CONCLUDING REMARKS 143

V. CONCLUDING REMARKS 145

APPENDIX A: DERIVATIONS OF SOME RESULTS FROM CHAPTER 2 150

APPENDIX B: A MONTE CARLO STUDY OF SOME INTERATIVE SWITCHING REGRESSIONS ESTIMATORS 154

1:INTRODUCTION. 154

2:AN ITERATIVE ESTIMATOR. 156

3:MONTE CARLO STUDY FOR ILSE IN THE SINGLE MARKET CASE. 164

4:ESTIMATION OF MULTIMARKET SWITCHING REGRESSION MODELS. 170

5:MONTE CARLO STUDY FOR ILSE AND TSILSE IN THE TWO MARKET CASE. 176

6:A TSLS METHOD FOR THE TWO MARKET CASE WITH QUANTITATIVE EXTRANEOUS INFORMATION 184

7:CONCLUSIONS. 188

APPENDIX C: ESTIMATION OF THE DURBIN-WATSON STATISTIC WHEN THE VECTOR OF ESTIMATED RESIDUALS CONTAINS MISSING OBSERVATIONS 190

APPENDIX D: DATA SERIES AND DEFINITIONS 195

APPENDIX E: THE DERIVATION OF A SHORT-RUN LABOUR DEMAND FUNCTION 213

APPENDIX F: A SURVEY OF DIFFERENT TESTS FOR DISEQUILIBRIUM ..218

REFERENCES 223

LIST OF TABLES

TABLE		PAGE
3.1	Equilibrium Estimates of the Consumption Function	74
3.2	Equilibrium Estimates of the Goods Supply Function	75
3.3	Equilibrium Estimates of the Labour Demand Equation	77
3.4	Equilibrium Estimates of the Participation Rate Equation	79
3.5	Estimates of the Equilibrium Model with Ad hoc Adjustment Scheme	85
3.6	Disequilibrium Estimates of the Model: TSLS Method	92
3.7	Regime Classification on the Basis of Price and Wage Adjustment Data	96
3.8	Disequilibrium Estimates of the Model: Qualitative Method	97
3.9	Disequilibrium Estimates of the Model: ILSE Method	102
3.10	Equilibrium and Disequilibrium Estimates of the Lucas and Rapping Model for the U.S.: TSLS Method	104
3.11	Forecasting Performance for Gross National Expenditure	107
3.12	Forecasting Performance for Employment	107
3.13	Forecasting Performance for the Participation Rate	108
3.14	Forecasting Performance for Consumption	108

B.1 Characteristics of the Experiments 167

B.2 MSE of ILSE Estimates: The Single Market Case 168

B.3 Bias of ILSE Estimates: The Single Market Case 168

B.4 MSAD of ILSE Estimates: The Single Market Case 169

B.5 The Relative MSE Performance of OLS and ILSE 169

B.6 The Parameters of the True Model 177

B.7 The Characteristics of the Different Experiments 179

B.8 The Relative MSE Performance of ILSE and TSILSE: The Two Market Case 180

B.9 Bias of ILSE Estimates: The Two Market Case 181

B.10 MSE of ILSE Estimates: The Two Market Case 182

B.11 Bias of TSILSE Estimates: The Two Market Case 183

D.1 Description, and Definitions of Symbols used in Chapter 3 197

D.2 Data Series 200

LIST OF FIGURES

FIGURE		PAGE
2.1	The Notional Situation on the Goods Market and the Labour Market.	22
2.2	The Effective Situation on the Goods Market and the Labour Market	25
2.3	Iso-employment and Iso-output Lines and the Effective Market Constellation	28
3.1	Histograms of the Rates of Change of the Price Deflator and the Nominal Wage Rate	90
4.1	The Monopolist in Conjectural Disequilibrium	127
4.2	The Monopolist in Conjectural Equilibrium	127
4.3	A Monopolistic Producer and a Labour Union in Conjectural Disequilibrium	137
4.4	A Monopolistic Producer and a Labour Union in Conjectural Equilibrium	137
B.1	Step Function and its Cumulative Normal Approximations	159
B.2	The Dummy Generating Function	162

NOTE ON CROSS REFERENCES AND NOTATION

Throughout each chapter and appendix, equations, tables, and figures have been numbered consecutively. Appendices are identified by letters, whereas chapters are numbered. Only in references across chapters and appendices, is the chapter number or appendix letter included as part of the equation, table, or figure number. For example, equation (3.1) is the first equation in chapter 3, table B.10 is the tenth table in appendix B, whereas figure 2.1 is figure 1 in chapter 2. Furthermore, RHS(x) and LHS(x) denote the right hand side and left hand side of equation (x) respectively.

I. INTRODUCTION

This thesis is a report on the development of the author's personal research programme. Rather than viewing it as a finished product which needs no further elaboration, it should be seen as the result of a journey through a fast growing and exciting body of literature that is for the most part very recent, and is loosely referred to as "disequilibrium theory" or "non-Walrasian economics". We shall see that this literature can be separated into two distinct, and unfortunately in many cases disjoint, groups, namely theoretical and empirical. Consequently, our own investigation shall proceed along both lines as well.

The theoretical literature is to a large extent inspired by John Maynard Keynes' The General Theory of Employment, Interest, and Money, a book which, after nearly half a century, still exerts a powerful influence on contemporary theoretical and applied economists. One of the reasons for this continued interest by the profession may be that its message is still not fully understood: "Keynes ... was a very careless writer, very sloppy ... the General Theory contains nothing which we would recognize as a proof of any proposition" (Hahn, 1980, p. 164). Another, more positive, reason may be that "Keynes had a certain vision of the economy ... and I think that it is very relevant ..." (Hahn, 1980, p. 164). Hence, for nearly five decades, neoclassical theorists are still following Keynes' "vision" and are searching for the necessary microeconomic foundations: "... Keynes and the Keynesians were totally ignorant of value theory. They had no micro theory worth having. I don't think Keynes even understood it" (Hahn, 1980, p. 164). There are of course others who have denied the necessity of providing microeconomic foundations for Keynes' economics.[1] For example, the so-called Post Keynesians, who regard themselves as the true and only executors of Keynes' legacy, claim that the "neoclassical synthesis" of the postwar period is fallacious because "the essential logic of Keynes' economic theory was discarded" (Davidson, 1981, p. 151).[2] In their view, neoclassical economists assume full employment from the outset, and are consequently forced to view unemployment as a purely temporary "disequilibrium" situation, caused by money-wages being too high and rigid (Davidson, 1981, pp. 154-156).

As we shall see in the critical literature survey contained in chapter 2 of this thesis, this is indeed the main criticism that has been levelled against the early non-Walrasian models. As one of the main proponents of non-Walrasian economics, Frank Hahn, puts it:

---

[1]We do not claim to have surveyed the entire massive Post Keynesian literature. It seems that Davidson (1981) is a fairly representative member of this school of thought and he will therefore serve as a "scapegoat".

[2]It must be stressed here that this thesis is not about Post Keynesian economics, nor is it intended as an historical analysis of the Keynesian Revolution. Davidson's main criticisms against neoclassical theory in general are included here merely in order to show that they have been accomodated by modern non-Walrasian theorists.

> Recent fixed-price models certainly do not capture what Keynes was after, and in any case are quite unsatisfactory as long as they lack a theory of price formation. But at least they introduced quantity signals into the story which is the beginning of good sense (1982, p. 62).

Therefore, the second part of chapter 2 is devoted to the more recent literature on non-Walrasian economics including explicit price setting. Interestingly enough, it is shown there that a link can be traced back between this literature and the monopolistic competition literature of the early 1930s. Hence, Keynesian macroeconomics and the monopolistic competition literature that were originally offered as <u>alternative</u> explanations for the world-wide economic crisis of the 1930s with its persistent high unemployment, now find themselves more or less integrated in this (new) non-Walrasian explanation of the modern day crisis of the 1970s and 1980s. A certain feeling of "deja vu" imposes itself upon us. The main conclusion we come away with in chapter 2 is that "an economy can have bootstrap equilibria ... which are perfectly rational for each of the agents, [but] which nevertheless are very bad equilibria" (Hahn, 1980, p. 164). Hence, one of the objections raised by the Post Keynesians, that of equating unemployment with disequilibrium, has been countered by the purely neoclassical theory of Hahn (1978). Other Post Keynesians objections to neoclassical theory in general are that: (i) the economy is a process in historical time, (ii) expectations have unavoidable and significant effects on economic outcomes, and (iii) economic and political institutions play an important role in determining real world economic outcomes (Davidson, 1981, pp. 158-162). With regard to the first two of these, Hahn has shown that neoclassical non-Walrasian economics is fully consistent with uni-directional and irreversible time, as well as with expectations (1982, pp. 2-3).[3] Consequently, it seems that although the Post Keynesians, were probably correct in their verdict on the early postwar "neoclassical synthesis", it is far from obvious whether they are also right about their conjecture that neoclassical theory _per definition_ cannot help to develop the research programme started by Keynes some fifty years ago.[4]

In chapter 3, we make our contribution to the relatively meagre and scattered literature on empirical non-Walrasian models. To that effect, we survey the available studies, both Walrasian and non-Walrasian, especially in the Canadian context. It is shown that, in both types of study, the use of adjustment mechanisms is frequently left without any theoretical justification. Methodological reasons lead us to conclude that empirical testing in the strongest sense is impossible, but that

----

[3]With regard to Davidson's third objection, that of neglecting the importance of institutions in neoclassical economics, one needs only to refer to the work of Coase (1937, 1960), in which institutions are themselves the outcome of economically efficient decisions made by individuals, and hence are certainly not deemed to be unimportant. These, and other issues, are further pursued in Heijdra and Lowenberg (1983).

[4]We shall introduce Lakatos' (1978) methodology of scientific research programmes in some detail in chapter 3 below. At the risk of anticipating our discussion somewhat, we may conclude that neoclassical non-Walrasian economics is certainly not a degenerate research programme in the Lakatosian sense. See also Leijonhufvud (1976) for a discussion, in Lakatosian terms, of the Keynesian Revolution in the postwar period.

instead, econometric results should be viewed as "circumstantial evidence" aiding theorists in their choice of which research programme ought to be pursued by them. Some empirical evidence is presented on the relative usefulness of non-Walrasian and Walrasian models in the Canadian context.

In chapter 4, we report our own attempts at constructing a non-Walrasian model, making use of Hahn's insights on the possibility and likelihood of bootstrap or self-fulfilling equilibria. In addition to this, we include an endogenous learning theory in our model, utilizing Bayesian decision theory. This enables us not only to speak of the existence of (non-Walrasian) equilibria, but also of the adjustment mechanism steering the economy towards these equilibria. In other words, real time and expectations formation form an integral part of the model. Although nobody knows for sure "how people really learn", as the multitude of different theories of learning in psychology indicates, we feel confident that the Bayesian approach brings out the central element of learning in an economic context, where new observations on a small number of key variables become available to each agent every day, and these observations are then used by the individual agent to update his "personal theory" about the world.

Chapter 5 reports the main conclusions that can be drawn from the thesis as well as the possibilities for further research. Some of the more technical aspects of this thesis, including the development and Monte Carlo simulations of a computationally cheap estimator for the switching regression case, are relegated to a number of appendices at the back. Finally, we would like to re-iterate that, paraphrasing Bowden (1978a, p. viii), we may not have produced a "cut and polished jewel" but have instead wandered "with the hope of picking up a few stones which may be indications of more valuable finds to come."

II. A SURVEY OF NON-WALRASIAN ECONOMICS.

1: INTRODUCTION

In this chapter we give a selective survey of so-called "disequilibrium" models which explicitly challenge the traditional neoclassical assumption of tatonnement and the auctioneer.[1] The term disequilibrium is very misleading, however, as all the models discussed below are equilibrium models with the only difference being the fact that the auctioneer, who serves as a useful device ensuring continuous market clearing in the traditional models, has been "laid-off". Roughly speaking all the models have in common the explicit aim of deriving a macroeconomic model from microeconomic foundations, mostly by using highly aggregated agents. The second common denominator is the fact that most models derive their raison d'etre from Keynes' General Theory and several concepts introduced by Keynes without explicit derivations are in fact by-products of the models described below. Examples are the consumption function, involuntary unemployment and the

----

[1]The auctioneer, whose behaviour is not based on maximization principles, precludes Walrasian general equilibrium theory from establishing a completely "psychologistic" explanation of the economic system. In this sense, the non-Walrasian models we discuss below aim at such an explanation and hence exhibit a higher degree of consistency. See also Arrow (1959, p. 43) and Boland (1982, p. 50-51).

multiplier.

When an economy without an auctioneer is described, it is useful - as a first approximation - to assume the price vector to be fixed altogether. Section 2 describes models of this type, starting with the work of Patinkin (1956) and Clower (1965) and refined by Barro and Grossman (1971, 1976) and Benassy (1975). This section includes an extensive example of a disequilibrium model based on Benassy (1978). Section 3 describes the main criticism these types of models have encountered in the literature. In section 4 a number of models are described which carry the analysis one step further and explicitly introduce price setting behaviour. In the absence of the auctioneer and with recognition of divergences between plans and realizations it is a reasonable assumption, following Arrow (1959), to assign the task of price setting to one (or some) of the agents, i.e. to introduce some sort of imperfectly competitive behaviour. The models described in this section consequently exhibit an increasing level of mathematical sophistication together with decreasing empirical tractability. In the last section we give some concluding remarks. In Appendix A to this thesis some of the longer derivations from section 2 are presented in detail.

2:FIX PRICE MODELS

The earliest attempt to deal with economies characterized by sticky prices and wages is Patinkin (1956). In chapter 13 of his book, Money, Interest, and Prices, he discusses involuntary unemployment, which can only occur if firms are off their Walrasian labour demand curve. However, this curve is derived on the implicit assumption that firms can sell all of the resulting output at the prevailing prices. As soon as this assumption is violated and firms encounter a sales constraint, the resulting labour demand will differ from the Walrasian labour demand. In a subsequent contribution Clower (1965) analyzes the behaviour of households with and without quantity constraints. Notional behaviour is defined as resulting from utility maximization subject to the budget constraint. However this notional behaviour is only relevant when the economy is in equilibrium and all plans are realized. As soon as the price vector is different from the Walrasian market clearing price vector and is fixed, some agents will be unable to realize their notional behaviour and instead will send effective signals to the market. Effective behaviour is defined as the result of utility maximization subject to the budget constraint and the quantity constraint(s) due to the "wrong" price vector. Below we will discuss the different definitions of effective behaviour in the subsequent literature following Clower and Patinkin.

Using the dual decision hypothesis, Clower is able to show that the Keynesian consumption function is the effective demand for goods when households are unable to sell as much labour as they wish at the existing vector of prices. This can be clarified by the following example, which is a simple version of Clower's model. Suppose there are two goods, labour and a consumption good, denoted by L and C respectively. Households have the following utility function:

$$(1) \qquad U = a1 * \log(C) + a2 * \log(T-L) \qquad a1,\ a2 > 0$$

where T is the maximum number of hours supplied, which is assumed fixed. Households face the following budget constraint:

$$(2) \qquad R + w * L = p * C$$

where w and p are the wage rate and the price of the consumption good respectively and R is the anticipated distributed profits which are assumed to be fixed. The notional labour supply and goods demand are now obtained by maximizing (1) subject to (2):

$$(3) \qquad Ls = \frac{a1 * T}{a1 + a2} - \frac{a2 * R}{(a1 + a2) * w}$$

$$(4) \qquad Cd = \frac{a1*(w*T + R)}{(a1 + a2)*p}$$

These notional schedules are a function of wages and prices plus the exogenous variables only.

Suppose now that the household is constrained in the labour market and can only sell Lo units of labour where $Lo < Ls$. The household is now forced to abstain from its notional demand for consumption goods and instead sends effective signals to the market. The relevant maximization problem is now as follows:

$$(5) \qquad \underset{\{C\}}{MAX}\ U = a1*\log(C) + a2*\log(T-Lo)$$

$$(6) \qquad s.t.\ R + w*Lo = p*C$$

This yields the effective (or to use Clower's terminology, constrained) demand for consumption goods, denoted by Cde :

$$(7) \qquad Cde = \frac{R + w*Lo}{p} = \frac{Y}{p}$$

where Y denotes exogenous nominal income. This expression is of course nothing else than the Keynesian consumption function in which quantity signals enter the behaviour of the households.[2]

Clower also shows that, in the case of effective behaviour due to the existence of quantity constraints, Walras' Law is no longer valid:

> Contrary to the findings of traditional theory, excess demand may fail to appear anywhere in the economy under conditions of less than full employment (1965, p. 122)

This point is also stressed by Leijonhufvud (1967, 1968, 1969) in his important re-interpretation of Keynes' magnum opus. Leijonhufvud suggests that the basic novelty in the economics of Keynes is the fact that prices do not move infinitely faster than quantities. In this sense an analysis which takes the extreme case and assumes total price inflexibility could be a reasonable (first) approximation to Keynes' price theory.[3]

----

[2]The difference between the notional and effective demands for consumption goods lies in the exogeneity of income in the latter case, caused by a constraint in the labour market. Because households in this simple model have no possibility of saving, they always consume their entire income. Later models by Benassy (1975), Malinvaud (1977) and Muellbauer and Portes (1978) introduce real balances into the utility function. In that case households save by accumulating money balances and the marginal propensity to consume is not necessarily equal to unity. Compare equation (23) in the text.

[3]According to Drazen (1980), the main problem with Leijonhufvud's approach is that nowhere does he formalize his concepts into a model based on the maximization principle. If we want to formalize an economy in which, as Leijonhufvud suggests, prices adjust more slowly than quantities, we run into serious modeling problems because we would have to construct an explicitly dynamic model. Benassy (1976) is an example of a model that attempts to incorporate Leijonhufvud's ideas regarding the relative speed of adjustment.

Leijonhufvud states the basic features of Keynesian price theory: (i) agents maximize objective functions, (ii) price incentives do work, (iii) there may exist a full employment price-wage vector, (iv) there is no auctioneer (1967, pp. 409-410).

Barro and Grossman (1971, 1976) combine Patinkin's analysis of firms under disequilibrium conditions with Clower's analysis of households facing quantity constraints. They use the fix price method to derive the different equilibria that may result, depending on the different price-wage constellations.[4] Distinguishing two goods, labour and a consumption good, they show the existence of three different regions: general excess supply, general excess demand, and a mixed case of excess demand for consumption goods and excess supply of labour. In Barro and Grossman (1976) they expand the model by adding price and wage adjustment equations of the usual (ad hoc) kind where adjustment depends on the excess effective demand.[5] As Arrow (1959) pointed out, however, these functions do not make sense under conditions of disequilibrium, so that we cannot really take seriously the resulting convergence to the Walrasian equilibrium which they

----

[4]The term fix price method is due to Hicks (1965). This method analyzes the equilibrium that will result if one takes the price vector to be fixed, i.e. if one assumes that the period is short enough for prices to remain fixed.

[5]Barro (1972) discusses monopolistic price setting under stochastic demand and claims to derive the usual price adjustment equation from the maximizing behaviour of the firm. However, as Gordon (1981) notes, what Barro calls excess demand is not what is usually meant by that term (it corresponds to the error term of the stochastic demand curve).

predict.[6] Below we discuss quantity constrained models that include price setting behaviour in a theoretically more convincing fashion. The most sophisticated contribution in the class of fix price models without endogenous price setting is Benassy (1975), a model that is also used by Malinvaud (1977). This model is sketched in some detail in order to clarify the nature of equilibrium in quantity constrained models of this sort. The model describes a monetary economy where all transactions are against money only. Prices of all goods are assumed to be fixed. During a given period, individuals visit successive markets expressing net effective demands against money. The main body of the paper uses a simultaneous version of the model with tatonnement in quantities.[7] When trading at non-Walrasian prices takes place, there exists disequilibrium somewhere in the system and net effective demands are the relevant signals. Before defining these effective demands, two important concepts need to be explained, namely the rationing scheme and the perceived constraints. When agents are on the short side of a market they cannot all be satisfied and a rationing scheme has to be introduced in the model.[8]

---

[6] Another contribution by Grossman (1971) suffers from the same defect in that ordinary adjustment functions are used in a disequilibrium setting.

[7] In an appendix to Benassy (1976) the sequential trading version of the model is explicitly analyzed. The order in which markets are visited is assumed exogenous. Benassy claims that the two models yield comparable results.

[8] As Drazen has noted, several types of rationing schemes have been used in the literature: deterministic, stochastic, manipulable, non-manipulable (1980, p. 288). See also section 4

Benassy imposes the following inherently reasonable hypotheses regarding these functions: (i) voluntary exchange: one cannot force any agent to trade more than he wishes, (ii) frictionless markets: there cannot be both rationed sellers and buyers in the same market, (iii) all rationing functions are continuous functions of effective demands. A second important concept for the determination of effective demands is that of constraint perception. To simplify the analysis, Benassy assumes specialized goods, i.e. a given agent is either a demander or a supplier of the good but he never changes sides. A perceived constraint is defined as the maximum amount an agent expects to be able to trade on any given market. Furthermore, it is assumed that the agents estimate these perceived constraints as a function of all their information, which in turn is a function of all effective demands. Again a number of hypotheses is made regarding the nature of the perceived constraint functions: (i) agents on the long side of a market take their realized transaction as the perceived (objective) constraint, (ii) agents that can fulfil their net demands may perceive (subjectively) some additional trading possibilities in the same direction, especially if they are on the short side of the market, and (iii) the perceived constraint functions are continuous in their arguments.

---

[8](cont'd) of Grandmont (1977a) for a discussion of different rationing schemes, as well as Benassy (1977) and (1982, p. 17-27).

The next important ingredient in Benassy's analysis is the utility function which includes money balances as a store of value yielding indirect utility. Roughly speaking, this indirect utility can be seen as resulting from the recursive solution of a multiperiod stochastic optimization problem.[9] We now have all the ingredients necessary to give the Benassy definition of effective demands. The net effective demand for good h is the h-th component of the vector that maximizes utility given the budget constraint and the perceived constraints in all markets <u>other</u> than that for good h.[10] Only this effective demand for h (and none of the other components) is submitted to the market.[11] In this sense the agents are, to use the words of Drazen (1980, p. 289), allowed to "experiment": they may submit effective demands that violate their constraints in order to find out whether these constraints are binding. Benassy goes on to show the existence of a so-called K-equilibrium where effective

----

[9]Muellbauer and Portes (1978), in a model similar to Benassy (1975), involving maximization by firms and households over two periods, derive the indirect utility of money. They, like Benassy, point out that the multipliers might become very unstable due to expectations effects on money balances. See also Grandmont (1977a), section 2 for a discussion of the role of expectations in this type of analysis as well as further references.

[10]An alternative definition of effective behaviour is given by Dreze (1975). In his model agents take into account the constraints on <u>all</u> markets when forming the effective demand for a certain good. This model furthermore differs from Benassy's in that prices are rigid but not fixed. See also Drazen (1980, p. 287-288).

[11]In order to obtain the effective demands for the other goods, there will be as many optimization programmes to be calculated as there are goods, excluding money.

demands, perceived constraints, and realized transactions are all consistent with the rationing and constraint perception functions and they maximize utility over the relevant constraint set.[12] To clarify the nature of such a K-equilibrium we present an example that is due to Benassy (1978).[13] There are again two goods, labour and a consumption good, denoted by L and C, with wage rate w and price p. Furthermore, the stock of money balances is denoted by M. The household's utility function is as follows:

(8) $U = a1*\log(C) + a2*\log(T-L) + a3*\log(M/p)$

and the household's budget constraint is:

(9) $p*C + M = Mi + R + w*L$

where Mi and M are intitial and final money balances respectively, and R is the firms' profits, assumed to be distributed to the households. The firms have a short run

---

[12]Grandmont (1977b) points out that the logic of the Benassy analysis implies recontracting among agents at fixed prices or tatonnement in quantities (the multiplier effect), and trading at "false" quantities is assumed away. This point was also recognized by Benassy (1975, 1976).

[13]This example, which we follow quite closely, has also been used by Grandmont (1977b), Negishi (1979), chapter 5, and in a slightly modified form by Malinvaud (1977).

production function of the following kind:

$$(10) \qquad C = b1*L^{b2} \qquad b1 > 0 < b2 < 1$$

There are no investments or inventories.[14] Firms are assumed to maximize profits that are defined as:

$$(11) \qquad R = p*C - w*L$$

The notional labour demand and goods supply are obtained by maximizing the profit function (11) with respect to L, subject to the short run production function (10):

$$(12) \qquad Ld = c1*(w/p)^{1/(b2-1)}$$

$$(13) \qquad Cs = c2*(w/p)^{b2/(b2-1)}$$

----

[14] Muellbauer and Portes (1978) consider a model in which inventories are introduced that serve a similar role as money balances for the households, namely as a buffer against unanticipated shocks. Introduction of investment and hence medium term growth considerations would require an explicitly dynamic model of overwhelming complexity.

$$c1 = (b1*b2)^{1/(1-b2)} > 0$$

$$c2 = b1*c1^{b2} > 0$$

The notional labour supply, goods demand and money demand are obtained by maximizing utility (8) with respect to L, C, and M/p subject to the budget constraint (9):

(14) $$Ls = \frac{(a1 + a3)*w*T - a2*(Mi + R)}{(a1 + a2 + a3)*w}$$

(15) $$Cd = \frac{a1*(Mi + R + w*T)}{(a1 + a2 + a3)*p}$$

(16) $$Md = \frac{a3*(Mi + R + w*T)}{a1 + a2 + a3}$$

But, in view of (11), we can substitute for the planned profits $(p*Cd-w*Ls)$ and rewrite these notional schedules as follows:

(17) $$Ls = T - \frac{a2*Mi}{a3*w}$$

(18) $$Cd = \frac{a1*Mi}{a3*p}$$

(19) $$Md = Mi$$

We can now distinguish five <u>notional</u> states of the economy:[15]

Classical Unemployment (C): $Ls>Ld$ and $Cs<Cd$,

Keynesian Unemployment (K): $Ls>Ld$ and $Cs>Cd$,

Repressed Inflation (R): $Ls<Ld$ and $Cs<Cd$,

----

[15] Malinvaud (1977) distinguishes only three cases as in his model firms cannot be rationed in both markets simultaneously due to the absence of inventories. Muellbauer and Portes (1978) introduce inventories so that their model can analyze the fourth case where firms face excess supply in the goods market and excess demand in the labour market and hence must be adding to their inventories. This fourth case they refer to as underconsumption.

Underconsumption (U): Ls<Ld and Cs>Cd,

Walrasian Equilibrium (W): Ls=Ld and Cs=Cd.

Equations (12), (13), (17) and (18) are drawn in Figure 1 with w/p and M /p on the axes.[16] Given the notional market situation we can now distinguish a number of effective market situations. In doing so we have to take account of the requirement of voluntary trade which implies that the quantity traded is the minimum of quantities demanded and supplied.

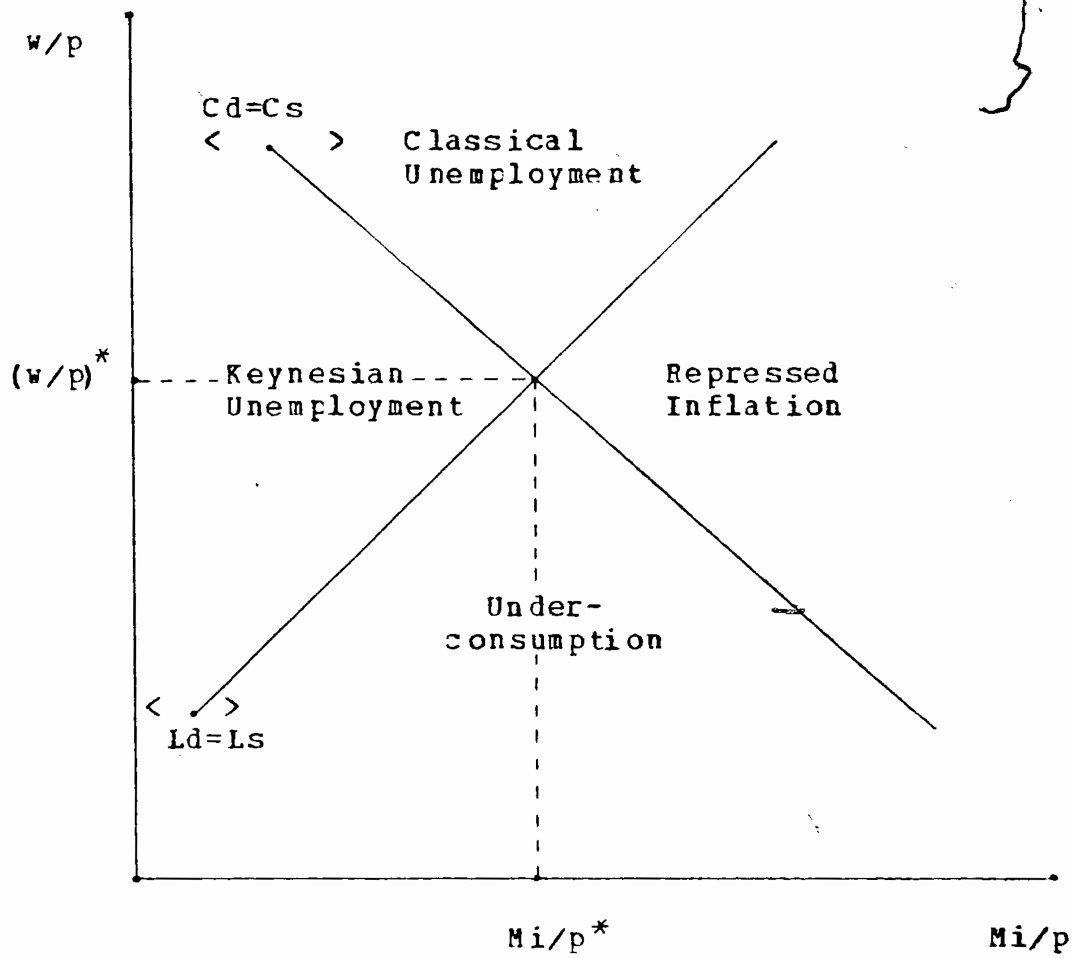
In the region of Classical Unemployment (C) households are constrained in the labour market and hence formulate their effective demand for consumption goods, where effective values are denoted by "e". At the same time they are constrained in the goods market and their effective labour supply is relevant. In formal terms this is represented as follows:

(20) Cs = Co and Ld = Lo

where the index "o" denotes the (perceived) constraints. Households maximize utility (8) with respect to C and M/p subject to the budget constraint (9), and the constraint on their sales of labour services to obtain the effective demand for goods:

---

[16]These curves are drawn as straight lines for illustrative purposes only.



<u>Figure 1: The Notional Situation on the Goods Market and the Labour Market.</u>

$$\text{(21)} \qquad Cde = \frac{a1*(Mi + R + w*Lo)}{(a1 + a3)*p}$$

Their effective labour supply can be derived in a similar fashion by taking account of the constraint on their purchases:

$$(22) \qquad Lse = T - \frac{a2*(Mi + w*T + R - p*Co)}{(a2 + a3)*w}$$

In view of the realized profits (p*Co-w*Lo), these equations can be rewritten as:

$$(23) \qquad Cde = \frac{a1*(Mi + p*Co)}{(a1 + a3)*p}$$

$$(24) \qquad Lse = T - \frac{a2*(Mi + w*T - w*Lo)}{(a2 + a3)*w}$$

These schedules are confronted with the notional supply of goods (13) and the notional labour demand (12) as firms are not rationed at all. Starting at the Walrasian point W in <u>Figure 2</u>, we can trace out a line ensuring equality between Cde and Cs . This line can be shown to coincide with the notional goods market equilibrium line WA. The line ensuring equality between Lse and Ld correspondingly coincides with the notional labour market equilibrium line WB.[17]

In the region of Keynesian Unemployment (K) households are constrained in the labour market only and formulate their effective demand for goods. Firms are constrained in the goods market (face a sales constraint) and formulate their effective demand for labour:

$$(25) \qquad Lde = (Co/b1)^{1/b2}$$

$$(23) \qquad Cde = \frac{a1*(Mi + p*Co)}{(a1 + a3)*p}$$

The transactions are determined by the short side of the markets:

$$(26) \qquad Lde = Lo \quad \text{and} \quad Cde = Co$$

We already know that WA is the line ensuring Cde=Cs. We also know that the slope of the line Lde=Ls is larger than that of

----
[17]See appendix A.

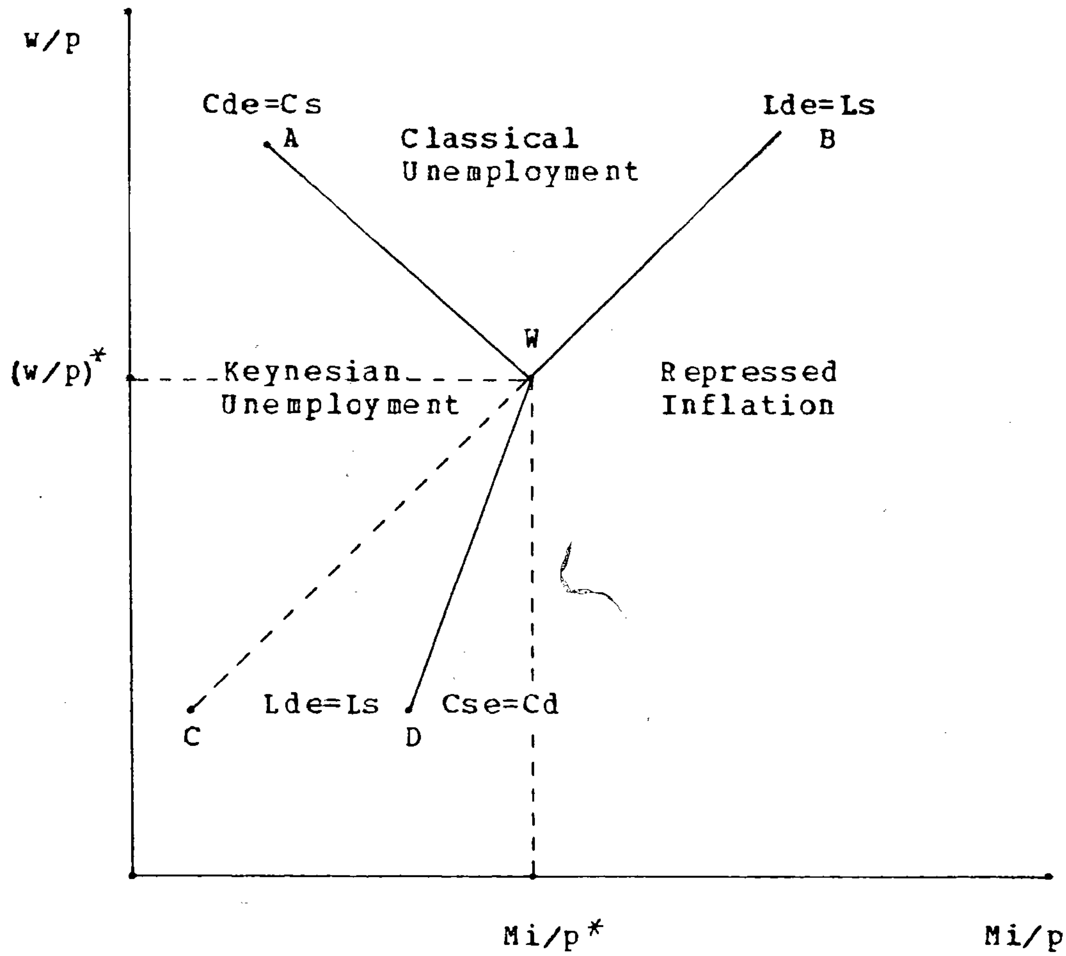


Figure 2:The Effective Situation on the Goods Market and the Labour Market

the Ls=Ld line because Lde<Ld.[18] The line Lde=Ls is drawn as WD in Figure 2.

In the region of Repressed Inflation (R) there exists excess demand in both markets. Households cannot buy all the goods they want and hence formulate their effective supply of

[18]See appendix A.

labour (they substitute part of their forced savings for leisure). Firms cannot buy all the labour they want and hence formulate their effective supply of goods:

$$(24) \qquad Lse = T - \frac{a2*(Mi + w*T - w*Lo)}{(a2 + a3)*w}$$

$$(27) \qquad Cse = b1*Lo^{b2}$$

The short side of the market determines the transactions:

$$(28) \qquad Lse = Lo \quad \text{and} \quad Cse = Co$$

In view of (28), (24) can be written as:

$$(29) \qquad Lse = T - \frac{a2*Mi}{a3*w}$$

Hence, we see immediately that the line Lse=Ld must coincide with WB in <u>Figure 2</u>. The effective supply of goods is confronted with the notional demand for goods. It can be shown that this line coincides with the line derived earlier for the Keynesian case: WD.[19]

In this model, where firms do not accumulate inventories, the Underconsumption region collapses to the line WD. In Figure 2 the solid lines separate the three different regions. Benassy furthermore introduces iso-employment and iso-output lines which are shown in Figure 3. The closer the economy gets to W, the larger output and employment are.

Grandmont (1977b) mentions a number of conclusions that can be drawn from this simple model: (i) a decrease in the nominal wage, holding M and p constant, has positive output effects only in the Classical Unemployment region and negative or zero effects in the other cases, (ii) an increase in initial money balances, holding w and p constant, has positive output effects in the Keynesian Unemployment region and zero or negative effects in the other cases. These conclusions can be easily checked with the help of Figure 3. Malinvaud (1977) discusses the effects of fiscal policy as well as price and wage policies in a model slightly more detailed than the one discussed above. His results can be summarized as follows: (i) In the Keynesian Unemployment region, expansionary fiscal policy or balanced price and wage deflation will have beneficial effects, both in utility and market balancing terms. Specific measures aimed at wages or prices separately are ambiguous in their effects. (ii) In the region of Classical Unemployment an expansionary fiscal

---

[19] See appendix A.

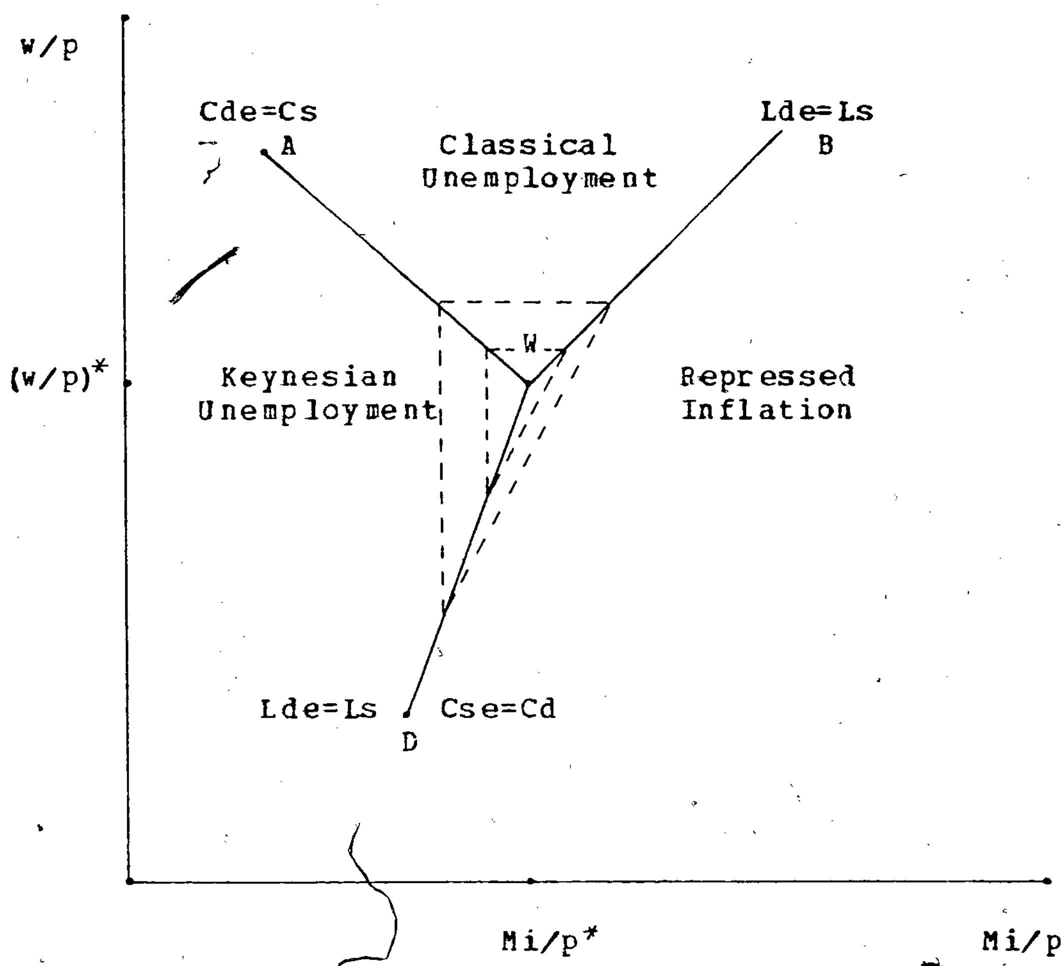


Figure 3: Iso-employment and Iso-output Lines and the Effective Market Constellation.

policy works in a redistributive way. Due to increased rationing on the goods market, employed households will consume less and take more leisure. Output being constant, this will mean more people working and hence smaller unemployment. A general deflation of wages and prices will have roughly the same effects. Again specific wage and price measures have ambiguous effects. (iii) In the Repressed Inflation case restrictive fiscal policy will have beneficial effects. A general inflation of prices and wages will be beneficial, provided rationing is strong.

3:CRITICISM OF FIX PRICE MODELS.

In this section we briefly indicate the objections that have been raised against the fix price models described above. The most common criticism is the fact that these models merely assume the prices to be fixed and never explain why this is the case, a point noted - among others - by Drazen (1980). Therefore, the models have "too many" equilibria and consequently only weak predictive power (Gale, 1983, p. 17). One suggested rationale for firms to adjust prices more slowly than quantities is the existence of inventories. Kawasaki, McMillan and Zimmermann present empirical evidence showing that output and prices are both adjusted in response to demand changes that are perceived to be permanent, but that transitory changes are met with output changes only (1983, p. 606). This model can obviously not serve as a rationale for continual price inflexibility in the face of ongoing disequilibria since firms would inevitably learn to distinguish permanent from transitory changes in demand. Barro (1979) also expresses his doubts regarding the validity of the fix price assumption, as it implies an unexplained inefficiency of the private sector relative to the government. It was expected that the contracting literature would provide the rationale for this price fixity. However, this literature takes the stand that continuous market clearing is a better framework for analyzing employment and output determination. Instead of deriving Keynesian results from a model in which certain gains from trade remain unexploited, Barro finds it more rewarding to focus on expectations as a possible source of divergence between efficiency of private agents and the government. A final verdict should be based on empirical results, a stand he also takes in a later paper (1980). Grossman (1979) has also renounced his earlier work on non-clearing markets, but instead of following Barro in adopting the equilibrium view, he retains the assumption that the economy is basically non-Walrasian. In his view the economy can be adequately described by incomplete information models plus implicit contracts.[20]

Another criticism that can be leveled against the simple static disequilibrium models described above is the absent or ad hoc treatment of expectations. Neary and Stiglitz (1983) develop a two period model with sticky wages and prices in which agents form expectations of future quantity constraints. These expectations in turn influence the present behaviour of the agents. They show that even in the case of rational constraint expectations, which in their deterministic model amounts to perfect foresight, Walrasian equilibrium is not guaranteed

---

[20]See Azariadis and Stiglitz (1983) for a discussion of the possible interaction between the implicit contract literature and the fixed price disequilibrium literature.

(Neary and Stiglitz, 1983, pp. 218, 224). Their model is of course subject to the same criticism as the early disequilibrium models in that the fixity of wages and prices is not explained in any way within the model.[21] Their model does allow for the existence of so-called "bootstrap" equilibria which are, as we shall see in the next section, at the core of the most recent non-Walrasian models with explicit price setting.[22]

Against the criticism of Barro (1979) and Grossman (1979), we maintain that, even though fix price equilibria can be shown to be inefficient when compared to the pure flex price model, this might be the wrong comparison. If the economic system is better described by a model without an auctioneer then the concept of efficiency _with_ an auctioneer loses its relevance as the standard of comparison. Benassy (1975) shows that the non-Walrasian equilibria are efficient if there does not exist a Pareto improving chain of pairwise barter trades. This is a requirement most likely to be fulfilled in the decentralized

---

[21]They defend price and wage fixity as follows: "One possible objection to our concept of rational constraint expectations is that with so much information available, agents should be able to change prices directly to attain Walrasian equilibrium. We believe, however, that this type of argument greatly underestimates the difficulty of coordinating individual behavior in a decentralized economy with highly imperfect information. In such an environment the two assumptions of rational expectations and wage-price flexibility are by no means equivalent" (Neary and Stiglitz, 1983, p. 225).

[22]Peeters (1983a, 1983b) extends the analysis of Neary and Stiglitz by working with a dynamic overlapping generations model, and shows that beside the traditional Walrasian equilibrium, there exist a continuum of equally rational equilibria with unemployment.

systems of the western world. In our opinion, most of the criticism could be countered if we were able to augment the fix price models with a specific price adjustment mechanism in the face of non-Walrasian equilibria. Therefore, we will now discuss a number of models that include endogenous price setting while retaining the basic non-Walrasian characteristics.[23]

4: MODELS WITH ENDOGENOUS PRICE SETTING.

The arbitrary nature of the additional constraints on the agents' optimization procedure (i.e. the fixed price vector that leads to frustration of plans), leads to the development of a second generation of non-Walrasian models, which all derive from a much cited paper by Arrow (1959). The central idea is that in the absence of the (costless) auctioneer (a curiosum not explained within the general equilibrium system of maximizing agents), price taking behaviour on the parts of all agents is theoretically untenable outside of equilibrium:

> ... when supply and demand do not balance, even in an objectively competitive market, the individual firms are in the position of monopolists as far as the imperfect elasticity of demand for their product is concerned (1959, p. 46).

Hence, once again it becomes clear that the early non-Walrasian models of the fix price type, which assumed price taking behaviour on the part of all agents even in conditions of disequilibrium, cannot serve as an adequate theory of the short

----

[23] The next section relies heavily on Heijdra and Lowenberg (1983).

run. A related point that Arrow makes is that outside of equilibrium there is no logical necessity for the law of one price to hold (1959, p. 46). In other words, we might say that outside of equilibrium the price ceases to be the only relevant information-carrying signal, or to cite the words of Arrow once again:

> In conditions of disequilibrium ... a premium is placed on the acquisition of information from sources other than prices and quantities of the firm's own sales (1959, p. 47).

Arrow's paper makes perfectly clear that in order to build a theoretically consistent non-Walrasian model, the inclusion of some sort of price setting behaviour is inevitable.

In the last two decades, two different ways of including price (and wage) setting have been introduced into the non-Walrasian literature. The first approach, suggested by Negishi (1960-1961), formalizes the earlier literature on monopolistic competition. Hart uses a similar model to derive Keynesian results like the multiplier (1982). In this model, monopolistically competitive firms and unions set the prices and wage rates, based upon perceived demand curves for goods and labour respectively. Elsewhere, Negishi analyzes "Keynesian" equilibria with the help of kinked perceived demand curves (1979, pp. 87-98). Slight changes in effective demand are accomodated entirely by quantity adjustment with prices remaining fixed (1979, p. 90). This result obtains because of the discontinuity in the perceived marginal revenue curve at the current level of output. Negishi's claim that price fixity is now explained rather than assumed (as in the first generation fix price models) seems to be unwarranted since the reasons he mentions for the existence of the kink are not very convincing and are based upon unexplained asymmetric behaviour of consumers (1979, pp. 36, 81).

A subsequent contribution explicitly introducing quantity constraints is presented by Grandmont and Laroque (1976). In their model all prices are set by sellers and fixed at the beginning of the period. Quantity adjustments take place within the period. In order to set their own prices agents have to forecast all other prices, the maximum quantities they can trade at these prices, and the effective demand for their goods (or labour if the agent is a consumer-worker). Hence expectations regarding the future state of the economy play an important role in determining the agents' behaviour in the current period. If firms' expectations are particularly pessimistic and labour supply is inelastic, then there will be involuntary unemployment at all positive wages. This result obtains because in their model the amount of labour demanded is strongly influenced by the firms' expectations about future effective demand (Grandmont and Laroque, 1976, pp. 60-61).[24]

---

[24]The term "involuntary" is not clearly defined by them. Negishi seems to equate "involuntary" with "constrained" (1979, p. 5-6). This seems strange because virtually every outcome of neoclassical theory would be "involuntary" under this interpretation. Hahn defines the technical concept of involuntary unemployment as that situation in which "... the shadow real wage of the unemployed is below the prevailing real wage." (1982, p. 49). He gives the following example: "... suppose you are an unemployed professor and you can get a job as an advisor to Mrs. Thatcher. You may be perfectly willing to

The second way of incorporating price setting behaviour in non-Walrasian models is to view all firms as pure monopolists who set the price of their goods such that profits are maximized. An example is Benassy (1976). In this model the economic agents are assumed to behave as follows: (i) firms fix the prices at the beginning of the period on the basis of their (subjective) perceived demand curve; (ii) within the period, quantity adjustment will occur and a K-equilibrium, described in section 2 above, will be established and transactions will be executed; and (iii) firms will observe a new price-quantity constellation and re-estimate their perceived demand curves. A general monopolistic equilibrium is attained if no firm wants to change its price on the basis of its observations.

The most advanced work in the group of second generation non-Walrasian equilibium models is that of Frank Hahn (1977, 1978). In contrast with the above mentioned authors, Hahn wishes to nest a Walrasian equilibrium in the general non-Walrasian model, rather than make imperfect competition intrinsic to the model (1978, p. 2). In his model agents form conjectures or "theories" of how a given constraint might be relaxed by offering at a different price. In other words, agents are now allowed (partially) to trade their way out of rationed situations. The agents maximize their objective functions

---

[24](cont'd) work rationally as a professor at a wage less than that prevailing for this group, without being willing to move to 10 Downing Street. As a professor you are involuntarily unemployed." (1982, p. 50).

subject to, among other things, their conjectures and, under certain conditions, a non-Walrasian equilibrium exists, even though prices are perfectly flexible. Two assumptions are made about these conjectures: (i) agents that are not experiencing a quantity constraint act as price takers, i.e. they are implicitly assumed to be unable to observe the constraints of the other agents; (ii) agents that are experiencing a quantity constraint conjecture in a non-perverse and unsophisticated way, i.e. they conjecture that they must raise (if buyers) or lower (if sellers) the price that they offer. Hahn maintains that the first assumption is rather strong and may need additional justification in terms of informational imperfections (1978, p. 8). A conjectural equilibrium implies that all markets are cleared and all agents accept the prices as optimal. Hahn points out that although the conjectures are exogenously given and hence arbitrary, the same holds for the ones that are implicit in the traditional Walrasian model, namely that agents can trade whatever they wish at given prices, which can only be true in equilibrium (1978, p. 11). Concepts that are well defined in Walrasian equilibrium theory like rationality and correctness become extremely difficult in a non-Walrasian setting, e.g. agents may be right for the wrong reasons but this would only be revealed to them by experimentation and not by observation. Drazen (1980) points out that in a world of costly search, experimentation may be absent, so that the non-Walrasian equilibrium may be called rational. This aspect of non-Walrasian theory has not yet been well developed. Although far from perfect, Hahn's approach seems to be the most fruitful avenue towards more satisfying non-Walrasian models.

5: CONCLUDING REMARKS.

The main points in this chapter can be summarized as follows: (i) In the absence of an auctioneer and hence continuous price flexibility and market clearing, the concept of notional behaviour is no longer valid and needs to be replaced by effective behaviour which takes account of quantity constraints. (ii) Even in a very simple model involving only two goods plus money, very Keynesian results can be derived from neoclassical maximizing behaviour. However, these results only hold in a certain context. (iii) Even though the disequilibrium models yield equilibria in which mutually advantageous trades are possible but not carried out, this does not mean that in the absence of an auctioneer these equilibria are inefficient. (iv) Inclusion into the model of explicit price adjustment is most naturally achieved (as a first approximation) by establishing a link with the imperfect competition literature. (v) In Hahn's model a truly more general system is described in which both Walrasian and non-Walrasian equilibria are possible outcomes. Although this kind of model is far from perfect, it seems to be a step in the right direction.

The main concluding remark of this chapter, however, is of a different nature. All the discussion so far has been on a purely theoretical basis. However, it is now apparent that pure theorizing will not give us any definite answer as to which assumption - solely price signals or price and quantity signals serves best to describe the actual situation in capitalist economies. Therefore, first priority should be given to empirical testing.

III. TESTING A NON-WALRASIAN MODEL FOR CANADA.

> More than other scientists, social scientists need to be selfconscious about their methodology. (Friedman, 1953, p. 40)

> Empirical econometrics, as opposed to econometric method, is not so much an academic discipline as a practical pursuit, concerned with the quest for useful quantitative knowledge about economic phenomena and relations. (Cramer, 1969, p. 1)

1: INTRODUCTION.

In the last chapter we announced the intention to turn to the data for a possible verdict on the usefulness of non-Walrasian economics. In this chapter we shall use Canadian data to estimate and test (in a specific way elaborated upon below) a simple non-Walrasian model with exogenous and fixed (at least within the period) prices. The estimated model will be confronted with a typical Walrasian model of the Canadian economy, thereby making possible a direct comparison between the usefulness of the two hypotheses.[1] Our testing will attempt to avoid the "moral hazard" problem that is so common in applied econometric work, where researchers (or "alchemists", according to Hendry, 1980) continue to run regressions (in non-, semilog-,

---

[1] Thereby we will presumably give a first answer to Frank Hahn's suggestion that "Keynesian" and "Monetarist" models be tested in a comparative fashion (1982, p. 36). Also, as we recall from the previous chapter, one of the pioneers (later turned heretic) of non-Walrasian economics, Robert Barro, will get the answers he has been asking for (1979, p. 59).

log-, or just plain linear form) until their "pet theories" pass the t-test and another paper can be submitted for publication.

The methodology that we propose as a modest replacement will be described in section 2. In section 3 we give a selective survey of the relevant portions of previous research on the Canadian economy. We shall be particularly interested in the kinds of specifications and explanatory variables that were used, as well as the reasons given. In section 4 we present and estimate the two models using different estimators. All regressions run will be reported, for reasons elaborated upon below. Section 5 will analyze the relative predictive performance of the non-Walrasian and the Walrasian models. Section 6 brings together the main conclusions that can be drawn from the confrontation of theory with data. In Appendix B a Monte Carlo sampling experiment is performed for a number of estimators that we propose to apply to the non-Walrasian model. In Appendix C we present an efficient way of testing for first order autocorrelation in the switching regression case, where the vector of estimated residuals is discontinuous. Appendix D reports all the data used for estimation of the different models, as well as the exact sources. Appendix E reports the derivation of a short-run demand for labour function, which incorporates the idea that capital and labour are not substitutable in the short-run. Finally, Appendix F surveys the literature on the testing of disequilibrium models with switching regressions.

2: METHODOLOGY, TESTING, AND ECONOMETRICS.

The instrumentalist methodology of Milton Friedman has been (implicitly) predominant in most applied econometrics and a brief summary of it will be useful in the discussion below.[2] The central element in Friedman's methodology is prediction:

> The ultimate goal of a positive science is the development of a "theory" or "hypothesis" that yields valid and meaningful ... predictions about phenomena not yet observed (1953, p. 7).

If the predictions of a theory are contradicted, it must be abandoned, whereas in the case of predictions being "correct" (i.e. not contradicted) the theory survives.[3] Friedman points out that "if there is one hypothesis that is consistent with the available evidence, there are always an infinite number that are" (1953, p. 9) and adds criteria such as "simplicity" and "fruitfulness" in order to be able to choose among alternative hypotheses that are equally consistent with the available data

---

[2]It is not intended as a critical appraisal of Friedman's methodology. The appropriate reference for this is Boland (1982, pp. 139-152).

[3]In Lakatos' terminology we may label this as "naive methodological falsificationism" (1978, pp. 20-31). Sophisticated methodological falsificationism adds a number of additional requirements. Falsification of theory T is said to have occurred if another theory T' has been proposed that (i) has excess empirical content over T, (ii) explains the previous success of T, (iii) has part of its excess empirical content corroborated (1978, p. 32). A strong case in favor of the use of sophisticated falsificationism in applied econometrics is presented, inter alia, by Hendry (1980, p. 396) and Davidson et al. (1978, p. 662).

(1953, p. 10).[4]

Empirical evidence serves the two distinct purposes of providing us with hypotheses, and testing these hypotheses (1953, p. 12). As we shall see below there exist potential dangers in this interaction of hypothesizing and observing. Friedman warns us against the testing of the "assumptions" of theories because:[5]

> ... the relevant question to ask about the "assumptions" of a theory is not whether they are descriptively "realistic," for they never are, but whether they are sufficiently good approximations for the purpose at hand (1953, p. 15).

He also points out that the reliance on uncontrolled experiments renders the task of testing hypotheses more difficult, and gives greater scope for confusion about the methodological principles involved (1953, p. 40). Unfortunately, it seems that not many applied econometricians have taken sufficient notice of Friedman's (by now) grandfatherly advice and many problems with

----

[4] As we shall see below, this is precisely what our comparison between the Walrasian and the non-Walrasian model will amount to. If it turns out that the former predicts just as well as the latter, then the "Occam-Friedman Razor" would urge us to choose the Walrasian model as an adequate description of the real world.

[5] Therefore, if our purpose is the explanation of real output and employment, then the assumption of exogenous wages and prices (that are fixed within the period) explicit in the non-Walrasian model below need not worry us too much, even in the face of wage and price inflation. The non-Walrasian model can still provide an explanation of short run real activity, although obviously it cannot explain inflation. Such an explanation may still be consistent with Friedman's requirements for an instrumentalist methodology, despite the fact that the assumptions upon which it is grounded may not always accord with observed reality.

the use of the econometric method remain.[6] This has been recognized by number of authors in recent years. A brief discussion of the main objections raised by them against the "use and abuse" of econometric techniques is appropriate at this stage.

In a recent paper, David Hendry observes that "econometricians have found their Philosophers' Stone; it is called regression analysis and is used for transforming data into 'significant' results!" (1980, p. 390). He cites an impressive list of problems associated with econometric methods (some of which were already pointed out by Keynes some forty years before), but concludes that the subject is not hopeless (1980, p. 396).[7] He offers us the following thought:

> My own empirical "research programme" has been to investigate modelling based on <u>minimal</u> assumptions about

---

[6]Positive exceptions are, inter alia, Cramer (1969) and Wallis (1979). They analyze the delicate interplay of economic theory and econometric methods in a number of case studies, and in doing so provide applied econometricians with a wealth of useful advice. See also Kennedy (1979).

[7]As reported by Hendry, Keynes mentioned the following problems associated with the linear regression model: (i) omitted variable bias, (ii) inadequacy of the data, (iii) spurious correlation due to the use of proxy variables and simultaneity, (iv) multicollinearity, (v) assuming linear form without knowing the appropriate dimensions of the regressors, (vi) dynamic misspecification, (vii) incorrect prefiltering of the data, (viii) invalidly inferring causality from correlation, (ix) non-constant parameters, (x) confusing statistical with economic significance. Hendry adds the following problems to this already impressive list: (xi) stochastic misspecification, (xii) incorrect exogeneity assumptions, (xiii) inadequate sample sizes, (xiv) aggregation, (xv) lack of structural identification, (xvi) inability to refer back uniquely from observed empirical results to any given theory (Hendry, 1980, p. 396).

the intelligence of agents and the information available to them, with maximal reliance on data using "economic theory" guidelines to restrict the class of models considered (Hendry, 1980, p. 402)

Even though it is easy to obtain spurious results, which could lead us to discard econometrics as mere "alchemy", these results can fortunately be revealed as "fools' gold" as long as we are willing to follow the three golden rules of econometrics: "test, test and test" (Hendry, 1980, p. 403). As a practical example of Hendry's preferred research programme we refer to Davidson et al. (1978). In this paper the authors focus on three studies of consumers' expenditure on nondurables in the United Kingdom, all of which reported different results even though similar economic theories and approximately the same data series were used (Davidson et al., 1978, p. 661). In order to detect which aspects of the methodologies used by the different researchers are responsible for the different published results, a general model is constructed which includes the three published preferred equations as special cases (Davidson et al., 1978, pp. 661-663). After re-estimating the three models within the context of the generalized model, it turns out that the equation considered to be the least reasonable of the three from the point of view of economic theory is selected on statistical criteria (Davidson et al., 1978, p. 663).[8] As a result of this, the authors develop their own equation which (i) satisfies their

----

[8]It turns out that their preferred equation (24) on p. 675 in the generalized model corresponds to equation (15) on p. 671, which does not have a static equilibrium solution (Davidson et al., 1978, p. 672).

desired theory criteria, (ii) fits as well as the previously best fitting equation, and (iii) includes the rejected models as special cases (Davidson et al., 1978, p. 663).[9] The conclusion we draw from the work of Hendry and associates is that a necessary (but not sufficient as we shall argue below) condition for econometrics to be a useful supplement to theoretical economics is our willingness to submit empirical findings to the closest possible scrutiny.

As Feige points out "we have all too often come to associate 'poor' results with the lack of achievement of statistical significance and 'good' results with the achievement of statistical significance" (1975, p. 1291). He cites simulations showing that "data grubbing" procedures almost inevitably result in "significant" results, "even when the

[9]Thus, their methodology can be seen to fulfil the requirements of what Lakatos refers to as a "progressive research programme" (1978, pp. 47-52). A research programme has two parts: (i) the negative heuristic, which describes what paths of research one should avoid, and (ii) the positive heuristic, which indicates what other paths one should pursue (Lakatos, 1978, p. 47). The negative heuristic forms the "hard core" of a research programme and the modus tollens cannot be directed at it (cf. the maximization principle in neoclassical economics). Whenever "refutations" are produced one must invent "auxiliary hypotheses" to construct a "protective belt" around the core. As long as these auxiliary hypotheses lead to progressive problem shifts (i.e. the empirical content is increased and part of the excess content is corroborated) the research programme can be called progressive (Lakatos, 1978, pp. 48-49). Indeed, the positive heuristic of the research programme proposed initially by Sargan (1964) and pursued vigorously by Hendry and associates has led to a number of further studies on the same topic: Mizon and Hendry (1980), Hendry and von Ungern-Sternberg (1981), and Davidson and Hendry (1980). For a further discussion of the applicability of the notion of scientific research programmes to neoclassical microeconomics and Keynesian macroeconomics see Latsis (1976) and Leijonhufvud (1976) respectively.

dependent variable is generated by a simple autoregressive stochastic process rather than causally" (Feige, 1975, p. 1292).[10] Consequently, most published empirical work (i) takes no account of pretest bias,[11] (ii) may not be very robust, as intermediate results and alternative specifications are not presented, (iii) under-represents "negative" results, thereby hiding potentially useful information, and (iv) includes an unnoticed proliferation of Type-1 errors (i.e incorrectly rejected null-hypotheses) (Feige, 1975, p. 1293). As a minimum standard, Feige suggests that data and procedures should be fully reported, regardless of whether the final result is "positive" or "negative" (Feige, 1975, p. 1293).[12]

----

[10]The results of these simulations have been published recently in Lovell (1983).

[11]A non-technical discussion of pretest bias is presented by Kennedy (1979, pp. 50-52). Pretesting occurs, for example, when we run a regression, observe the t-statistic of the regressors, drop the regressors that are insignificant at some preset critical level, and re-run the regression, possibly with additional regressors, etc. As a result the sampling properties of this so-called pretest estimator are not the same as those of the normal OLS model. Lovell presents a simulation of three different kinds of pretesting strategies, together with a rule of thumb relating "claimed" significance levels to "true" significance levels (1983). Loosely speaking this rule of thumb increases the level of the test as more extensive pretesting is performed. For a more detailed discussion of the pretest estimator and the vital role played by the critical level of the test see Judge et al. (1980, pp. 61-67).

[12]The same suggestion has been made earlier by Thomas, on the grounds that such full reporting of results would enable readers to "make up their own minds" when evaluating empirical results (1967, p. 175). See also Lovell (1983, p. 1) and Cooley and LeRoy (1981, pp. 826-828).

Mayer compares applied econometrics with "game playing", where on the one hand complex techniques are used "not so much because they are likely to lead to the right answer, but probably as much, or more, because their very complexity creates a fascinating challenge, and also generates the applause of one's peers" (Mayer, 1980, p. 169). On the other hand, important but unglamorous topics such as replicability of the results and quality of the data are ignored (1980, pp. 170-171).[13] Mayer admits the usefulness of using econometrics, albeit mainly because we have nothing with which to replace it, but proposes a number of guidelines, some of which were already suggested by Feige (1975): (i) instead of treating econometric results as "crucial experiments", we should think of them more as "circumstantial evidence",[14]

----

[13]See also Belsley, Kuh, and Welsch for a strong plea to examine more closely the suitability of particular data sets for specific econometric analyses (Belsley and Kuh, 1979, pp. 644-645; Belsley, Kuh, and Welsch, 1980).

[14]This idea seems to be closely related to Friedman's methodology in which repeated successful application of a hypothesis (rather than a correct sign in one empirical study, we may add) becomes indirect testimony in its favour (Friedman, 1953, p. 23). Hence, under this interpretation it should be evident that in this chapter we will not be able - once and for all - to devise a "crucial experiment" such that, depending on the outcome, either the non-Walrasian model or the Walrasian model will have to be discarded. Rather, we will present one case in which these two theories are confronted (hopefully in a methodologically sound way), which can then be used as circumstantial evidence. It is interesting to consider Lakatos on instant rationality in the natural sciences. Among competing research programmes "crucial experiments" will have no impact, whereas within a research programme "minor crucial experiments" to decide between its subsequent versions will still be appropriate (Lakatos, 1978, pp. 70-71). Unfortunately, in economics even this may not be possible, as experiments per se are impossible. The process of comparing the n-th and the

(ii) research should be evaluated on the basis of the likely validity of its result, (iii) more emphasis should be placed on collecting relevant data, (iv) we should guard against data mining (pretesting), and all regressions should be reported,[15] (v) some data should be set aside for testing (prediction), (vi) insignificant results should also be accepted by journals, (vii) unpublished data should be made available, to ensure and encourage replicability.

A radically different approach to econometrics and specification searches has been proposed by Leamer (1978, 1983). He presents a strong case in favor of the Bayesian position.[16]

----

[14](cont'd) (n+1)-st version of a research programme in economics will necessarily be more time consuming as "circumstantial evidence" needs to be accumulated. There is of course the additional logical problem of testing theories using models, as any theory can be specified in an infinite number of different ways (Boland, 1982, p. 121; Leijonhufvud, 1976, pp. 76-77). Hendry presents a contrasting, and by his own admission ad hoc, structure which ultimately reduces to the selection of "usefulness" as the relevant criterion (1980, pp. 398-402, esp. p. 401).

[15]Recently, Blanchard and Wyplosz (1981) estimated an empirical structural model of aggregate demand reporting all the regressions run. Their study is the exception rather than the rule, however.

[16]The standard reference for the usefulness and applicability of Bayesian methods to econometrics is Zellner (1971a). An extensive comparison between the traditional econometric modeling approach and Bayesian alternatives is given in Zellner (1979, pp. 628-636). A methodological discussion of the strengths and weaknesses of Bayesian methods in decision theory and econometrics is presented by Zellner (1971b) and Rothenberg (1971) respectively. All parties seem to agree that Bayesian methods are extremely useful in decision problems (see chapter 4 below), but Rothenberg argues that not all inference problems can be regarded as decision problems (1971, p. 200). He rejects the notion (implicit in the Bayesian notion of learning from experience) of smooth scientific progress as an adequate description of how scientists work, and instead favours the

Even though both the classical and the Bayesian models of inference are invalidated by specification searches, the latter is flexible enough to make these searches legitimate and understandable (1978, p. 2; 1983, pp. 36-37). In Leamer's view the goal of objective inference is counter-productive as both the prior distribution (introduced explicitly by a Bayesian and implicitly by all others) and the sampling distribution are <u>opinions</u> and not facts (1983, p. 37). Given the subjective nature of inferences "the fundamental problem facing econometrics is how adequately to control the whimsical character of inference, how sensibly to base inferences on opinions when facts are unavailable" (Leamer, 1983, p. 38). Even though the formulation of a prior distribution is arbitrary, the mapping from assumptions (i.e. the prior and sampling distibutions) to inferences (i.e. the posterior distribution) is the significant aspect of the Bayesian method (Leamer, 1983, p. 38).[17] Although we will not utilize formal Bayesian estimation

----

[16](cont'd) Popper-Kuhn view whereby scientific progress results from criticism and attack (conjecture and refutation). Given this interpretation, Rothenberg argues, the Bayesian view must be rejected as historically invalid (1971, pp. 200-202). Lakatos builds upon Popperian foundations but dismisses Kuhn because "in Kuhn's view scientific revolution is irrational, a matter for mob psychology" (1978, p. 91). Instead, Lakatos stresses the <u>continuity</u> of science, so that Rothenberg's objections are unwarranted under this interpretation (Lakatos, 1978, pp. 86-90). See also Zellner (1971a, pp. 1-11).

[17]For a further discussion of desirable ways to present the results of a Bayesian analysis see Zellner (1971a, pp. 40-41).

procedures in this chapter,[18] the main point we borrow from the Bayesian approach is its insistence upon the <u>subjective</u> nature of inferences and its methodological stand in favour of smooth scientific progress by learning from (one's own and others') experience.[19]

We are now in a position to draw together the main implications of the above arguments relating to applied econometrics in general and our study of an empirical

----

[18]The reason for this decision is the costly nature of most Bayesian techniques (Belsley and Kuh, 1979, p. 644). This can be easily confirmed by looking at Zellner (1971a). This practical problem is particularly formidable in the context of our analysis of a switching regression model. Swamy and Mehta present an early Bayesian analysis of switching regressions with two regimes (1975). They show that the ordinary ML method is problematic in this context (1975, p. 593). In order to simplify the analysis, they interpret the coefficient vector in an unusual way, namely as random drawings from a continuous multivariate distribution (1975, pp. 594-599). Conceptually, we could extend the Bayesian approach in a more usual way by combining prior distributions with the likelihood functions that have been derived in the literature. See Maddala and Nelson (1974, pp. 1014-1018) for the single market case, and Ito (1980, pp. 109-112) for the two market case. It would not be easy to obtain any tractable results, however, in view of the complexity of the likelihood functions involved. See appendix B for a further discussion of some of the problems involved with the ML method in the switching regression case.

[19]As was pointed out by Zellner, the prior distribution can be formulated by using other researchers' results (data-based prior) and/or by using introspection, casual observation, or theoretical considerations (nondata-based prior) (1971a, pp. 18-21). Leamer presents an example in which different hypothetical researchers (with different priors) are asked whether capital punishment has a deterrent influence on the crime rate. The prior information of each researcher consists of a list of variables classified as important or doubtful in an explanation of the crime rate. It turns out that any inference from the data is too fragile to be believed because the different researchers obtain dramatically different results from them (Leamer, 1983, pp. 41-42).

non-Walrasian model for Canada in particular.[20] In the remainder of this chapter we shall follow the following guidelines or "rules of the game".

(i) From a theoretical point of view the non-Walrasian model constitutes a progressive problem shift within the research programme of neoclassical general equilibrium theory. Thus empirical testing of the non-Walrasian model should be done by comparing it with the Walrasian model it supposedly replaces. Therefore, we shall set up two models for estimation, so that direct comparison is possible.

(ii) The ultimate goal of empirical model building in this

----

[20]Despite all the problems associated with the econometric method and the estimation of structural models we do not take the extreme attitude that has been proposed by Sims (1980). He argues that large scale macroeconometric models are unlikely to be identified (1980, pp. 2-15). As a remedy Sims suggests an atheoretical approach in which models are estimated using an unconstrained vector autoregression model, without incorporating any theoretical perspectives. After estimation, specific theories can be tested by imposing restrictions on the system (1980, pp. 16-17). We do not, however, share Sims' pessimism vis-a-vis the usefulness of structural modeling. For a strong defence of the structural approach, see Malinvaud (1981). Malinvaud regards Sims' strategy as complementary to current practice "for it renews our knowledge of the evolutions which have been experienced and familiarizes us with the existence of complex correlations and of lag structures that are marked by a certain permanence, and thus meaningful" (1981, p. 1371). He further argues that the restrictions that have to be imposed in Sims' approach, such as the length of the maximum lag and the number of variables which are treated simultaneously, are "notoriously artificial" (pp. 1371-1372). He concludes that more emphasis should be placed on the testing of the constraints and exogeneity assumptions, as well as specifications (pp. 1373-1374). An intermediate position is taken by Zellner who makes a strong plea for integration of the time series and structural modeling approaches and outlines a possible way of achieving this (1979, pp. 636-640).

chapter is prediction.[21] Therefore, we shall set aside a number of observations that can be used to judge the relative performance of the Walrasian and the non-Walrasian models.

(iii) In order to avoid pretesting, all regressions run will be reported. Furthermore, different specifications and estimators will be utilized in order to get a clearer view of the robustness of the results.

(iv) Econometric inference and specification searches are ultimately subjective. Therefore, it is of paramount importance to set our explanation (or lack thereof) within the context of previous explanations.[22] To this effect we shall investigate and report a number of previous Canadian studies on the behavioural equations that our models include. We shall try to analyze what was included in the equations, and why. Furthermore, some recent empirical non-Walrasian models estimated for the United States, Belgium, and the Netherlands will be subjected to the same scrutiny.

(v) All data used, including those constructed, are reported and referenced in Appendix D to this thesis.

----

[21] Another goal, that of policy simulation, is not pursued in this chapter. Due to the incomplete treatment of expectations, our model can strictly speaking not be used for this purpose (Lucas, 1981). A recent model by Blanchard and Wyplosz is a first attempt to build a policy invariant structural model of the demand side of the economy (1981).

[22] According to Rothenberg "the art of model building involves much trial and error,...It also involves the interaction of many different persons and many overlapping data sets. We base our models on all the past models we have read about, even if we only dimly remember them" (1979, p. 648).

(vi) Regardless of the "results" of the estimation, we must keep reminding ourselves that no more (and no less) than "circumstantial evidence" is provided. It must be emphasized that many instances of circumstantial evidence pointing in the direction of one theory would be required in order to serve ultimately as positive support for it.

By following the guidelines proposed above we hope to increase the informativeness of our empirical results.

3:OVERVIEW OF PREVIOUS EMPIRICAL RESEARCH.

In the highly aggregated models to be estimated below we shall be interested in the aggregate goods and labour markets only. Consequently, in accordance with the "rules of the game" proposed above, we shall now give a selective survey of existing research on the supply and demand equations on these two markets.[23] Furthermore, we shall analyze some of the very recent literature on empirical non-Walrasian models. As we shall be utilizing annual data below and due to the highly aggregated nature of our analysis we shall to a large extent ignore the highly disaggregated quarterly models developed by Helliwell et al. (1971), Bodkin and Tanny (1975), and Statistics Canada (1978).

----

[23] Our discussion is not intended to be exhaustive. See Tsurumi (1973) for a detailed discussion of a number of Canadian macroeconometric models, including Choudhry et al. (1972), and Helliwell et al. (1971).

Aggregate demand for goods.

Within the context of the highly simplified models considered below, only the demand for consumption goods can be explained. Hence, all other components of aggregate demand are assumed to be exogenous, an assumption that would have to be relaxed in subsequent research.[24] However, in view of our goal of comparing the usefulness of non-Walrasian models with that of Walrasian models, this approach has some justification since both types of models are equally over-simplified.

It seems that Keynes' heritage is still especially notable in the aggregate demand for consumption goods. In all Canadian evidence we have analyzed some kind of Keynesian consumption function is employed. For example, Choudhry et al. regress real per capita consumption of durables on its own value lagged one year, real personal disposable income per capita, a long rate of interest, and a relative price term (1972, p. 16). The nondurables and services equations contain their own variables lagged one year, real personal disposable income per capita lagged once, the first difference in real personal disposable income, a relative price term lagged once, and the first difference in the relative price term. The formulations are rationalized in a rather cavalier manner, referring to "habit

----

[24] Obvious omissions are: (i) investment demand, (ii) the foreign sector, and (iii) the financial sector. Inclusion of each of these components would increase the complexity of the theoretical model needed considerably as a number of additional spill-over effects would now be possible in the non-Walrasian model. For an excellent survey of existing approaches to the modeling of the Canadian foreign sector, see Lowenberg (1981).

persistence and lags in consumer behaviour" (Choudhry et al., 1972, p. 16), and "psychological stocks of consumer habits" (p. 18).[25] Statistics Canada uses similar specifications, although disaggregated even further and using "permanent income" instead of actual income as a regressor (1978. pp. 24-31). As we have seen in the previous chapter, however, the Keynesian consumption function can only be justified within the <u>static</u> optimization context if consumers are facing a constraint on their sales of labour and formulate their effective demand for goods. From elementary price theory we know that the notional demand for goods is homogeneous of degree zero in prices and initial income, a fact which can also be confirmed by looking at the previous chapter.[26] Hence, if we want to formulate a Walrasian and a non-Walrasian model based upon a static optimization model, these models should at least incorporate these ideas.[27] However, in a recent publication, Sneessens estimates a non-Walrasian model for the Belgian aggregate goods and labour

---

[25] Oksanen and Spencer (1972) present empirical estimates for the Canadian aggregate consumption function using the Houthakker-Taylor model in which "habits" are central. See also Deaton and Muellbauer (1980, pp. 373-377) for a discussion of habits and lags in the consumption function for durables.

[26] Compare equations (2.18) and (2.21) for the expressions of notional and effective demands for goods respectively.

[27] This is not to say that one could not derive a Keynesian consumption function within a Walrasian model if the objective functions were different, See Evans (1969, pp. 13-47) for a survey of attempts in that direction. The main point for our analysis is that "we cannot have our cake and eat it" in that our notional goods demand cannot have an income term as one of the regressors.

markets which includes a consumption function of the traditional kind (1981, pp. 97-98), even in the regime of repressed inflation, where workers are not constrained, that he finds to have obtained during 1964-1965 and 1969-1972 (p. 119). Likewise, Kooiman and Kloek adopt a similar (by their own admission ad hoc) approach (1980a, p. 13; 1981, p. 10). Any spill-overs from the labour market are assumed to occur through <u>unexplained</u> changes in the level of disposable income (1980, p. 13). The dynamic consumption function in the estimated model is due to Hendry and von Ungern-Sternberg (1981), and includes an income and a liquidity term (Kooiman and Kloek, 1980a, p. 30).

The conclusion we draw from the above discussion is that, in order to remain as close as possible to the spirit of purely Walrasian and non-Walrasian models, we should insist on an aggregate demand function that is homogeneous of degree zero in prices, wages and possibly a term measuring the accumulated "purchasing power" in the economy (e.g. non-human wealth) in the former case, and adopt a consumption function in the latter. Although the inclusion of a net wealth term is theoretically defensible, data problems preclude us from doing so. Instead, we adopt the approach suggested by Rosen and Quandt (1978, p. 373), in which net unearned income is included as a proxy of net wealth (in their case in the labour supply equation). They admit that this approach may cause a biased coefficient of the net unearned income term in the labour supply equation as this term in reality depends upon past hours of work (p. 373). In a static optimization context, however, inclusion of this term should not cause any problems.[28] In order to account partially for the foreign sector, the price of imports relative to the GNE deflator can be included as a regressor as well. In order to stay close to the existing specifications of the Canadian aggregate consumption function it seems reasonable to adopt a linear specification, regressing real per capita consumption on the relevant variables. As an alternative specification, we can adopt a loglinear form to form a logical counterpart of the labour supply equations we discuss below. In order to capture the idea that a significant part of Canadian consumption consists of durables, which should be interpreted as households' investment adding to a stock the services of which yield utility, we shall include a long interest rate in our specifications below.

Aggregate supply of labour.

Choudhry et al. (1972, p. 11), and Statistics Canada (1978, pp. 56-59) assume the aggregate supply of labour (or the participation rate) to be exogenous. Helliwell et al. endogenize

---

[28] Romer (1981, p. 145) suggests that inclusion of the net unearned income term invites more problems than it solves in the Rosen and Quandt model because it is endogenous in a dynamic life-cycle consumption-leisure model. He suggests dropping the term altogether and hopes that the "bias caused by this deliberately incorrect specification will be small compared to the biases that resulted from the endogeneity of nonlabor income" (1981, p. 145). Cuddington (1982, p. 333) alludes to the existence of quarterly data on wealth for Canada for the period 1966-I to 1980-IV. We do not know of a sufficiently long annual series of data on wealth for Canada, however.

the participation rate and include as regressors the proportion of the labour force population in school, and real personal disposable income per member of the labour force population (1971, pp. 105-106). For the same reasons as mentioned above in the case of the aggregate demand for goods, it does not make sense, within the context of our static model, to include an income term in the participation rate equation. It seems that Helliwell et al. are not very happy with their equation either and that is was chosen for pragmatic rather than theoretical reasons (1971, p. 105).[29] Bodkin and Tanny regress participation rates of different age groups and sexes on (among other things) the ratio of total employment to the labour force, and a real wage term (1975, pp. 173-180). Interestingly enough, they interpret their employment ratio as a measure of "tightness" of the labour market (p. 175), whereas in our non-Walrasian model we could view it as a proxy (through Okun's Law) for the spill-over from the goods market that occurs in the regimes of classical unemployment and repressed inflation.[30]

----

[29]According to them "the income variable helps the equation, whereas two more defensible alternatives - the degree of capacity utilization, and the unemployment rate - do not. Thus we have a personal income variable supposedly standing for the marginal benefits of labour force participation" (Helliwell et al., 1971, p.105).

[30]Eaton and Quandt include a term representing the probability of being rationed in the labour market into the labour supply function (1983, p. 229). This discouraged worker effect is rationalized by postulating the existence of positive transactions costs associated with entering the labour force (pp. 222-224). In the models we estimate below, we will not include these internal spill-overs in the labour market, because our models are based on the Benassy concept of effective behaviour, which excludes internal spill-overs (see above,

[31] Kooiman and Kloek assume labour supply to be exogenous (1980a, p. 13; 1981, p. 7). They point out, however, that this leads to problems of defining aggregate labour supply. As measured unemployment is always positive, defining labour supply as the sum of actual employment plus reported unemployment would lead to the a priori exclusion of the regimes of repressed inflation and underconsumption from the sample. As a remedy they assume "normal frictions" on the labour market to be an unknown fraction of existing employment (Kooiman and Kloek, 1980a, p. 14). This fraction can then be estimated simultaneously with the other parameters.[32] As Lucas and Rapping point out, however, it is far from sure whether all reportedly unemployed workers are seeking work <u>at the current wage rate</u> (1970, p. 272). In fact, in their model the current wage rate equates the short-run

----

[30] (cont'd) section 2.2; Drazen, 1980, p. 287).

[31] Compare equation (2.24) for the expression of effective supply of labour. Using equations (2.17) and (2.18), effective labour supply can be written as:

$$Lse=Ls+a2/(a2+a3)*(Co-Cd)*(p/w)$$

See also Ito (1980, p.100), and, for a more general discussion examining the underlying class of preferences for which linear spill-overs are valid, Deaton and Muellbauer (1981, pp. 1529-1531). For a discussion of linear spill-overs on the production side of a simple non-Walrasian model, see Kooiman and Kloek (1980b).

[32] Their estimate for the Netherlands using a sample including the years 1952-1977 turns out to imply a frictional (or natural) rate of unemployment of about 1 percent (Kooiman and Kloek, 1980a, p.36). This seems rather low. In their subsequent paper they allow the frictional unemployment rate to drift up somewhat after 1967 (1981, p. 7).

demand and supply on the labour market so that existing non-frictional unemployment is entirely due to workers that are searching for work <u>at their expected normal wage rate</u> (Lucas and Rapping, 1970, p. 273). Sneessens introduces frictions on the labour market by adding a non-positive constant (a) to a (loglinearized) minimum transaction rule, that also attempts to incorporate the effects of labour hoarding due to "hiring and firing costs" (1981, p. 95):

$$(1) \qquad \log(Lo) = a + b * MIN(\log(Ld), \log(Ls)) + (1-b) * \log(Lo)_{-1}$$

$$a < 0 < b < 1$$

In addition to this, Sneessens deducts another fraction of the available labour force in order to capture "those registered unemployed workers with very little skill who should actually be regarded as out of the labour force" (1981, p. 101). His final results, obtained by setting a=0, indicates that about 2.5 percent of the Belgian labour force consists of this category of workers (p. 118).

In a recent paper, Rosen and Quandt (1978) develop and estimate a single market non-Walrasian model of the United States aggregate labour market. The loglinear labour supply function is assumed to depend on a real after tax wage term, net unearned income, and the work age population (1978, p. 373).

Because the aggregate goods market is not analyzed, their model cannot distinguish between notional and effective behaviour and spill-overs do not exist, which makes their model less than completely satisfactory. A more serious problem with their analysis is the fact that they estimate the model using data on <u>actual</u> employment only, thereby ignoring the problem pointed out by Kooiman and Kloek (1980a, 1981) and Sneessens (1981) vis-a-vis frictional unemployment (Rosen and Quandt, 1978, p. 374). Their method implies that potentially valuable information on unemployment is thrown away. They then proceed to define a measure of "involuntary unemployment" (R) of the following kind (p. 378):

$$(2) \qquad R^e = (Ls^e - Ld^e)/Ls^e$$

where the superscript "e" denotes estimated values. Of course, R should be interpreted as the deviation of actual from frictional unemployment, and the anomalous results reported by them should be understood in this fashion (p. 378).[33]

---

[33]The period analyzed by Rosen and Quandt (R-Q) is 1930-1973. The anomalous results referred to in the text involve a large <u>excess demand</u> for labour from 1930 to 1946 (Rosen and Quandt, 1978, p. 378). In a subsequent comment on the R-Q paper, Romer (1981, p. 146) presents a graph showing the extremely poor in-sample predictive performance of the R-Q model. He proposes to deal with this problem by excluding the unearned income term from the labour supply equation, as it is conjectured to be endogenous, and indeed the predictive performance improves somewhat (Romer, 1981, p. 146). In another comment, Yatchew re-estimates the R-Q model by restricting the sample to include

It is very hard to interpret the overall validity of the Rosen and Quandt model, as nowhere are the estimated residuals submitted to any kind of test.[34]

In a much cited study of the aggregate United States labour market, Lucas and Rapping (1970) present a much more solid analysis. Their labour supply curve is derived from a two period utility maximization programme. The budget constraint includes present and future (expected) prices and wages, a discount rate, and initial non-human assets in money terms (1970, p. 264). The theory suggests that labour supply (or the participation rate) is negatively influenced by expectations of temporary future price and wage increases (p. 265). Adding adaptive expectations schemes for expected prices and wages enables them to formulate their suggested participation rate equation as a function of the current and lagged real wage, the ratio of current and past prices, and the participation rate lagged once (p. 268). Theoretically interesting variables like the real interest rate, and the non-human wealth term were dropped from the results

---

[33] (cont'd) only the postwar years and finds that the results are more plausible (1981, p. 143). He also recognizes the fact that unemployment was incorrectly interpreted by R-Q and that a correction for frictional unemployment is appropriate (p. 144). By postulating different corrections for different time periods it may be possible to improve the R-Q model quite substantially.

[34] For instance, it would be interesting to test if significant autocorrelation is present in the Rosen and Quandt (1978) results. Indeed, as was indicated by Maddala and Nelson (1974, p. 1019), the likelihood functions becomes computationally intractable in the presence of autocorrelation. In Appendix C we indicate how we can approximate the Durbin-Watson statistic in the switching regression case, where the vectors of estimated residuals of the different equations are discontinuous.

reported in the main text for empirical reasons (p. 267). Fortunately, Lucas and Rapping do report a large number of their different results, as well as the data used in appendices (pp. 286-305). This enables us to compare our non-Walrasian model with their (sophisticated) equilibrium model, which will provide us with some additional "circumstantial evidence".[35]

The conclusion we draw from the discussion above is that it seems most sensible to estimate an equation for the participation rate, rather than the level of the labour supply. Candidate independent variables to be included are the current real wage rate, preferably corrected for the average number of hours worked per year, a non-human wealth term or its proxy, and possibly a real interest rate. From a methodological point of view, lagged dependent variables are only allowed to enter into the equation in the case of the Lucas and Rapping model, which is also estimated for Canada below. The dependent variable can either be actual employment or the estimated labour force, but in the latter case a correction for frictional unemployment must be made.

<u>Aggregate Demand for Labour and Aggregate Supply of Goods.</u>

In the literature we have examined, the supply sides of the models seem to have "suffered" less from Keynesian influences than the demand sides, and are consequently more consistent with

---

[35]Unfortunately, no such comparison is possible with the Rosen and Quandt model as their data on the dependent variable are not publicly available (1978, p. 374).

neoclassical theory. In a great number of cases labour demand is derived from an expression for the marginal productivity of labour. Rosen and Quandt, for example, derive a loglinear labour demand equation corresponding with a CES production function (1978, p. 373).[36] Regressors include a real wage term, a time trend, and real output. This last term is assumed to be exogenous, although Rosen and Quandt admit the desirability of studying a multi-market system in which output would be endogenous (1978, p. 373). As was pointed out above it is hard to assess the merits of the Rosen-Quandt formulation. Choudhry et al. derive desired employment in the business non-agricultural sector from a Cobb-Douglas production function but postulate that actual employment diverges from desired employment for the following reasons:

> ...as actual output may diverge from expected output, and as costs of hiring and firing are not negligable, and as the pool of manpower available for hiring is limited, we must assume that actual employment will adjust to desired employment with a lag which depends on the available labour pool as measured by the lagged rate of unemployment (1972, p. 43)

They formalize this as follows:

---

[36]The same formulations re-appear in follow-up studies of the Rosen-Quandt model by Yatchew (1981), Romer (1981), and Eaton and Quandt (1983).

(3) $$\log Lo_t = a*\log Ld_t + (1-a)*\log Lo_{t-1} + b*U_{t-1} + c$$

Here, as in chapter 2, Lo and Ld denote actual and desired employment respectively, and U is the unemployment rate. Actual employment is determined by the demand side of the model. Although this formulation is entirely ad hoc, it does bring out an important feature for our purposes, namely adjustment problems. In the case of the labour market the following reasons for lagged adjustment have been proposed in the literature: (i) positive hiring and firing costs, (ii) the quasi-fixed nature of (overhead) labour, (iii) capital and labour are not freely sustitutable in the short run, but they are in the long run (Sneessens, 1981, pp. 87-95). The adjustment schemes that are usually imposed without any theoretical justification can cause methodological problems in our comparison of equilibrium and disequilibrium specifications. As was shown by Nerlove, it does not make a great deal of sense to superimpose ad hoc adjustment schemes on basically static models (1972, p. 223). The disequilibrium models we estimate below are of a static nature, so that one relevant comparison is with a static equilibrium model with the same "degree of theoretical consistency."[37] Another, perhaps more empirically relevant, comparison is between the static disequilibrium model and the equilibrium-cum-adjustment model. What the disequilibrium formulation is attempting to achieve is a theoretical underpinning for an adjustment mechanism which is based upon individuals' maximizing behaviour. Consequently, it does not make much sense to append the static disequilibrium model with ad hoc adjustment mechanisms, because the entire crux of disequilibrium models lies in their prediction that behaviour is actively affected by the existence of disequilibria in the system. Therefore, one impending dilemma is that our empirical investigation may conclude that static <u>pure</u> equilibrium and <u>pure</u> disequilibrium models are both inadequate descriptions of the data generating process, and that either ad hoc adjustment mechanisms are unavoidable, or intrinsically dynamic models ought to be constructed in accordance with the suggestion made by Nerlove (1972).[38] A comparison between pure disequilibrium

----

[37]We differ from Hendry in the sense that in his research programme ad hoc adjustment mechanisms are allowed and indeed recommended in order to "explain" the disequilibrium data (1980, pp. 401-402). Needless to say, we of course also differ from the majority of the macroeconometric model builders that construct the different sections of their model on inconsistent (or in many cases invisible) foundations.

[38]As we have seen in chapter 2 above, dynamic disequilibrium theory is virtually unexplored, mainly because questions of (rational) expectation formation are complicated tremendously by the simultaneous existence of quantity and price constraints. A pioneering contribution in this respect is Neary and Stiglitz (1983).

models and "equilibrium-cum-ad-hoc-adjustment-mechanism" models determines whether the adjustment theory endogenous in the former is ready to challenge the ad hoc adjustment mechanism of the latter.[39] If both models turn out to be empirically inadequate, then an intrinsically dynamic disequilibrium <u>and</u> equilibrium model ought to be constructed and tested. This would provide the adjustment mechanism of the equilibrium model with a sound theoretical underpinning. We return to these issues in further detail below.

The existence of adjustment costs was also hinted at by Lucas and Rapping, who postulate a marginal productivity condition based upon a CES production function (1970, p. 270). They anticipate Hendry by using the following equation for estimation purposes (Lucas and Rapping, 1970, p. 271):

$$(4) \qquad \log(Q*L/Y)_t = c1 + c2*\log(W/Q)_t + c3*\log(Y_t / Y_{t-1}) + c4*\log(Q*L/Y)_{t-1}$$

Here Q is an index for labour quality (years of schooling

----

[39]Rosen and Quandt, for example, contrast purely static equilibrium and disequilibrium models and observe that "the equilibrium system is somewhat artificial in that it was specifically designed to facilitate easy comparison with the disequilibrium system that we found to be estimable if not ideal." They conclude that "the comparison does not affect the standing of a sophisticated equilibrium model such as the L[ucas]-R[apping] model" (1978, p. 377).

completed), L is employment in manhours per year, Y is real GNP, and W is the real hourly wage. For stationary values of output and employment this equation converges to the ordinary static marginal productivity condition (p. 271).[40] Lucas and Rapping do not estimate a labour demand function directly because its regressors would include the price level, which in their model is no less exogenous than is the level of real output is in equation (4) (1970, p. 272). They somehow seem to be able to accept the simultaneity bias caused by real output but not that caused by the price level (p. 271). Their analysis does also not analyze the short-run fixity of the capital stock.

Sneessens, on the other hand, presents an interesting, albeit ad hoc, way of incorporating the lack of short-run substitutability between labour and capital (1981, pp. 88-90). In his model, capitalists solve two optimization programmes. The first one maximizes long run expected profits by choice of freely substitutable capital and labour. The resulting optimal long-run capital labour ratio (r), based upon an extrapolative

----

[40]Davidson et al. use a similar approach in their study on consumers' expenditure (1978, pp. 680-681). Lucas and Rapping defend the necessity of their ad hoc adjustment mechanism as follows: "there is a great deal evidence that varying labour entails adjustment costs and that this leads firms to adjust gradually [to the static equilibrium] rather than attempting to maintain it continually through time" (1970, pp. 270-272). The question we are left with is why this adjustment was not modelled properly if it is as important (theoretically) as claimed. It seems that by their reasoning Lucas and Rapping attempt to have their cake and eat it, in that they claim to develop a pure equilibrium model of the labour market and in the same breath postulate that the actual economy will never end up in equilibrium.

expectations formation mechanism for the factor prices, is fixed and the short-run production function is then merely a function of the labour input and the fixed r. This short-run production function is then used to derive the short-run demand for labour. When demand for goods falls short of its long-run expected level, then part of the capital stock will remain idle and only the amount of labour hired is adjusted (Sneessens, 1981, p. 88). In addition to this, Sneessens models the frictions in the labour market in the manner described above in equation (1). In appendix E we derive a labour demand function following an approach similar to Sneessens'. Now, instead of choosing the optimal long-run capital-labour ratio, only the optimal long-run capital stock is chosen in advance. This enables us to derive the following labour demand equation:

$$(5) \qquad \log L_t = c1 + c2*t + c3*\log(W/P)_t + c4*\log(C/W)_t + c5*\log Ko_{t-1}$$

Here, W, P, and C denote the nominal wage rate, price level, and the users' cost of capital respectively. Ko denotes the long-run optimal predetermined capital stock.

Finally, we can mention the contributions by Kooiman and Kloek in which notional and effective labour demand are derived in a consistent manner using a clay-clay type vintage production model (1980a, pp. 27-29; 1981, pp. 8-10). We prefer the much simpler method outlined in appendix E to take account of the short-run fixity of the capital stock, however.

One of the salient features of the majority of the studies reviewed here is the fact that direct estimation of an aggregate supply of goods equation is absent. In fact, Helliwell et al. admit this and warn us with the following words:

> Nobody has yet been rash enough to consider a full neoclassical framework in which output and all factor inputs are determined solely by expected relative prices. There are too many measurement errors, too many dangers in aggregating across diverse products, too many non-clearing markets, and too much heterogeneity in expectations to allow this procedure much chance of success (1971, p. 49)

Whereas this quote could be taken as a criticism against <u>all</u> macroeconometric modelling, we shall instead choose to be "rash". The results of our empirical investigations are presented in the next section.

4: THE EMPIRICAL SPECIFICATIONS AND RESULTS

In the highly aggregated models we attempt to estimate below, only four behavioural relationships need to be formulated, namely the consumption function, an aggregate goods supply function, a labour demand function, and a labour supply equation. On the basis of the arguments presented at length in the previous section, the following equations were chosen as the basic representation of the goods and labour markets:[41]

(6) $\log(Cp) = a1 + a2 * \log(Wc) + a3 * \log(Pm) + a4 * Rc + U1$

(7) $\log(Y) = b1 + b2 * \log(Wp) + b3 * Pk + b4 * T + U2$

(8) $\log(L) = c1 + c2 * \log(Wp) + c3 * Pk + c4 * T + dummies + U3$

(9) $\log(Lp) = d1 + d2 * \log(Wc) + d3 * Rc + dummies + U4$

In equation (6) we attempt to capture the idea that notional demand for goods should be related to relative price variables only.[42] We also present some empirical results with a proxy for wealth in this equation. The relative price of imports was

---

[41] The different symbols are defined at the beginning of appendix D.

[42] It could be objected that equations (6) and (9) should contain a time trend in order to capture the long-run exogenous changes in, for example, labour force participation rates. Our specification has been adopted for the sake of consistency with standard practice in much of the literature.

included in order to capture partially the impact of the foreign sector. The real wage rate was measured in "wage goods", i.e. the real rate as perceived by consumers in both the goods demand and labour supply equations (6) and (9). Producers, on the other hand, are assumed to measure the real wage in terms of "producer goods" in both goods supply and labour demand equations (7) and (8). This asymmetric treatment has the attractive feature that no simultaneity exists in the two markets, so that simple OLS can be used in order to estimate the equilibrium representation. [43] The production side of the model, consisting of equations (7) and (8), can be derived from a simple Cobb-Douglas production function with both factors variable in the short-run. Alternative specifications that are estimated below consist of (i) replacing Pk in equations (7) and (8) by K, the actual capital stock, or, alternatively (ii) adopting either of the two specifications derived in appendix E (i.e. equations (E.10) and (E.11) and their analogues for goods supply). The labour supply function has also been estimated by replacing Lp by Lsp, which incorporates the labour force. Two dummies, D1 and D2, were included in order to capture the effects of the changes in the labour market definitions that occurred in 1946 and 1966. The third dummy, D3, was introduced to measure the potential effects

---

[43] Rosen and Quandt introduce a similar asymmetry by assuming labour supply to depend on the real <u>after</u> tax wage and labour demand on the real <u>before</u> tax wage (1978, pp. 374-375).

of wars on economic activity in the labour market.[44]

One of the disadvantages of the Canadian labour market data is the fact that employment etc. are all measured in terms of numbers of persons, whereas it would be theoretically more desirable to measure them in terms of manhours per year.[45] Unfortunately, Canadian labour market data in manhours are not available, and only incomplete data are available on the average number of hours worked _per week_ in selected industries (Statistics Canada, 1983a, E128-135).[46] In appendix D we outline the method we followed in order to obtain an estimate of weekly hours worked. The index (H) we derive there has been used to adjust all labour market data, i.e. labour demand, labour supply and the different real wage terms. The regressions run with these re-defined data are also reported below. The period of estimation is 1927 to 1975. _Tables 1 to 4_ report the results obtained by using the model defined by equations (6) to (9), as well as its refinements.

The results in _Tables 1 to 4_ indicate strong evidence of autocorrelation for each of the behavioural relationships. This positive autocorrelation leads to an upward bias in the

---

[44] Lucas and Rapping also include a war-time dummy in one of the additional estimates of their model (1970, pp. 292-293).

[45] Lucas and Rapping (1970) and Rosen and Quandt (1978) use such data for the U.S. labour market.

[46] Choudhry et al. construct an economy wide index of average weekly hours worked by calculating a weighted average of industry indices. They conclude, however, that "because of changes in coverage and variation in weights ... the quality of the [index] is not high" (1972, pp. 44,65).

Table 1: Equilibrium Estimates of the Consumption Function.

DEPENDENT VARIABLE: log(Cp)

INDEPENDENT VARIABLES:

	constant	log(Wc)	log(Wch)	log(Pm)	Rc	log(A)	$\bar{R}^2$	d	SER
(10)	3.069 (49.1)	0.763 (44.9)		-0.313 (-2.62)	-0.006 (-2.71)		0.983	0.57	0.050
(11)	3.709 (25.9)	0.594 (15.6)		0.083 (0.64)	-0.003 (-1.76)	0.189 (4.79)	0.989	0.45	0.041
(12)	2.886 (40.3)		0.700 (36.6)	-0.346 (-2.36)	-0.005 (-2.14)		0.975	0.40	0.060
(13)	3.711 (21.1)		0.511 (12.5)	0.144 (0.93)	-0.003 (-1.14)	0.229 (4.97)	0.984	0.32	0.049

*) The different variables are described and defined in the list of symbols in Appendix D. The period of estimation is 1927-1975. Values in parentheses are t-statistics, $\bar{R}^2$ is the corrected coefficient of determination, d is the Durbin-Watson statistic, and SER is the standard error of the regression.

Table 2: Equilibrium Estimates of the Goods Supply Function.

DEPENDENT VARIABLE: log(Y)

INDEPENDENT VARIABLES:

	constant	log(Wp)	log(Wph)	Pk	T	$\bar{R}^2$	d	SER
(14)	15.69 (221.3)	1.518 (74.6)		-0.007 (-3.32)		0.992	0.40	0.063
(15)	14.65 (31.7)	1.271 (11.6)		-0.006 (-3.01)	0.008 (2.29)	0.992	0.40	0.060
(16)	15.25 (195.7)		1.372 (62.6)	-0.007 (-2.58)		0.988	0.30	0.075
(17)	14.84 (22.4)		1.273 (8.37)	-0.006 (-2.39)	0.003 (0.66)	0.988	0.29	0.075
				log(K)				
(18)	15.59 (15.6)	1.516 (17.5)		0.004 (0.06)		0.989	0.27	0.070
(19)	15.05 (15.8)	1.252 (10.0)		-0.053 (-0.84)	0.011 (2.77)	0.991	0.30	0.065
(20)	14.16 (13.4)		1.292 (15.1)	0.070 (1.01)		0.987	0.27	0.079
(21)	13.88 (12.4)		1.183 (7.32)	0.051 (0.69)	0.005 (0.80)	0.986	0.27	0.079

(continued on next page)

(Table 2, Continued)

DEPENDENT VARIABLE: log(Y)

INDEPENDENT VARIABLES:

	constant	log(Wp)	log(Wph)	T	log(Kf)	$\log(K_{-1})$	Pkw	$\bar{R}^2$	d	SER
(22)	15.51 (15.8)	1.509 (17.6)			0.009 (0.14)			0.989	0.27	0.070
(23)	14.99 (16.0)	1.248 (10.1)		0.011 (2.75)	-0.050 (-0.79)			0.991	0.30	0.065
(24)	14.13 (13.5)		1.290 (15.3)		0.072 (1.05)			0.987	0.27	0.079
(25)	13.86 (12.5)		1.184 (7.36)	0.004 (0.77)	0.053 (0.73)			0.986	0.27	0.079
(26)	12.61 (12.7)	1.195 (12.6)				0.181 (2.90)	-0.027 (-4.51)	0.993	0.46	0.059
(27)	12.73 (12.4)	1.162 (10.3)		0.002 (0.55)		0.154 (1.93)	-0.025 (-3.44)	0.992	0.42	0.059
(28)	11.47 (10.0)		1.017 (9.94)			0.235 (3.18)	-0.028 (-3.73)	0.989	0.35	0.070
(29)	11.37 (9.95)		1.138 (8.04)	-0.007 (-1.23)		0.300 (3.32)	-0.033 (-3.88)	0.990	0.43	0.070

*) See note to Table 1.

Table 3: Equilibrium Estimates of the Labour Demand Equation.

DEPENDENT VARIABLE: log(L) or Log(Lh)*

INDEPENDENT VARIABLES:

	constant	log(Wp)	log(Wph)	Pk	T	D1	D2	D3	$\bar{R}^2$	d	SER
(30)	10.76 (71.8)	0.623 (16.9)		-0.006 (-3.98)		-0.075 (-2.55)	0.113 (5.08)	-0.037 (-2.09)	0.983	0.74	0.037
(31)	9.47 (44.2)	0.320 (6.28)		-0.005 (-4.95)	0.010 (6.85)	-0.088 (-4.26)	0.090 (5.72)	-0.047 (-3.80)	0.993	1.10	0.026
(32)	10.46 (74.2)		0.498 (14.9)	-0.007 (-4.72)		-0.128 (-4.24)	0.134 (6.23)	-0.065 (-3.70)	0.977	0.95	0.037
(33)	10.45 (27.9)		0.498 (5.79)	-0.007 (-4.56)	0.000 (0.01)	-0.128 (-4.17)	0.133 (6.00)	-0.065 (-3.65)	0.977	0.95	0.037
				log(K)							
(34)	7.36 (7.87)	0.296 (3.29)		0.195 (3.42)		0.030 (0.92)	0.098 (4.04)	0.041 (1.98)	0.982	0.56	0.038
(35)	8.45 (10.3)	0.215 (2.77)		0.053 (0.92)	0.010 (4.43)	-0.030 (-0.98)	0.098 (4.79)	-0.005 (-0.27)	0.987	0.74	0.032
(36)	7.97 (7.09)		0.261 (2.58)	0.138 (1.98)		-0.020 (-0.50)	0.131 (4.73)	0.010 (0.39)	0.968	0.62	0.043
(37)	7.97 (7.01)		0.253 (2.16)	0.135 (1.78)	0.000 (0.13)	-0.021 (-0.51)	0.130 (4.65)	0.009 (0.31)	0.968	0.62	0.044

(continued on next page)

(Table 3, Continued)

DEPENDENT VARIABLE: log(L) or log(Lh)*

INDEPENDENT VARIABLES:

	constant	log(Wp)	log(Wph)	T	$\log(K_{-1})$	Pkw	D1	D2	D3			
(38)	6.380 (11.4)	0.193 (3.58)			0.261 (7.43)	-0.020 (-7.70)	-0.016 (-0.74)	0.083 (4.95)	0.008 (0.59)	0.993	1.20	0.024
(39)	7.061 (11.4)	0.178 (3.42)		0.004 (2.18)	0.186 (3.85)	-0.017 (-5.93)	-0.035 (-1.55)	0.088 (5.46)	-0.008 (-0.53)	0.994	1.01	0.023
(40)	7.227 (8.19)		0.178 (2.26)		0.187 (3.33)	-0.018 (-4.79)	-0.057 (-1.70)	0.124 (5.15)	-0.020 (-0.99)	0.981	0.57	0.034
(41)	6.603 (7.78)		0.265 (3.33)	-0.008 (-2.76)	0.289 (4.54)	-0.023 (-5.87)	-0.039 (-1.25)	0.119 (5.30)	0.000 (0.00)	0.984	0.92	0.031
					log(Kf)							
(42)	7.608 (8.43)	0.306 (3.52)			0.175 (3.17)		0.034 (1.08)	0.110 (4.59)	0.041 (2.02)	0.983	0.53	0.037
(43)	8.782 (11.1)	0.233 (3.17)		0.010 (4.56)	0.028 (0.50)		-0.029 (-0.99)	0.109 (5.51)	-0.008 (-0.40)	0.989	0.70	0.031
(44)	8.451 (7.75)		0.288 (2.95)		0.103 (1.51)		-0.021 (-0.54)	0.146 (5.41)	0.006 (0.23)	0.971	0.59	0.041
(45)	8.450 (7.65)		0.28[illegible] (2.57)	-0.000 (-0.01)	0.103 (1.39)		-0.021 (-0.51)	0.146 (5.32)	0.006 (0.22)	0.970	0.59	0.042

*) Dependent variables are L in (30)-(31), (34)-(35), (38)-(39), and (42)-(43). Lh features in all other equations. See note to Table 1.

Table 4: Equilibrium Estimates of the Participation Rate Equation.

DEPENDENT VARIABLE: log(Lp), log(Lph), log(Lsp) or log(Lsph)*

INDEPENDENT VARIABLES:

	constant	log(Wc)	log(Wch)	Rc	log(A)	D1	D2	D3	$\bar{R}^2$	d	SER
(46)	-0.344 (-2.49)	0.070 (2.11)		-0.005 (-2.99)		-0.082 (-2.59)	0.041 (1.82)	0.001 (0.05)	0.407	0.48	0.038
(47)	-0.664 (-3.15)	0.139 (2.92)		-0.005 (-3.30)	-0.087 (-1.96)	-0.111 (-3.26)	0.070 (2.65)	-0.018 (-0.87)	0.444	0.62	0.037
(48)	-0.682 (-3.44)		-0.040 (-0.87)	-0.004 (-1.79)		-0.079 (-1.63)	0.075 (2.22)	-0.005 (-0.18)	0.383	0.33	0.057
(49)	-0.918 (-2.76)		0.005 (0.08)	-0.005 (-1.88)	-0.062 (-0.88)	-0.101 (-1.85)	0.095 (2.32)	-0.019 (-0.59)	0.380	0.37	0.058
(50)	-0.474 (-8.22)	0.017 (1.22)		-0.001 (-1.32)		-0.083 (-6.31)	0.073 (7.74)	-0.024 (-3.13)	0.833	1.31	0.016
(51)	-0.289 (-4.11)	-0.040 (-2.64)		-0.001 (-1.11)	0.061 (4.23)	-0.057 (-5.22)	0.059 (6.89)	-0.008 (-1.31)	0.907	0.91	0.012
(52)	-0.460 (-2.83)		-0.123 (-3.63)	-0.000 (-0.34)	0.070 (2.04)	-0.071 (-2.67)	0.073 (3.64)	-0.018 (-1.17)	0.857	0.49	0.028
(53)	-0.546 (-3.38)		-0.125 (-3.87)	-0.000 (-0.31)	0.059 (1.78)	-0.068 (-2.65)	0.083 (4.23)	-0.017 (-1.15)	0.868	0.32	0.027

*) Dependent variables are: Lp in (46)-(47), Lph in (48)-(49), Lsp in (50)-(51), and Lsph in (52)-(53). See note to Table 1.

coefficient of determination and may indicate severe misspecification of the model (Kennedy, 1979, p. 87). Furthermore, the usual t-test is no longer valid (Intriligator, 1978, p. 159). Therefore, we can be brief about these results, which is not to say that we dismiss them as irrelevant. In fact, the results in Tables 1 to 4 bring out a number of highly relevant facts, namely:

(i) Purely static equilibrium models, such as the one estimated here, do not adequately describe the Canadian "data generating mechanism".[47]

(ii) If the economy is in reality better characterized by a disequilibrium model with spill-overs accross markets, one should expect the equilibrium model to exhibit misspecification. If the regime switches of the disequilibrium model follow a cyclical pattern, then the equilibrium model must display positive autocorrelation, as it does.

(iii) Considerable doubt is cast on the validity of Rosen and Quandt's (1978) comparison, because they compare their disequilibrium model of the labour market with a purely static equilibrium model which is clearly misspecified.[48]

---

[47]The criterion upon which this judgement is made is the presence of autocorrelation, which in our view indicates that the model is misspecified. An alternative (and popular) approach consists of "correcting" for autocorrelation using a GLS procedure, which would seem to obscure relevant information regarding the specification of the model.

[48]Rosen and Quandt's specification of the labour market is close to the one we adopted in equations (8) and (9). As was pointed out in a footnote to the previous section, Rosen and Quandt do realize that their comparison does not amount to much, but fail to develop a more realistic comparison (1978, p. 377).

In a typical specification search, results such as the ones shown in Tables 1 to 4 would probably not be reported. Instead, new variables would be used, different error structures would be tried, ad hoc adjustment mechanisms would be postulated, etc., etc., but only the final results would be shown, thereby throwing away the information contained in the earlier stages of the search. Rather than following this, unfortunately well trodden path, we instead investigate the results of two alternative strategies.

The first approach, which, as we have seen above, can be associated with the names of Lucas and Rapping and Hendry inter alia, is to assume that the static equilibrium ought to be tested as if valid in the long-run. This approach then "explains" any short-run disequilibrium phenomena by postulating an ad hoc adjustment or feedback mechanism (Lucas and Rapping, 1970, p. 271; Davidson et al., 1978, pp. 680-681; Hendry, 1980, p. 401; Hendry and von Ungern-Sternberg, 1981, pp. 238-244; Bean, 1981, p. 107). In a recent publication, Salmon (1982) recognizes that simply adding an arbitrary short-run adjustment scheme is not very satisfactory. He refers to literature in which the adjustment scheme is "derived" from a cost function which agents are assumed to be minimizing over time, but which is separate from the maximization programme which implies their static equilibrium behaviour (Salmon, 1982, p. 615). He justly argues that such schizophrenic behaviour on the part of the agents is less than fully satisfactory, and suggests that both the steady state equilibrium _and_ the error correction mechanism ought to be derived from the _same_ dynamic optimization exercise (Salmon, 1982, pp. 624-626). He points out that "this naturally returns the issue of the specification of the cost function to one of economic theory concerning the selection of the appropriate decision variables to be included" (Salmon, 1982, p. 626). As an interesting aside, Salmon also shows that, depending on the different dynamic properties of the equilibrium, different error correction mechanisms must be used in order to assure consistency and convergence (1982, pp. 612-620). For example, the standard partial adjustment mechanism is the correct error correction mechanism _only_ if the equilibrium target value is constant over time: "if the target path is constantly growing, the partial adjustment model will lead to a fixed offset and will thus never satisfy the target level even in the steady state" (Salmon, 1982, pp. 619-620).[49] According to Bean, this data-based approach is especially fruitful "in the absence of a well-defined theory of short-run behaviour by economic agents" (1981, p. 119). Disequilibrium theory has been proposed as such a short-run theory, so that a logically alternative approach is available. This second approach appends the pure equilibrium model of equations (6)-(9) with an additional assumption, namely that in the short-run prices and

----

[49]Thus the adjustment scheme used by Lucas and Rapping (1970) in their marginal productivity equation is only valid if the equilibrium value of the marginal productivity is constant over time, which seems a rather odd requirement.

wages are fixed and spill-overs occur accross markets. This approach clearly challenges the data-based but poverty inspired method of Lucas and Rapping, and Hendry and associates.

In order to keep this investigation within reasonable limits, and due to the fact that the results in Tables 1 to 4 are qualitatively very similar for each of the behavioural equations, only one equation from each of the four tables is selected to feature in this second round of the specification search. The results of the first strategy, using the basis equations (13), (17), (33), and (49), are the first four equations reported in Table 5. As these regressions indicate, the problem of autocorrelated errors has only been removed for the participation rate equation. In all other cases significant positive autocorrelation precludes us from making any inferences on the basis of t-statistics.[50] The numbers in square brackets in Table 5 are the long-run steady state values of the coefficients. Comparison of these long-run coefficients and the

---

[50]In fact, Lucas and Rapping's preferred equations for the participation rate, which is the driving force in their model, and the unemployment rate are not entirely free of autocorrelation either (1970, pp. 280-281). As the appropriate test statistic in the presence of lagged dependent variables, Durbin's h, indicates, both equations exhibit significant autocorrelation at the 5.8 percent one-tail test level (for the participation rate equation h=1.568, while h=1.572 for the unemployment rate equation). Lucas and Rapping must be excused, of course, in view of the fact that this more satisfying test statistic was not available at the time they performed their tests. Nevertheless, it does reduce the robustness of their conclusions somewhat. Equations (58) and (59) are Canadian estimates of Lucas and Rapping's expressions for the labour market (1970, pp. 280-281). These equation are not satisfactory either in view of the rather high absolute values of h, which indicate the existence of significant autocorrelation.

coefficients of the basic equations (13), (17), (33), and (49) reveals that only in the case of the participation rate equation are the results qualitatively different.[51] Equations (58) and (59) are included in Table 5 in order to facilitate the comparison of our results for the labour market with the ones obtained in the highly acclaimed study by Lucas and Rapping (1970, pp. 280-281). It seems that the Lucas and Rapping formulation does not capture the labour market data for Canada very well. Thus, some "circumstantial evidence" against their model has been produced. It is of course possible to postulate different feedback mechanisms, but the point is that the more we allow the data to (help) specify the model, the less clear it is whether the original theory can still be regarded as being the subject of the test.[52] The main conclusion we draw from the results in Table 5 is that we now have an alternative estimated model, which can serve as a standard of comparison for the disequilibrium estimates of the second strategy, to which we turn now.

As is pointed out in appendix B, estimation of disequilibrium models with spill-over effects across markets is

---

[51] Comparing equations (49) and (57) reveals that the signs of the constant term, the real unearned income term, and D2 are different, but not significantly so.

[52] It must be pointed out that the object of this chapter is not to find an empirically adequate equilibrium model. Rather, we attempt to show the typical results one obtains when following the strategy outlined by Lucas and Rapping and others. The outcome of their strategy can then be fruitfully compared with the one we suggest in this chapter, namely that perhaps a static disequilibrium model better describes the Canadian data.

Table 5: Estimates of the Equilibrium Model with Ad Hoc Adjustment Scheme. (*,+)

(54)

$$\log(Cp) = \underset{(3.46)}{\overset{[4.449]}{1.223}} + \underset{(1.50)}{\overset{[0.361]}{0.099}}*\log(Wch) + \underset{(2.08)}{\overset{[0.916]}{0.252}}*\log(Pm) - \underset{(-0.31)}{\overset{[-0.002]}{0.001}}*Rc + \underset{(3.32)}{\overset{[0.415]}{0.114}}*\log(A) + \underset{(7.37)}{0.725}*\log(Cp)_{-1}$$

$\bar{R}^2 = 0.993$ h=4.83 SER=0.032

(55)

$$\log(Y) = \underset{(1.54)}{\overset{[13.34]}{2.535}} + \underset{(0.92)}{\overset{[0.849]}{0.161}}*\log(Wph) - \underset{(-3.26)}{\overset{[-0.031]}{0.006}}*Pk + \underset{(1.07)}{\overset{[0.020]}{0.004}}*T + \underset{(7.78)}{0.810}*\log(Y)_{-1}$$

$\bar{R}^2 = 0.995$ h=5.16 SER=0.049

(56)

$$\log(Lh) = \underset{(1.72)}{\overset{[9.748]}{2.002}} + \underset{(0.80)}{\overset{[0.313]}{0.064}}*\log(Wph) - \underset{(-3.78)}{\overset{[-0.019]}{0.004}}*Pk + \underset{(1.29)}{\overset{[0.011]}{0.002}}*T - \underset{(-1.81)}{\overset{[-0.200]}{0.041}}*D1 + \underset{(0.95)}{\overset{[0.104]}{0.021}}*D2 - \underset{(-2.01)}{\overset{[-0.117]}{0.024}}*D3 + \underset{(7.47)}{0.795}*\log(Lh)_{-1}$$

$\bar{R}^2 = 0.992$ h=2.27 SER=0.022

(<u>Table 5, Continued</u>)

(57)

$$\log(Lph) = \underset{(0.57)}{\overset{[0.604]}{0.097}} + \underset{(0.78)}{\overset{[0.141]}{0.023}}*\log(Wch) + \underset{(0.39)}{\overset{[0.073]}{0.012}}*\log(A)$$

$$- \underset{(-3.69)}{\overset{[-0.023]}{0.004}}*Rc - \underset{(-1.99)}{\overset{[-0.294]}{0.047}}*D1 - \underset{(-0.16)}{\overset{[-0.019]}{0.003}}*D2$$

$$- \underset{(-0.07)}{\overset{[-0.006]}{0.001}}*D3 + \underset{(13.9)}{0.839}*\log(Lph)_{-1}$$

$\bar{R}^2 = 0.900$ h=0.56 SER=0.024

(58)

$$\log(Lph) = \underset{(-0.57)}{-0.040} + \underset{(6.61)}{0.713}*\log(Wph^{e}) - \underset{(-6.41)}{0.685}*\log(Wph)_{-1}$$

$$+ \underset{(3.91)}{0.304}*\Delta\log(Py) + \underset{(19.0)}{0.757}\ \log(Lph)_{-1}$$

$$- \underset{(-4.39)}{0.061}*D1 + \underset{(0.06)}{0.001}*D2 - \underset{(-2.51)}{0.020}*D3$$

$\bar{R}^2 = 0.956$ h=-1.81 SER=0.016

(59)

$$\log(Lh/Y) = \underset{(-0.77)}{-0.457} - \underset{(-0.73)}{0.082}*\log(Wph^{e}) + \underset{(8.36)}{0.906}*\log(Lh/Y)_{-1}$$

$$- \underset{(-10.2)}{0.602}*\Delta\log(Y) + \underset{(-0.01)}{0.000}*D1 + \underset{(0.64)}{0.009}*D2$$

$$- \underset{(-2.08)}{0.020}*D3$$

$\bar{R}^2 = 0.999$ h=-2.52 SER=0.017

(Table 5, Continued)

*) The observations for 1946 and 1966 have been excluded from the sample. The numbers in the square brackets above the coefficients denote their implied long-run steady state values, that are directly comparable with the ones in equations (13), (17), (33), and (49). See the note to Table 1.

+) The statistic h is a test for first order autocorrelation in the presence of lagged dependent variables due to Durbin (1970, p. 419). See also Judge et al. (1980, p. 219). It is defined as follows:

$$h = R1 * [T/(1 - T*V(b1))]^{1/2}$$

R1 is the estimated autocorrelation coefficient which can be approximated by 1-d/2, where d is the Durbin-Watson statistic. T is the sample size, and V(b1) is the estimated variance of the coefficient of the lagged dependent variable. The asymptotic distribution of h under the null hypothesis of no autocorrelation is N(0,1).

not straightforward. Ito proposed a relatively simple TSLS method which requires the availability of (reliable) quantitative price and wage adjustment data, as well as explicit specifications for the adjustment schemes (1980, p. 116). In addition to this estimation method, we will utilize two iterative estimators developed in appendix B, which can be used with or without a priori information.[53] A fourth method, which

---

[53] In appendix B the first three estimators are discussed in great detail. Monte Carlo sampling experiments are presented to illustrate the small sample properties of our two iterative estimators. Furthermore, disadvantages of the available ML method are mentioned there as well. The prior information in the case of our iterative estimators is qualitative rather than quantitative, and is only used in the first iteration.

is also applied below, consists of determining the appropriate sample separation on the basis of the data on price and wage adjustment in a <u>qualitative</u> fashion.[54] Then each regime is estimated separately, using the thus obtained sample separation, taking simultaneity into account.

The price and wage adjustment mechanisms we postulate for the TSLS method are the following:

(60) $$Dp_t = \Delta \log(Py)_t - py = a1*(\log(Yde)-\log(Yse)),\ a1\geq 0$$

(61) $$Dw_t = \Delta \log(Wh)_t - wh = a2*(\log(Lde)-\log(Lse)),\ a2\geq 0$$

Here py and wh denote the average rate of change of the GNE deflator and the nominal wage rate respectively. Again, as in chapter 2, the subscripts "d" and "s" denote demand and supply respectively, and "e" denotes effective behaviour. The terms py and wh are included in order to capture the effects of wage and

---

[54] For example, if the rate of change of nominal wages is larger than average, then we interpret this as evidence for excess demand in the labour market. Similarly, the rate of change of the price level in deviation from its average serves as an indicator for the situation on the goods market. This qualitative information can then be used to determine the different regimes. The advantage of this method over Ito's (1980) method is that no misspecification is added on to the model in the form of price and wage adjustment mechanisms.

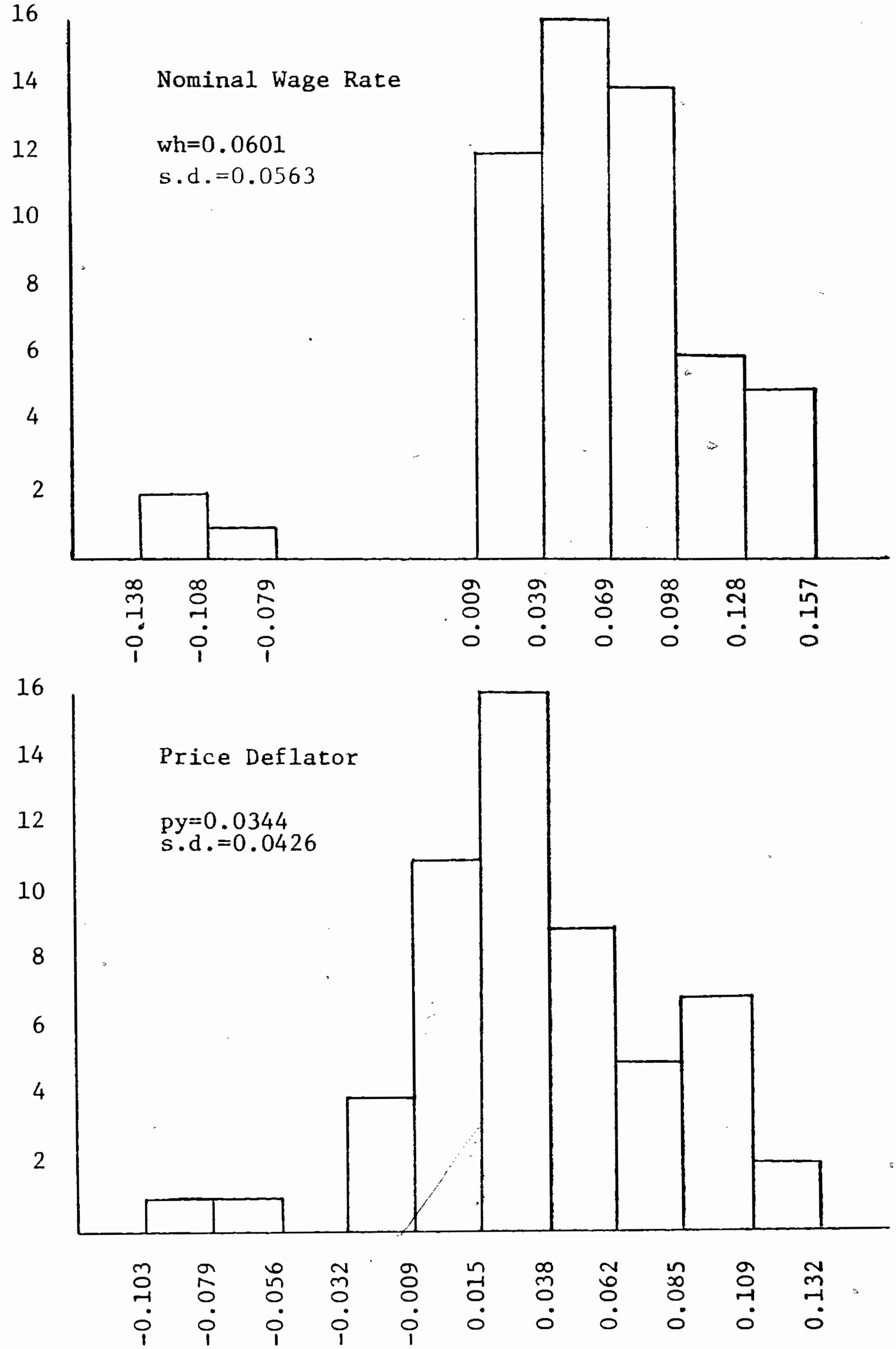
price changes due to all causes other than disequilibria. Equations (60) and (61) simply express the fact that prices and wages are assumed to vary positively with net excess effective demand in the goods and labour market respectively. In Figure 1 histograms have been drawn for the rates of change of Py and Wh, including the observations for the period 1927-1982.

The basic system again consists of equations (13), (17), (33), and (49), but now spill-over terms are also included. It is shown for the most general case in appendix B, section 6, that using the quantitative information on price and wage changes makes the system estimable. Furthermore, it is shown that in general all variables of labour supply enter into the equation for the goods demand, and vice versa. The same holds for labour demand and goods supply. We have implicitly assumed that the following spill-overs occur in the consumption function, the participation rate equation, goods supply, and labour demand respectively.

(62) $\log(Lphf) - RHS(49) = \log(Lphf) - \{a1*\log(Wch) + a2*Rc + a3*\log(A) + a4*D1 + a5*D2 + a6*D3\}$

(63) $\log(Cpf) - RHS(13) = \log(Cpf) - \{b1*\log(Wch) + b2*\log(Pm) + b3*Rc + b4*\log(A)\}$

Figure 1: Histograms of the Rates of Change of the Price Deflator and the Nominal Wage Rate.



$$(64) \quad \log(Lhf) - RHS(33) = \log(Lhf) - \{c1*\log(Wph) + c2*Pk + c3*T + c4*D1 + c5*D2 + c6*D3\}$$

$$(65) \quad \log(Yf) - RHS(17) = \log(Yf) - \{d1*\log(Wph) + d2*Pk + d3*T\}$$

Equation (62) indicates that the estimated effective participation rate minus the (unobservable) notional participation rate forms the spill-over from the supply side of the labour market tc the demand side of the goods market. Equation (63) describes the reverse case of a spill-over from the goods market (i.e. effective consumption demand) to the labour market. Equation (64), and (65) describe the spill-overs from the demand side of the labour market to the supply side of the goods market and vice versa respectively. As is shown in appendix B, section 6, the structural parameters can be calculated by incorporating cross-equation information on coefficient estimates.[55] In Table 6 we present the estimates of the four behavioural equations using Ito's (1980) TSLS method. A number of conclusions can be drawn on the basis of these

---

[55]See equations (B.47)-(B.50) for the general case. Even in the case of "common" regressors, the parameters in the system are identified.

Table 6: Disequilibrium Estimates of the Model: TSLS Method.

(66)

$$\log(Cp) = \underset{(14.2)}{\overset{[8.208]}{3.908}} + \underset{(10.6)}{\overset{[0.736]}{0.486}} * \log(Wch) - \underset{(-0.13)}{\overset{[-0.016]}{0.016}} * \log(Pm)$$

$$- \underset{(-0.69)}{\overset{[0.096]}{0.002}} * Rc + \underset{(4.01)}{\overset{[0.764]}{0.217}} * \log(A) + \underset{(3.30)}{0.132} * D1$$

$$- \underset{(-0.60)}{0.016} * D2 - \underset{(-0.57)}{0.012} * D3 - \underset{(-0.44)}{0.252} * Dppf$$

$$+ \underset{(6.39)}{0.748} * \log(Lphf)$$

$\bar{R}^2 = 0.994$ d=0.99 SER=0.029

(67)

$$\log(Lph) = \underset{(-12.1)}{\overset{[5.748]}{-5.406}} - \underset{(-9.75)}{\overset{[0.334]}{0.666}} * \log(Wch) + \underset{(0.01)}{\overset{[0.131]}{0.000}} * Rc$$

$$+ \underset{(0.46)}{0.046} * \log(Pm) - \underset{(-5.90)}{\overset{[0.732]}{0.307}} * \log(A)$$

$$- \underset{(-4.36)}{\overset{[-0.174]}{0.174}} * D1 + \underset{(2.32)}{\overset{[0.051]}{0.051}} * D2 + \underset{(0.93)}{\overset{[0.018]}{0.018}} * D3$$

$$- \underset{(-0.40)}{0.191} * Dwnf + \underset{(10.4)}{1.359} * \log(Cpf)$$

$\bar{R}^2 = 0.863$ d=1.29 SER=0.027

(68)

$$\log(Y) = \underset{(2.32)}{\overset{[15.11]}{7.060}} + \underset{(6.93)}{\overset{[1.408]}{1.217}} * \log(Wph) + \underset{(0.76)}{\overset{[0.044]}{0.003}} * Pk$$

$$- \underset{(-2.32)}{\overset{[-0.001]}{0.008}} * T - \underset{(-1.10)}{0.058} * D1 - \underset{(-1.11)}{0.052} * D2$$

$$+ \underset{(2.07)}{0.059} * D3 + \underset{(2.92)}{1.724} * Dpnf + \underset{(3.17)}{0.913} * \log(Lhf)$$

$\bar{R}^2 = 0.996$ d=1.25 SER=0.044

(Table 6, Continued)

$$(69)\quad \log(Lh) = \underset{(-0.65)}{\overset{[8.812]}{-2.079}} - \underset{(-2.40)}{\overset{[0.209]}{0.806}}*\log(Wph) + \underset{(2.19)}{\overset{[0.045]}{0.014}}*Pk$$

$$+ \underset{(2.52)}{\overset{[0.007]}{0.008}}*T + \underset{(0.12)}{\overset{[0.005]}{0.005}}*D1 + \underset{(0.44)}{\overset{[0.017]}{0.017}}*D2$$

$$- \underset{(-5.22)}{\overset{[-0.118]}{0.118}}*D3 + \underset{(2.79)}{2.828}*Dwpf + \underset{(3.90)}{0.721}*\log(Yf)$$

$\bar{R}^2 = 0.983$ $\quad d=1.24 \quad$ SER=0.032

*) See note to Table 1. The numbers in the square brackets above the coefficients denote the implied estimates of the structural parameters of the nctional curves, i.e. equations (13), (17), (33), and (49). See appendix B, section 6 for further details.

+) Dppf, Dpnf, Dwpf, and Dwnf are the dummies defined in equations (B.43)-(B.46). The third position in the names of these dummies indicates whether they are positive (p) or negative (n). The last position indicates fitted values (f). The same holds for Lphf, Cpf, Lhf, and Yf. For example, Dppf denotes the fitted value of Dp when Dp is positive, and Lphf denote the fitted values for the participation rate, obtained by using all exogenous variables as instruments. See appendix B, section 6 for details.

results:

(i) In comparison with the pure equilibrium formulations of equations (13), (17), (33), and (49), the results in Table 6 are qualitatively different, except for the consumption function. In all cases autocorrelation is substantially reduced but still present.

(ii) In comparison with the results in Table 5, the structural estimates in Table 6 confirm the positive real wage and real unearned income effects in the consumption function and participation rate equation, whereas the real wage terms in labour demand and goods supply are also present in both cases. In both approaches the severity of the autocorrelation is reduced substantially. Only the participation rate equation (53) seems devoid of autocorrelation problems. Thus, both strategies can be said to have failed in this second round of the specification search.

(iii) In the goods market the dummies representing the quantitative information on price adjustment, Dpp and Dpn, have the right signs and are large in absolute value. The coefficient for Dpn in equation (68) is furthermore significantly different from zero, which indicates that disequilibria and price adjustment may have played a significant role on the goods market in situations of excess supply. This conclusion cannot be very robust, however, in view of the autocorrelation present in the equations. The wage adjustment dummies, Dwp and Dwn, have the wrong signs, but only significantly so in the case of labour demand.

(iv) The estimates for the spill-over terms are all significant at the 0.5 percent significance level and have the right signs. This provides some "circumstantial evidence" in favour of the disequilibrium hypothesis. In the case of the spill-overs from the demand side of the goods market to the supply side of the labour market and vice versa, the sufficient condition for convergence as given by Ito (1980, p. 103) is violated

(1.359*0.748>1). This may the affect the reliability of the estimates.

The disequilibrium system has also been estimated by using only qualitative information on price and wage adjustment. The signs of Dw and Dp determine whether excess supply (Dw, Dp<0) or excess demand (Dw, Dp>0) prevails on the respective markets. Thus, the four regimes correspond with the configurations given in Table 7.[56] Inspection of the data on price and wage adjustment from 1927-1975 reveals that the K regime occurred 24 times, the U regime 9 times, the R regime 16 times, and the C regime never. In order not to exclude the Classical Unemployment regime a priori, we postulate the existence of intervals around wh and py, the observations in which are subjectively regarded as too close to zero to assign any definite signs to. Hence, observations that fall within these "uncertain" intervals are counted both as a positive and as a negative price or wage adjustment observation.[57] This approach, though ad hoc, has the attractive property that the same observations can be used for the estimation of more than one regime. Now, the K regime occurs 35 times, R 25 times, U 22 times, and C 14 times. Taking account

---

[56] See chapter 2, section 2, for an extensive discussion of these four regimes.

[57] The intervals are determined so as to include twenty percent around the mean, if the distribution of Dp and Dw were normal. Hence, the intervals for Dw and Dp are (wh-g*(0.0563),wh+g*(0.0563)) and (py-g*(0.0426),py+g*(0.0426)) respectively, where g=0.2533225 corresponds with the chosen level of "uncertainty", and can be found through loglinear interpolation in any table for the standard normal distribution (e.g. Intriligator, 1978, p. 619).

Table 7: Regime Classification on the Basis of Price and Wage Adjustment Data.

		Dw: Positive	Dw: Negative
Dp:	Positive	Repressed Inflation (R)	Classical Unemployment (C)
	Negative	Undercon-sumption (U)	Keynesian Unemployment (K)

of the definition of the different regimes (Ito, 1980, p. 109) the model can be estimated using the sample separation obtained in the manner described above. The results are reported in Table 8. Again, a number of conclusions can be drawn:

(i) All spill-over coefficients have the right signs and three out of four are of comparable magnitude to those estimated in Table 6. Thus, this alternative estimation method provides some additional circumstantial evidence in favour of the disequilibrium formulation. Unfortunately, the sufficient condition for convergence of the spill-over process is violated in the spill-over from the supply side of the goods market to the demand side of the labour market, which makes the implied structural coefficient estimates unreliable.

(ii) As in Tables 5 and 6, autocorrelation problems have not

Table 8: Disequilibrium Estimates of the Model: Qualitative Method. (*,+)

Keynesian Unemployment Regime:

(70)

$$\log(Cp) = \underset{(16.2)}{\overset{[0.269]}{3.502}} + \underset{(11.3)}{\overset{[0.366]}{0.532}}*\log(Wch) - \underset{(-0.52)}{\overset{[-0.006]}{0.076}}*\log(Pm)$$

$$- \underset{(-0.91)}{\overset{[-0.005]}{0.002}}*Rc + \underset{(2.94)}{\overset{[-0.176]}{0.133}}*\log(A) + \underset{(2.45)}{0.132}*D1$$

$$- \underset{(-0.37)}{0.009}*D2 + \underset{(0.08)}{0.003}*D3 + \underset{(7.06)}{0.729}*\log(Lphf)$$

$\bar{R}^2 = 0.995$ d=0.96 SER=0.026

(71)

$$\log(Lh) = \underset{(0.20)}{\overset{[-18.0]}{0.610}} - \underset{(-1.49)}{\overset{[-5.826]}{0.487}}*\log(Wph) + \underset{(0.27)}{\overset{[-0.063]}{0.001}}*Pk$$

$$+ \underset{(1.34)}{\overset{[0.239]}{0.005}}*T - \underset{(-1.22)}{\overset{[-0.060]}{0.060}}*D1 + \underset{(2.16)}{\overset{[0.065]}{0.065}}*D2$$

$$- \underset{(-3.51)}{\overset{[-0.099]}{0.099}}*D3 + \underset{(3.28)}{0.595}*\log(Yf)$$

$\bar{R}^2 = 0.975$ d=0.95 SER=0.034

(Table 8, Continued)

Repressed Inflation Regime:

(72)

$$\log(Y) = \underset{(0.14)}{\overset{[-31.3]}{0.783}} + \underset{(7.35)}{\overset{[-8.973]}{1.403}}*\log(Wph) + \underset{(1.29)}{\overset{[-0.108]}{0.005}}*Pk$$

$$- \underset{(-1.79)}{\overset{[0.394]}{0.032}}*T + \underset{(0.03)}{0.002}*D1 - \underset{(-1.81)}{0.075}*D2$$

$$+ \underset{(2.63)}{0.070}*D3 + \underset{(2.49)}{1.781}*\log(Lhf)$$

$\bar{R}^2 = 0.998$ d=1.37 SER=0.029

(73)

$$\log(Lph) = \underset{(-2.54)}{\overset{[-1.193]}{-4.525}} - \underset{(-1.70)}{\overset{[0.265]}{0.351}}*\log(Wch) - \underset{(-1.30)}{\overset{[-0.006]}{0.003}}*Rc$$

$$+ \underset{(0.75)}{0.098}*\log(Pm) - \underset{(-2.53)}{\overset{[-0.301]}{0.365}}*\log(A)$$

$$- \underset{(-4.16)}{\overset{[-0.215]}{0.215}}*D1 + \underset{(2.17)}{\overset{[0.054]}{0.054}}*D2 - \underset{(-0.03)}{\overset{[-0.001]}{0.001}}*D3$$

$$+ \underset{(2.18)}{1.035}*\log(Cpf)$$

$\bar{R}^2 = 0.593$ d=0.94 SER=0.022

(Table 8, Continued)

Classical Unemployment Regime:

(74)
$$\log(Y) = \underset{(12.2)}{14.83} + \underset{(4.65)}{1.291}*\log(Wph) + \underset{(2.14)}{0.013}*Pk + \underset{(0.10)}{0.001}*T$$

$\bar{R}^2 = 0.995$ d=0.79   SER=0.044

(75)
$$\log(Lh) = \underset{(5.88)}{5.954} - \underset{(-2.20)}{0.503}*\log(Wph) - \underset{(-1.72)}{0.007}*Pk + \underset{(4.63)}{0.037}*T - \underset{(-0.45)}{0.016}*D1 + \underset{(2.38)}{0.048}*D2 + \underset{(0.69)}{0.028}*D3$$

$\bar{R}^2 = 0.995$ d=2.29   SER=0.016

Underconsumption Regime:

(76)
$$\log(Cp) = \underset{(8.65)}{3.292} + \underset{(7.28)}{0.536}*\log(Wch) + \underset{(0.17)}{0.047}*\log(Pm) + \underset{(1.55)}{0.012}*Rc + \underset{(1.69)}{0.157}*\log(A)$$

$\bar{R}^2 = 0.981$ d=0.22   SER=0.048

(Table 8, Continued)

$$(77) \quad \log(Lph) = -0.951 - 0.025*\log(Wch) + 0.011*Rc - 0.045*\log(A) - 0.074*D1 + 0.048*D2 + 0.021*D3$$

t-values: (-1.71) (-0.20) (1.25) (-0.35) (-0.90) (0.99) (0.39)

$\bar{R}^2 = 0.411$ d=0.29 SER=0.057

*) See the notes to Tables 1 and 6.

+) The different regimes are estimated with observations from the following years: K: 1927-28, 1930-39, 1944-46, 1949-50, 1953-68, 1970-71; R: 1936-1937, 1940-43, 1946-52, 1956, 1965-1975; C: 1936-37, 1944-46, 1949-50, 1956, 1965-68, 1970-1971; U: 1928-29, 1935-37, 1942-43, 1945, 1949-50, 1952-53, 1956-57, 1964-71.

been entirely solved, although the inclusion of spill-overs seems to reduce the severity of these problems somewhat. Thus, it is reasonable to conclude that the disequilibrium formulations can help to describe cyclical patterns which could have caused the autocorrelation problems of the pure equilibrium model of Tables 1 to 4. The fact that the disequilibrium estimates of Tables 6 and 7 are not entirely free from autocorrelated errors suggests that the original model of equations (13), (17), (33), and (40) is otherwise misspecified.

Finally, the disequilibrium system has been estimated using the iterative ILSE estimator discussed in appendix B. The results for the goods market are presented in Table 9. Since the ILSE procedure failed to converge for the labour market equations, it is not possible to calculate the implied structural coefficients. The results in Table 9 are qualitatively very similar to the ones reported in Table 6.

An interesting comparison is now to take the universally acclaimed equilibrium model of Lucas and Rapping (1970), and estimate its implied empirical disequilibrium version. In Table 10 we report the resulting estimates of Lucas and Rapping's preferred model using their data (1970, pp. 280-281, 286). The model is estimated using the TSLS method. The results obtained by Lucas and Rapping themselves are also reported in order to facilitate the comparison.[58] The results in Table 10 indicate that disequilibria may have been an important factor on the U.S. labour market, since the dummies representing the wage adjustment have the right signs and are significant. Care must be taken in the interpretation of these results, however, since Lucas and Rapping themselves justify equation (80) using an adaptive expectations formation scheme (1970, p. 268), and it is not clear whether this is theoretically consistent with the disequilibrium interpretation. Furthermore, the participation rate equation under conditions of excess supply on the labour market, i.e. when Dwnf is non-zero, is ill-conditioned since the

[58] It turns out that the results reported by Lucas and Rapping (1970, pp. 280-281) are not the same as the ones we obtain. In particular, the constant terms are different, which may have resulted from the slightly different way in which Lucas and Rapping account for simultaneity.

Table 9: Disequilibrium Estimates of the Model: ILSE Method(*,+)

(78) $$\log(Cp) = \underset{(15.2)}{3.915} + \underset{(20.8)}{0.620}*\log(Wch) + \underset{(2.55)}{0.189}*\log(Pm) + \underset{(0.66)}{0.001}*Rc + \underset{(2.89)}{0.127}*\log(A) + \underset{(0.55)}{0.014}*D1 - \underset{(-0.10)}{0.004}*D2 - \underset{(-2.29)}{0.023}*D3 + \underset{(11.7)}{0.833}*\log(Lph)$$

$\bar{R}^2 = 0.999$ d=1.47 SER=0.016

(79) $$\log(Y) = \underset{(1.87)}{4.433} + \underset{(3.27)}{0.562}*\log(Wph) - \underset{(-0.79)}{0.001}*Pk + \underset{(1.45)}{0.009}*T + \underset{(0.67)}{0.072}*D1 - \underset{(-0.53)}{0.011}*D2 + \underset{(1.45)}{0.107}*D3 + \underset{(3.57)}{0.899}*\log(Lh)$$

$\bar{R}^2 = 1.000$ d=2.50 SER=0.011

*) See the notes to Table 1. The ILSE estimates for the labour market are not presented since they failed to converge, even in the case where extraneous information in the form of the unemployment rate was used in order to generate an initial sample separation.

+) The following sample separation was estimated for the goods market: excess supply in the periods 1929-41, 1946-55, 1957-61, 1972, and 1975; excess demand in the periods 1927-28, 1942-45, 1956, 1962-71, 1973-74.

nominal wage adjustment term (Dwnf) is an almost exact linear combination of the second, third and fourth terms on the RHS(81). Overall though, we can conclude that even an equilibrium model like Lucas and Rapping's lends some support to disequilibrium interpretation.[59]

5:THE RELATIVE FORECASTING PERFORMANCE OF THE EQUILIBRIUM AND DISEQUILIBRIUM FORMULATIONS

In this section the forecasting performance of the different models estimated in the previous section is analyzed for the period 1976-1982. The resulting information serves as additional "circumstantial evidence" vis-a-vis the relative merits of the equilibrium and disequilibrium hypotheses. Again the basic equations (13), (17), (33), and (49) serve as benchmarks for the other equations from Tables 5, 6, and 8. Following Zarnowitz (1978), we present the Mean Absolute Error (MAE), and the Mean Error (ME) of each forecast, as well as the correlation coefficient between predicted and actual change. This last statistic measures how well turning-points are predicted. In addition to this, so-called naive forecasts are also presented, which presume no change, as well as extrapolations.[60] The variables to be forecasted are real gross national expenditure from the goods supply equation, real consumption from the goods demand equation, employment from the

---

[59] In fact, Lucas and Rapping's own preferred equation (80) implicitly contains the necessary elements to interpret it as a disequilibrium formulation, since the second, third, and fourth terms on the RHS (80) can be interpreted as the nominal wage adjustment term under conditions of excess supply. Thus, equation (80) can equally well be thought of as the effective participation rate equation in conditions of unemployment.

[60] These extrapolations are calculated using the compounded growth rates of the different variables from 1926-1975.

Table 10: Equilibrium and Disequilibrium Estimates of the Lucas and Rapping Model for the U.S.: TSLS Method.(*)

(80)
$$\log(N/M)_t = \underset{(-1.04)}{-0.151} + \underset{(2.79)}{1.405}*\log(wf)_t - \underset{(-2.77)}{1.395}*\log(w)_{t-1}$$
$$+ \underset{(4.30)}{0.747}*\Delta\log(P)_t + \underset{(7.38)}{0.639}*\log(N/M)_{t-1}$$

$\bar{R}^2 = 0.799$ h=1.53 SER=0.045

(81)
$$\log(N/M)_t = \underset{(5.97)}{1.175} - \underset{(-0.61)}{0.157}*\log(w)_t - \underset{(-0.34)}{0.085}*\log(w)_{t-1}$$
$$- \underset{(-1.55)}{0.257}*\Delta\log(P)_t + \underset{(15.3)}{0.958}*\log(N/M)_{t-1}$$
$$+ \underset{(7.48)}{4.433}*Dwnf$$

$\bar{R}^2 = 0.913$ h=1.89 SER=0.029

(82)
$$\log(N*Q/y)_t = \underset{(3.68)}{1.967} - \underset{(-3.77)}{0.461}*\log(wf/Q)_t$$
$$+ \underset{(5.08)}{0.580}*\log(N*Q/y)_{t-1} - \underset{(-5.38)}{0.209}*\Delta\log(y)_t$$

$\bar{R}^2 = 0.993$ h=0.72 SER=0.016

(Table 10, Continued)

$$(83)\qquad \log(N*Q/y)_t = \underset{(6.21)}{2.131} - \underset{(6.44)}{0.504}*\log(w/Q)_t + \underset{(7.47)}{0.546}*\log(N*Q/y)_{t-1} - \underset{(-6.24)}{0.187}*\Delta\log(y)_t - \underset{(-2.88)}{0.146}*Dwpf$$

$\bar{R}^2 = 0.996$ $h=1.33$ $SER=0.012$

*) The notation refers to Lucas and Rapping (1970, p. 281). N is man-hours per year, M is population over 14 years of age with constant age-sex distribution, Q is an index of labour quality as measured by years of schooling completed, w is real compensation per man-hour, P is the implicit GNP deflator, and y is real GNP. The period of estimation is 1930-1965. Dwpf and Dwnf are obtained in a similar way as in Table 6, using deviations from the mean rates of change of the nominal wage rate as measures for the situation on the labour market. Furthermore, wf are the fitted values of w, using all exogenous variables as instruments.

labour demand equation, and the participation rate from the participation rate equation.[61] The results are reported in Tables 11 to 14. A number of conclusions can be drawn from these results:

(i) In virtually all cases both the equilibrium-cum-adjustment and the disequilibrium models forecast significantly better than the pure equilibrium model.

(ii) In terms of the MAE and ME of the forecasts, the

----

[61] We have chosen to forecast employment and the participation rate uncorrected for the index of weekly hours worked since this index is itself a constructed variable, whereas employment and the participation rate are readily available data published by Statistics Canada.

equilibrium-cum-adjustment and disequilibrium formulations are of comparable quality, neither one dominating the other uniformly. However, it seems that the latter predicts turning-points better than the former, at least in most cases, which is an interesting piece of evidence in favour of the disequilibrium hypothesis.

(iii) A rather sobering result, on the other hand, is that the naive forecasts and the extrapolated forecasts both dominate the structural forecasts of the participation rate on the basis of the MAE criterion. These naive forecasts do not predict any turning-points of course, so that this result should not be regarded as too serious a threat for macroeconometric modelling, provided the latter can indeed predict turning points.

6:CONCLUDING REMARKS

The main findings in this chapter can be summarized as follows:

(i) For econometric methodological reasons, empirical evidence can never transcend the level of "circumstantial evidence" against or in favour of the usefulness of different hypotheses. Furthermore, all such evidence must be reported, since "negative" results do convey useful information as well.

(ii) In a search for circumstantial evidence for the disequilibrium hypothesis, it is most informative to contrast and compare such findings with the ones obtained with the corresponding alternative equilibrium hypothesis. This strategy

Table 11: Forecasting Performance for Gross National Expenditure. (*)

	Equation	MAE	ME	R^2
Pure Equilibrium	(17)	15.75	-15.75	-0.139
Equilibrium with Ad Hoc Adjustment	(55)	1.63	-0.09	0.042
Disequilibrium	(68)	1.79	0.09	0.814
	(72)	2.73	2.73	0.955
	(74)	16.72	-16.72	NA
Naive		11.86	11.86	NA
Extrapolation		5.27	4.86	NA

*) MAE and ME denote the mean absolute forecast error and the mean forecast error respectively. Both are expressed in percentage of GNE. The period forecasted is 1976-1982, except for equation (74) for which only two observations are used. The forecasts from Table 8 are obtained by utilizing the price and wage information. Thus the following regimes are found to be relevant: R for 1976-1982, and C for 1978-1979.

Table 12: Forecasting Performance for Employment. (*)

	Equation	MAE	ME	R^2
Pure Equilibrium	(33)	15.21	-15.21	-0.210
Equilibrium with Ad Hoc Adjustment	(56)	2.23	-1.99	0.040
	(59)	1.30	0.46	0.846
Disequilibrium	(69)	7.70	3.34	0.326
	(75)	0.08	0.08	NA
Naive		9.07	9.07	NA
Extrapolation		1.96	1.73	NA

(Table 12, Continued.)

*) See remark Table 11. MAE and ME are expressed in percentage of employment. For the forecasts from equation (75) only two observations were used, 1978-1979.

Table 13: Forecasting Performance for the Participation Rate. (*)

	Equation	MAE	ME	R^2
Pure Equilibrium	(49)	7.76	-7.76	-0.592
Equilibrium with Ad Hoc Adjustment	(57)	6.54	-6.54	-0.176
	(58)	2.91	-1.17	-0.012
Disequilibrium	(67)	4.62	-1.11	0.464
	(73)	6.26	-5.34	0.213
Naive		1.92	1.92	NA
Extrapolation		1.86	-1.58	NA

*) See remark Table 11. MAE and ME are expressed in percentage of the participation rate.

Table 14: Forecasting Performance for Consumption. (*)

	Equation	MAE	ME	R^2
Pure Equilibrium	(13)	3.25	-1.26	0.519
Equilibrium with Ad Hoc Adjustment	(54)	6.59	6.44	0.833
Disequilibrium	(66)	3.08	-0.74	0.747
	(78)	2.93	2.29	0.815
Naive		11.24	11.24	NA
Extrapolation		6.43	5.91	NA

(Table 14, Continued.)

*) See remark Table 11. MAE and ME are expressed in percentage of consumption. Equation (78) is used to generate forecasts for the entire period 1976-1982, since the model estimates presented in Table 9 predict excess supply of goods for this entire period.

conveys valuable information about the relative usefulness of the two hypotheses. Since the principal objective of empirical economics must be prediction, the forecasting performance of the different hypotheses can serve as a measure of this relative usefulness.

(iii) Overall, it is shown that the Canadian data appear to reject the pure equilibrium formulations used in this chapter, in the sense that the presence of severe autocorrelation indicates misspecification. Equilibrium models appended with ad hoc adjustment mechanisms and disequilibrium models both constitute substantial improvements relative to the pure equilibrium formulations, but neither one dominates the other in terms of predictive performance.

(iv) It is shown that a celebrated equilibrium model like Lucas and Rapping's (1970) can be used to provide strong circumstantial evidence in favour of the disequilibrium hypothesis. In fact their labour supply equation, which is justified by them using an adaptive expectations mechanism, can equally well be interpreted as the effective labour supply when the labour market is in excess supply.

On the basis of these results, we hope to have shown in this chapter that the disequilibrium hypothesis deserves as much attention from applied econometricians as the ad hoc approach in which arbitrary lag structures are imposed on essentially static models. Ideally, both the equilibrium and the disequilibrium models ought to be derived from an explicit dynamic foundation, since the Canadian evidence suggests that virtually none of the models estimated above capture the dynamic data generating process completely. This must be left for future research, however.

IV. TOWARDS A MORE SATISFYING NON-WALRASIAN MODEL WITH CONJECTURES AND BAYESIAN LEARNING.

> There is something fundamentally wrong with an approach which habitually disregards an essential part of the phenomena with which we have to deal: the unavoidable imperfection of man's knowledge and the consequent need for a process by which knowledge is constantly communicated and acquired (Hayek, 1945, p. 530).

> The statement that, if people know everything, they are in equilibrium is true simply because that is how we define equilibrium. The assumption of a perfect market in this sense is just another way of saying that equilibrium exists, but does not get us any nearer an explanation of when and how such a state will come about (Hayek, 1937, p. 45).

1:INTRODUCTION

In this chapter we will present a formalized model with explicit price setting under imperfect information. Integrated in the model is the notion, developed over the last two decades by proponents of the non-Walrasian approach, that in general price as well as quantity signals will be relevant for the short term equilibrating of the plans of decentralized agents. Born, as it is, out of the marriage of highly formalized general equilibrium theory and less than fully understood Keynesian visions, non-Walrasian economics has generally speaking succeeded in proving "reasonable doubt" vis-a-vis the propositions of the proponents of the New Classical school. The equilibria that are possible - and indeed likely - in the non-Walrasian models are characterized by unemployment without there being forces operating to mitigate it. As is shown by Neary and Stiglitz (1983), this result obtains regardless of whether expectations are assumed to be rational or not. They show that it is the perfect price and wage flexibility assumption of the New Classical school which serves as the necessary condition for full employment (Neary and Stiglitz, 1983, p. 201). Of course, the way we choose (here) to formalize the short run operating of an economy with imperfect information is by no means the only one. An enlightened theorist of the (Walrasian) New Classical persuasion would presumably be able to achieve the same results using models with perfectly flexible and hence instantaneously market clearing prices. Such models would postulate the existence of positive transactions costs, due to imperfect information, that would drive a wedge between supply and demand so that the usual (perfect information) Walrasian equilibrium would not be attained. In our view the approach we propose attempts to open up the "black box" of "positive transactions costs" or "information costs" by deriving the existence of these costs from assumptions about the behaviour of the individual agents. Admittedly, the "black box" could turn out to be a "can of worms", but even in this (worst) case a service would be rendered to both non-Walrasian and (enlightened) New Classical theorists. As we interpret it, the two explanations are not mutually exclusive; they merely present different angles from which the same phenomenon is viewed.

The chapter is subdivided as follows. In section 2 we present a possible way in which individual agents adjust their (quantity <u>and</u> price) expectations in the light of new information. All uncertainty we will be dealing with in this chapter is subjective uncertainty. A simple adaptive adjustment rule is developed. In section 3 we apply this rule to the case of a single monopolist "groping" for the profit maximizing solution. It turns out that - in general - he will end up "being right, but for the wrong reasons" to quote Hahn (1978). The application of the rule will lead to a "bootstrap" equilibrium in the sense that the expectations tend to be self fulfilling. In section 4 we present the basic model describing the interaction between a monopolistically competitive goods market and a unionized labour market. Every period, firms and unions set the price and wage rate respectively, which are then <u>fixed</u> during the period. After each period, the firms and unions update their "theories" on the basis of the new information. Our model thus enables us to distinguish between short-run quantity constrained equilibria, and long-run equilibria in which all perceived gains from trade have been exploited. The firm faces a large number of price taking consumers, and each union faces many wage taking firms. Again, even in the long-run, an equilibrium may be attained in which agents perceive themselves to be maximizing but in fact are "only" right for the wrong reasons. Section 5 contains the main conclusions.

2:CONJECTURES AND ADAPTIVE LEARNING

In Walrasian general equilibrium models all agents base their behaviour on the presupposition that they will be able to realize their plans. The additional assumption of instantaneous and costless price adjustment and hence continual market clearing vindicates this presupposition ex post. Consequently, in a Walrasian world, prices are the only relevant signals to the decentralized decision making agents. The introduction of explicit price setting results in further complications. In order for an agent to be able to set a price he must have some knowledge about market conditions facing him. For example, in the models we develop below, we encounter monopolists trying to make an "educated guess" as to how much they will be able to sell at different prices. A commonly used short-cut to the problem of determining the basis of the monopolists' behaviour is to assume that he somehow knows the true demand curve (e.g. Hart, 1982). This seems less than desirable and defines away the problem rather than tackling it. A more satisfactory approach was introduced by Bushaw and Clower (1957) and subsequently used by Clower (1959), Negishi (1960-1961), and others. These theorists make use of the perceived demand curve, which is a structural estimate of the "true" demand curve. As time evolves, agents "learn" - incorporate more information - by re-estimating this structural equation (e.g. Kirman, 1975; Benassy, 1982, pp. 50-57). An unfortunate implication of viewing price setting behaviour in this manner is that it is entirely up to the researcher to determine how many explanatory variables the agents are supposed to be incorporating in the estimation procedure, as well as how close the agents' structural model comes to the "true" structure. A certain amount of ad hoccery seems unavoidable. As Frank Hahn puts it:

> We have no theory of expectations firmly founded on elementary principles comparable, say, to our theory of consumer choice. Clearly, expectations must be based on the agent's observations, which is of course meant to include the history of such observations. But as I have noted elsewhere, the transformation of observations into expectations requires the agent to hold a theory, or, if you like, requires him to have a model. The model itself will not be independent of the history of observations. Indeed, learning largely consists of updating models of this kind. Although we have Bayes's theorem, very little is known about such learning in an economic context. There is thus a great temptation to short-circuit the problem, at least in a first approach, and to consider only economic states in which learning has ceased (1982, p. 3).

Other contributions attempt to describe the behaviour of learning agents by directly acknowledging the subjective nature of the decision procedure. They make use of Bayesian learning, which implies that theories are updated by gathering new sample information and combining this new information with prior beliefs in a systematic way (e.g. DeGroot, 1970; Cyert and DeGroot, 1970, 1974; Grossman, 1975a, 1975b). As is pointed out by Blume, Bray, and Easley (1982), the recent literature on learning and convergence to rational expectations can be divided into roughly two groups. The first of these again assumes that agents possess correct information on the structure of the economy, and only need to estimate the coefficients somehow. The best known examples are Cyert and DeGroot (1970, 1974, pp.

530-532), Friedman (1979), Frydman (1982), Grossman (1975a, 1975b), Lewis (1981), Prescott and Townsend (1980), and Turnovsky (1969). As in indicated by Blume et al. this approach "embodies fully rational learning, but is extraordinary demanding in terms of the information, understanding, and calculating ability of agents" (1982, p. 314). In a sense this method does not add much to the simple thought experiment that is usually employed in defence of the existence and uniqueness of rational expectations equilibria. This thought experiment usually proceeds along the following lines: (i) Any equilibrium in which potential gains from trade are left unexploited cannot be a "true" equilibrium; (ii) In a rational expectations equilibrium, there are no unexploited gains from trade; (iii) Ergo, from (i) and (ii), the only "true" equilibrium must be a rational expectations equilibrium. Apart from the purely logical error this kind of reasoning contains, another criticism against it is that "the situation seems here to be that before we can explain why people commit mistakes, we must first explain why they should ever be right" (Hayek, 1937, p. 34). In other words, without an explicit theory of expectations formation and adjustment, this thought experiment cannot be very convincing. Blume et al. also show that in the models of this category, convergence to rational expectations follows directly from the asymptotic properties of Bayesian estimators (1982, pp. 314-315; DeGroot, 1970, pp. 201-204).

The second group, on the other hand, assumes that agents do not possess the correct model, but instead learn on the basis of a misspecified representation of the economy. The main examples are Blume and Easley (1982), Bray (1982), Brock (1972), Cyert and DeGroot (1974, pp. 524-530), and DeCanio (1979). The main drawback from a theoretical point of view is that in this approach the learning process itself is not rational in that agents do not use statistical procedures to test whether their personal models are correct (Blume et al., 1982, p. 314).

In our view, even though both approaches suffer from serious shortcomings, the second approach, which introduces agents subjectively learning on the basis of incorrect models, is to be preferred over the first in modelling the behaviour of decentralized agents "each of whom possesses only partial knowledge" (Hayek, 1945, p. 530). Consequently, the approach that we use below can be viewed as a mixture of the idea of the perceived demand curve and simple Bayesianism. Instead of assuming agents to form an educated guess about the entire structure of the demand curve, we follow Hahn (1978) in using the notion of conjectures. A conjectured demand is a schedule which relates the expected quantity constraint to the price level (Hahn, 1978, p. 7). It must be stressed here that it is not a structural model of the demand curve. All components influencing demand other than the price are lumped together. Hence, the model is clearly misspecified and known to be so, and each agent finds it too costly or too difficult to obtain a "better" or "truer" model. Furthermore, we assume these conjectures to be linear.[1] In the case of a single isolated monopolist it could take the following form:

$$(1) \qquad Xe_t = (A/b)_t - (1/b)_t * P_t \qquad A, b>0$$

Here Xe is the maximum amount the monopolist expects to be able to sell when he sets his price at P. The parameters A and b are unknown (fixed) quantities about which the producer has to form an educated guess in each period. Note that in the deterministic models in this chapter there is no "outside" objective uncertainty vis-a-vis the parameters of the conjectured demand. Hence the use of Bayesian methods seems to be the most natural way of introducing learning of the agents about the uncertain parameters. In Bayesian decision theory, the decision maker who is faced with the problem of making a guess about uncertain parameters forms a prior distribution which incorporates all his beliefs about those parameters. Suppose the monopolist attempts to learn about the parameters of the conjecture. Rewrite equation (1) as follows:

----

[1] Since we analyze the case in which agents possess incorrect knowledge of the economic process, <u>any</u> incorrect specification can be used. We use the linear specification for simplicity only.

(2) $$P_t = A_t - b_t * Xe_t$$

Define B=(A,b). Now the monopolist's prior distribution at time t can be written as follows:

(3) $$p(B_t)$$

The next step is for the producer to take a sample to update his beliefs. In a sequential economic context where observations are by nature discrete, it is natural to think of the sample being of fixed size equal to unity. In other words the monopolist sets the quantity Xa at the beginning of the period and observes what price level will prevail, and he does this every period.[2] Suppose that the actual price turns out to be Pa and that the conjectured price, obtained by using equation (2) is equal to Pc. As there is no outside market uncertainty, the difference between the actual and the conjectured price is entirely attributable to the agents' inaccurate knowledge about the parameters of the conjectured demand. More specifically, if Pc>Pa then the sample information tells the producer that either

[2] Alternatively, we could assume that the price is set at the beginning of the period and the quantity signal is used to update the conjecture. Indeed, this is the approach followed in section 4 below.

A was too high or b was too low or both, and vice versa in the case of Pc<Pa. Following established practice (e.g. Cyert and DeGroot, 1970, p. 1180; 1974, p. 525), we introduce Bayesian decision theory in its simplest form, by assuming the prior distributions of A and b to be independent and of the following form.[3]

(4) $$A_t \sim N(Ae,V)$$

(5) $$p(b_t = b) = 1$$

Equation (4) tells us that the prior beliefs of the producer regarding A can be represented by a normal distribution with mean Ae and variance V, whereas his prior beliefs about b are "unshakeable" in the sense that its distribution is a spike over the fixed value b. In a similar fashion, Cyert and DeGroot (1970) analyze the behaviour of two duopolists that know the

----

[3]It must be noted that we have chosen this simplest case for convenience only. The distribution most frequently used in the literature dealing with learning is the normal distribution, which is only relatively manageable in the univariate case when the variance of the error terms is known with certainty (DeGroot, 1970, p. 167). Other, more general, distributions would complicate matters considerably without adding anything of import to the analysis.

slope coefficients, but are uncertain about each other's output and, in some cases, about the intercept term. In their model, the firms know the correct structure of the demand equation, however, whereas in our model the monopolist does not know this. Since the monopolist does not adjust the slope parameter in any way, the sample information on A, denoted by As, when the actual quantity and price are Xa and Pa respectively, turns out to be equal to:

$$(6) \qquad As_t = Pa_t + b^*Xa_t$$

If the prior distribution of A is N(Ae,V), and under the assumption that the true variance of A is known to be equal to Va, then the posterior distribution of A after obtaining the sample information As, is normal with mean Ae' and variance V':[4]

$$(7) \qquad Ae' = \frac{Ae/V + As/Va}{(1/V) + (1/Va)}$$

---

[4]See DeGroot (1970, p. 167) for a formal proof of this result. In words, 1/V denotes the confidence that the agents have in their subjective estimate of the intercept, whereas Va is the actual variance of the intercept which is assumed to be known.

$$(8) \qquad 1/V' = (1/V) + (1/Va)$$

Note that the mean of the posterior distribution can be rewritten as follows:

$$(9) \qquad Ae' = a*Ae + (1-a)*As$$

$$(10) \qquad a = \frac{(1/V)}{(1/V) + (1/Va)} \qquad 0 < a < 1$$

In other words, the posterior mean can be viewed as a weighted average of the pricr mean and the sample information, with the weights variable over time in view of equation (8).

If the objective function of the decision maker is linear in A, then the mean of the posterior distribution will be used to make the decisions in the next period:

$$(11) \qquad E_{t+1}(A)_{t+1} = Ae' = Ae_{t+1}$$

Hence, in period (t+1) the monopolist will not use equation (2) as the basis of his calculations, but instead he will use the updated conjecture:

$$(12) \qquad P_{t+1} = Ae_{t+1} - b^{*}Xe_{t+1}$$

Note that at the beginning of period (t+1) the posterior distribution of A (equations (7) and (8)), together with equation (5), will serve as the new prior to be combined with the sample information obtained in period (t+1).[5]

3:THE SINGLE MONOPOLIST

In order to illustrate the nature of the learning procedure developed in this chapter, we will describe the behaviour of a single monopolist who is unaware of the true demand curve for his product, but who forms simple linear "theories" regarding this demand curve. This example is very similar to Clower (1959).[6] He is assumed to know his own marginal cost curve with certainty. The true demand curve is given by:

$$(13) \qquad P_t = D(X_t) \qquad , \; D'(.)<0$$

----

[5]It was pointed out to me by Professor Kennedy that the decision making process introduced in this chapter can be regarded as a recursive decision system, the theory of which is discussed in Day and Kennedy (1970).

[6]Clower suggests the term "ignorant monopolist" since the monopolist only manages to make a reasonable guess about the form of the market demand function (1959, p. 709).

The monopolist's theory is a conjectured demand curve assumed to be of the following form:

$$(14) \qquad P_t = Ae_t - b*X_t \quad , \; Ae_t , b > 0$$

His marginal cost curve is given by:

$$(15) \qquad MC_t = MC(X_t) \quad , \; MC'(.)>0$$

The monopolist can do no better for himself than equating marginal cost with perceived marginal revenue. In other words his conjectured profit maximizing output and price signal (Pc,Xc) is determined by the following two equations:

$$(16) \qquad MC(Xc_t)=Ae_t - 2b*Xc_t$$

$$(17) \qquad Pc_t = Ae_t - b*Xc_t$$

When the monopolist sends this signal to the market it will generally prove to be inconsistent, i.e. he cannot get the price Pc and the quantity Xc at the same time. Suppose that the monopolist sets the actual quantity at Xa=Xc, and relies on the market to set the price. In that case the actual price, denoted by Pa, will be:

$$(18) \qquad Pa_t = D(Xa_t)$$

In general this price will diverge from the expected price, which will lead the monopolist to adjust his theory. As we have argued in the previous section (equation (9)), the learning process of the monopolist is a simple adaptive updating procedure, reminiscent of cobweb models, which can be formalized as follows:

$$(19) \qquad Ae_{t+1} = a*Ae_t + (1-a)*(Pa_t + b*Xa_t) \qquad 0<a<1$$

The situation has been illustrated in <u>Figure 1</u> below. In the case drawn in <u>Figure 1</u> the monopolist proves to have been too optimistic about demand, and he will adjust Ae downwards. This "tatonnement" in expectations (and consequently prices and quantities) will continue until Pc=Pa, or in other words, until the steady state equilibrium is attained and updating of the theory has ceased:

$$(20) \qquad Ae_t = Ae_{t+1} = \bar{A}$$

This situation, which can be called a fully rational or self fulfilling equilibrium, is illustrated in Figure 2 below. The signal sent by the monopolist on the basis of his perceived demand curve is (Pc,Xc), and the market repeats and thereby rationalizes that signal. In general however, this self fulfilling equilibrium is different from the "true" or perfect information equilibrium, which is defined as follows:

$$(21) \qquad D'(X^*_t)*X^*_t + D(X^*_t) = MC(X^*_t)$$

$$(22) \qquad P^*_t = D(X^*_t)$$

If the monopolist were <u>globally</u> correct (in the sense of possessing perfect knowledge of the true demand curve), rather than <u>locally</u> correct (in the sense of learning one point on the

Figure 1: The Monopolist in Conjectural Disequilibrium.

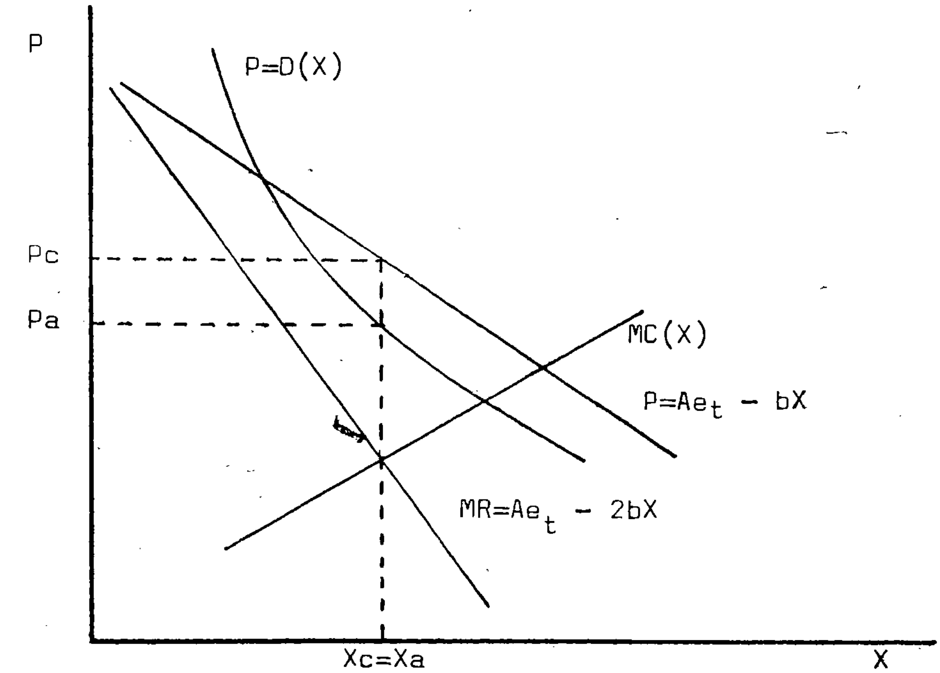
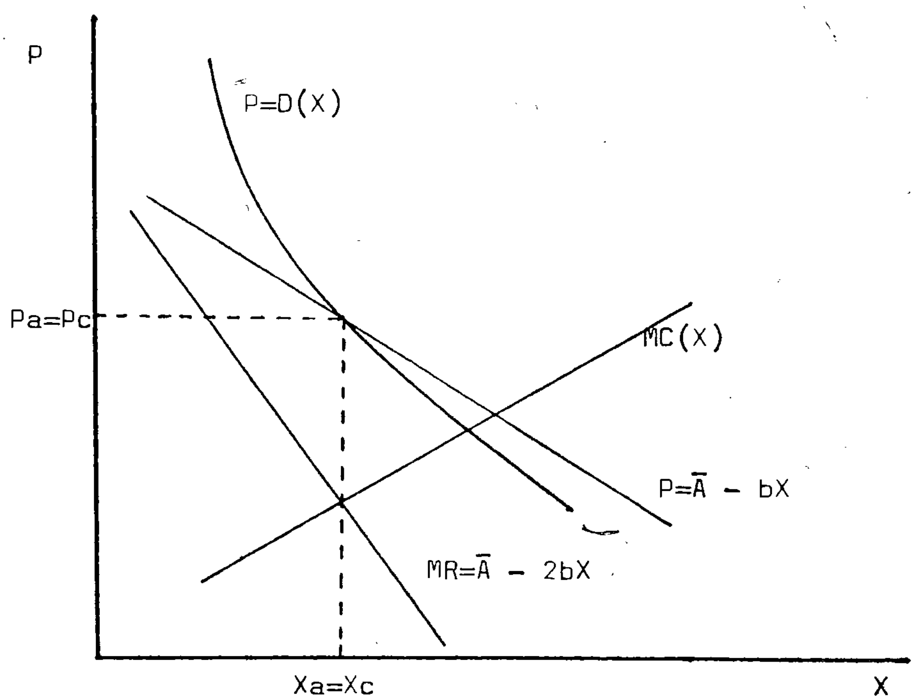


Figure 2: The Monopolist in Conjectural Equilibrium.



true demand curve), then he would attain this "true" equilibrium. It can easily be verified that the true optimum will only be attained if it happens to be that:

$$(23) \qquad -D'(X_t) = b$$

which is a strong requirement in view of our assumption vis-a-vis the formation and adjustment of the conjectures.

So far we have interpreted the analysis as if it were taking place in real time. An alternative interpretation could be to view the process of adjustment in the same way the Walrasian model does, namely <u>as if</u> it is an instantaneous adjustment, so that only equilibrium positions such as (20) are in fact observed. The adjustment could be regarded as being performed by a costless auctioneer who only completes trades if the plans of the monopolist and the rest of the market participants are fully consistent. This interpretation would lend additional support to the simple learning mechanism we proposed in the previous section, since the agents simply do not possess the information necessary to deduce more about the true nature of the economic process.[7] This is probably a reasonable approximation to the real world, where producers and consumers

---

[7] It remains true however, that an agent could engage in experimentation vis-a-vis his conjectured slope coefficient (Hahn, 1978, p. 12). We have thus implicitly excluded this "testing" of the perceived demand curve.

are constantly aware of the existence of excess demand or supply, but never of their exact magnitude. But it is time now to leave the world of the single monopolist, and to develop these ideas further in the context of two markets.

4:TOWARDS A MORE GENERAL MODEL WITH PRODUCTION AND CONSUMPTION

The second case we turn to now involves a hypothetical economy which is occupied by a large number of spatially separated monopolistically competitive producers and trade unions. Each producer buys the only input (labour) from many different unions, so that it is effectively a wage taker. Every union sells labour to many different producers, and does so on the basis of a perceived or conjectured demand for labour curve. The monopolistically competitive firms and unions are analyzed using the Cournot-Nash assumption, i.e. in the decision of one particular firm or union, the decisions of all other firms and unions are not taken into account (Hart, 1982, p. 111). Since all firms and unions are assumed to be identical in all respects, it is sufficient to analyze the behaviour of just one of each.[8] The behaviour of the producer of the good will be described first as it differs only slightly from that described

----

[8]This assumption implies that all firms and all unions have identical conjectures respectively. This is of course highly unrealistic since ideally one would like to analyze the resulting equilibrium when there are "bulls" and "bears" among the firms and the unions. This would complicate matters considerably, however, and the analysis in the remainder of this chapter should therefore be seen as only a first step in the development of a more satisfying model.

in the preceding section. The true and conjectured goods demand curves are still given by equations (13) and (14) respectively. The production function has the following simple form:

$$(24) \qquad X_t = L_t^{1/f} \quad , \; f \geq 1$$

The firm deals with many unions that are identical in all respects so that there exists one uniform wage rate at all times. Furthermore, the firm is a wage taker. Hence, the profit function of the firm can be obtained by combining equations (14) and (24):

$$(25) \qquad Z_t = (Ae_t - b*X_t)*X_t - W_t*X_t^f$$

The first order condition for a maximum is obtained by setting dZ/dX=0, or:

$$(26) \qquad Ae_t - 2b*X_t - f*W_t*X_t^{f-1} = 0$$

In the special case of constant returns to scale (f=1) the optimal choice of the firm, conditional upon its conjectures, simplifies to:

$$(27) \qquad Xsc_t = (Ae_t - W_t)/2b = Ldc_t$$

$$(28) \qquad Psc_t = (Ae_t + W_t)/2$$

Here, as in chapter 2, the subscript "d" and "s" denote demand and supply respectively. The firm is assumed to set the price at Psc, and to keep it <u>fixed</u> during the period. The firm's optimal plan is (Xsc, Ldc, Psc), of which Psc is submitted to the market. In general, this signal is inconsistent with the optimal behaviour of the consumer-workers that are all organized in the unions.[9]

We now turn to the behaviour of the individuals. They are identical and possess the following utility function:

----

[9]Oswald shows that the worker's expected gain from forming a union with his colleagues is a decreasing function of both the elasticity of labour demand and the worker's degree of aversion to risk (1982, p. 579). In this thesis we simply assume that so-called "closed shop" unions are beneficial to the consumer-workers, without pursuing the conditions under which this is valid any further. The interested reader is referred to Oswald (1982) and the list of references therein.

(29) $$U_t = x_t^{g} * (m/P)_t^{(1-g)} \quad , 0 < g < 1$$

Here x denotes the individual's consumption of the good, and m are final nominal money balances. An individual can either be unconstrained in the labour market (employed), in which case he supplies lo labour units inelastically, or constrained (unemployed), in which case he consumes by dissaving his fixed endowment of money (mo) only. The total number of individuals in each union (N) is fixed and the number of employed and unemployed individuals is denoted by N1 and N2 respectively. The employed individual maximizes utility subject to the following budget constraint:

(30) $$W_t * lo + mo = m_t + P_t * x_t$$

The wage rate is set by the union and taken as given by the individual labour suppliers. The optimal consumption and money balances for the employed individuals are given by:

(31) $$xd_t = g*((W_t *lo + mo)/P_t)$$

(32) $(md/P)_t = (1-g)*((W_t*lo + mo)/P_t)$

Similarly, the unemployed individual maximizes utility subject to the following budget constraint:

(33) $mo = m_t + P_t * x_t$

This yields the following expressions for the optimal plans of the unemployed individuals:

(34) $xd_t = g*(mo/P)_t$

(35) $(md/P)_t = (1-g)*(mo/P)_t$

Define the unemployment rate as follows:

(36) $U_t = (N2 / N)_t$

Now we can define aggregate consumption and money balances, denoted by X and M/P, as follows:

(37) $$Xd_t = N*g*[(mo/P_t)+(1-U_t)*(W_t*lo/P_t)]$$

(38) $$(Md/P_t) = N*(1-g)*[(mo/P_t)+(1-U_t)*(W_t * lo/P_t)]$$

Following Hart (1982, pp. 114, 118-122), we assume that unions maximize wage receipts of their members, thereby determining an optimal value of unemployment (Uo).[10] The union forms a conjecture as to the labour demand, which is again assumed to be linear:

(39) $$W_t = He_t - k*L_t$$

Total conjectured wage receipts are defined as follows:

---

[10]See Oswald (1982, pp. 580-583) for an concise discussion of the different union objective functions that have been proposed in the literature. Without wishing to choose sides in a topic "that has been hotly debated in the literature" (Oswald, 1982, p. 580), we simply note that maximization of the wage bill is one of the accepted objective functions.

(40) $W_t * L_t = (He_t - k * L_t) * L_t$

Maximizing this expression subject to $L < N * lo$ (no over-full employment) determines the optimal plans of the union. The interior solution to this programme is:

(41) $Lsc_t = He_t / 2k$

(42) $Wsc_t = He_t / 2$

(43) $Uo_t = 1 - \{Lsc_t / (N * lo)\}$

In full employment, when Uo=0 and Lsc=N*lo, we assume that the union accepts the wage associated with that level of employment. Hence:

(44) $$W^*_t = He_t - k*N*lo$$

The conjectured situation in the goods and labour market is illustrated in Figure 3 below. Here in panel (a) MC=W and MR(X|Ae) are the conjectured marginal cost curve and the conjectured marginal revenue curves respectively, conditional upon the state of the expectations (Ae). In panel (b) the curve labeled MWR(X|He) denotes the union's conjectured marginal wage receipts. The conjectured competitive solutions, which are of course generally different from the fully Walrasian competitive solutions, are denoted by (P^*, X^*) and (W^*, L^*) respectively. The situation depicted in Figure 3 is the ex-ante or conjectured situation.

In this model, two types of equilibria can be analyzed, namely short-run equilibria when firms and unions are still learning, and long-run equilibria when such learning has ceased. We describe both situations in some detail.[11]

---

[11]It must be stressed that our results depend on the assumption that the different equilibria exist, and that the Bayesian learning mechanism is such that convergence to these equilibria is guaranteed. These issues have not been addressed in this thesis, and remain important areas for further research. See also Day and Kennedy (1970), in which the existence issue is addressed in detail.

Figure 3: A Monopolistic Producer and a Labour Union in Conjectural Disequilibrium.

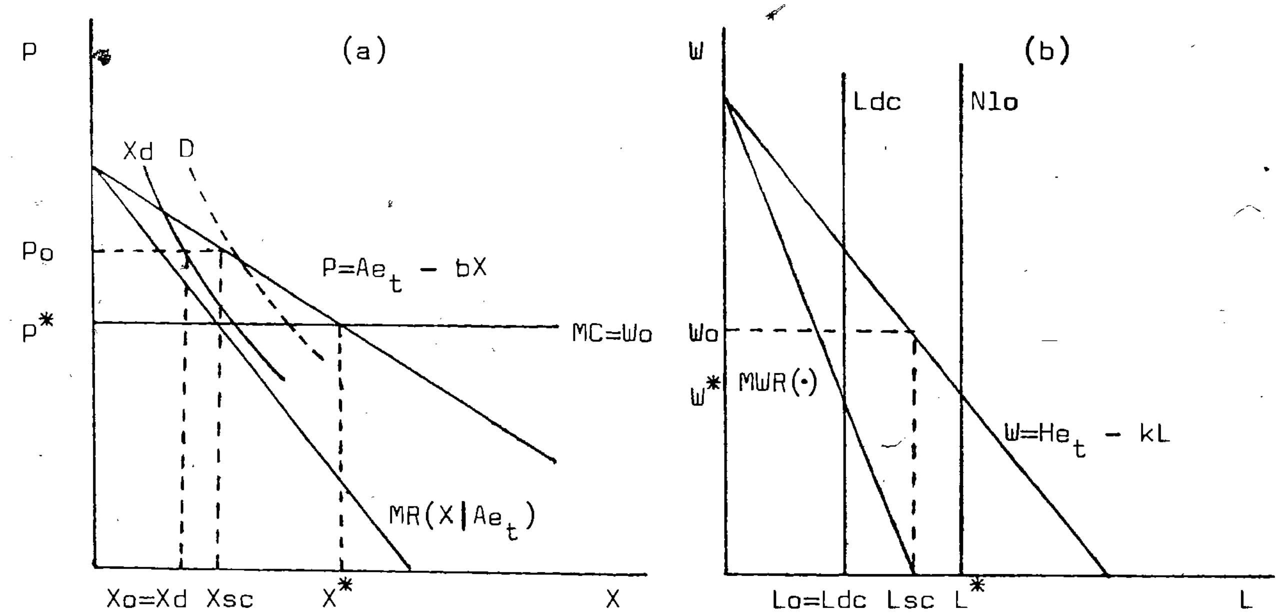
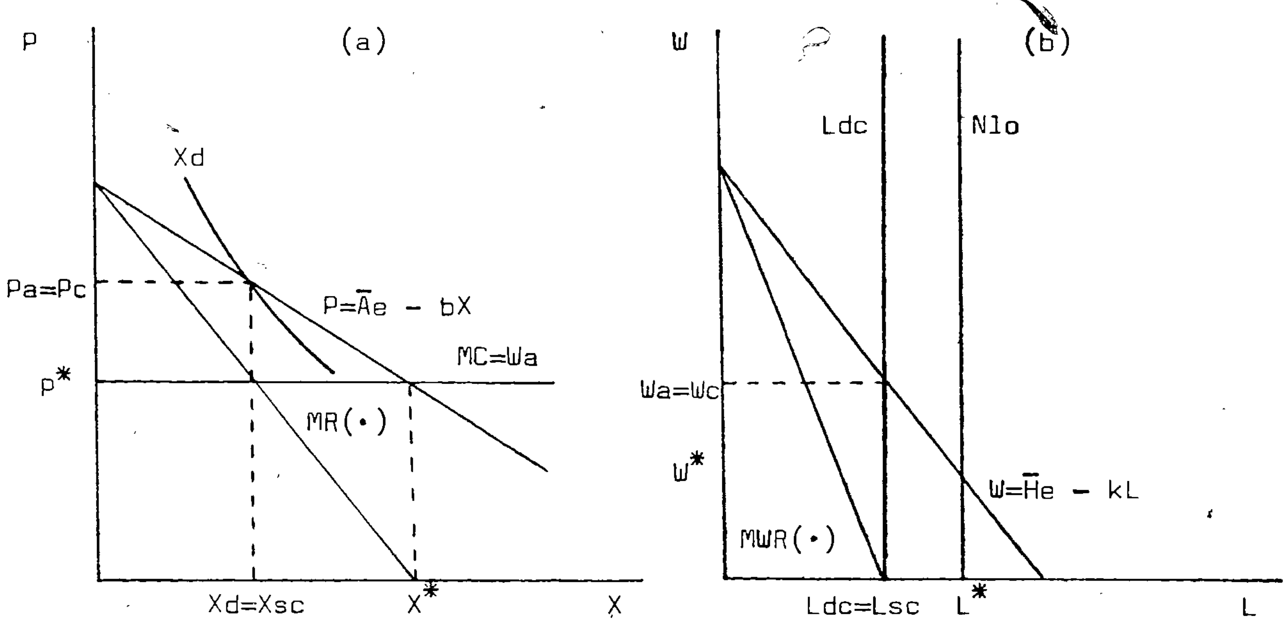


Figure 4: A Monopolistic Producer and a Labour Union in Conjectural Equilibrium.



Short-run quantity constrained equilibria.

We assume that firms and unions set the price and the wage rate respectively, and hold these fixed within the period. Hence, in general the plans of firms, unions, and consumer-workers are inconsistent at this price-wage vector. Following the insights of non-Walrasian fixed price models, we assume that nobody is forced to trade more than he wants to, so that the actual quantity traded is the minimum of demand and supply.[12] The fixed price and wage rate, denoted by Po and Wo respectively, are equal to:[13]

(28) $$Psc = \frac{Ae + Wo}{2} = Po$$

(42) $$Wsc = He/2 = Wo$$

Labour demand and supply at that wage-price vector are:

---

[12]See chapter 2 for a review of the fixed price literature.

[13]For convenience of notation the time subscript t has been dropped wherever confusion is impossible.

(27) $$Ldc = \frac{Ae - Wo}{2b}$$

(41) $$Lsc = He/2k$$

The actual quantity of labour traded (Lo) at the price-wage vector (Po,Wo) is the minimum of the quantities demanded and supplied:

(45) $$Lo = MIN\{Ldc,Lsc\}$$

The situation in the goods market is as follows:

(37) $$Xd = N*g*\{(mo/Po) + (1-U)*(Wo*lo/Po)\}$$

(27) $$Xsc = \frac{Ae - Wo}{2b}$$

(46) $$Xo = MIN\{Xd, Xsc\}$$

Furthermore, the rate of unemployment (U) is simply defined as follows:

(47) $$U = 1 - \frac{Lc}{N*lo}$$

The model can be simplified even further using the definitions in equations (28), (42), and (47), and noting that the total initial stock of money (Mo) is defined as Mo=N*mo.

(48) $$Ldc = (Po-Wo)/b$$

(49) $$Lsc = Wo/k$$

(50) $$Xd = g* \frac{Mo + Lo*Wo}{Po}$$

(51) $Xsc = (Po-Wo)/b$

The model of equations (45), (46), and (48)-(51) is a simplified version of the fixed price model described in detail in chapter 2. Since firms are always assumed to be on their production functions, the Underconsumption regime is impossible in this model. Consequently, three regimes are possible, namely the Keynesian Unemployment regime with excess supplies in both markets, the Classical Unemployment regime with excess demand for goods and excess supply of labour, and the Repressed Inflation regime with excess demands in both markets.[14] The Keynesian case of general excess supply has been drawn in Figure 3.[15]

On the basis of the information the unions and firms obtain in a situation like the one drawn in Figure 3, the conjectures are adjusted, using the updating formula developed in section 2 above. Note that, in contrast to the case of the single monopolist, the sample information is now quantity information (excess demand or supply), rather than price information. The intuitive idea behind the learning mechanism remains the same,

---

[14] See chapter 2 for a further discussion of the different regimes.

[15] The extension to the other regimes is straightforward. The dashed curve labelled D in Figure 3 represents the level of effective demand if the economy is in conjectural equilibrium, and consequently corresponds with the curve Xd in Figure 4.

however.

Long-run Equilibrium.

The economy is said to be in a long-run equilibrium if all market signals rationalize all conjectures. In such a situation, all learning on the part of unions and firms has stopped. Hence, the following conditions must be met in such an equilibrium: (i) All agents perceive themselves to be maximizing; (ii) All theories are locally right; (iii) Both the labour market and the goods market are cleared. Denote the values of Ae and He when learning has ceased by:

(52) $$Ae_t = Ae_{t+1} = \bar{A}e$$

(53) $$He_t = He_{t+1} = \bar{H}e$$

In Figure 4 such a long-run equilibrium has been drawn. This equilibrium is again, as in the case of the single monopolist, characterized by agents that are "right, but for the wrong reasons".

5: CONCLUDING REMARKS

In this chapter we have presented our attempt at the development of a non-Walrasian model which avoids the shortcomings of the early fixed price models, while retaining the basic insights obtained from these models. To this effect we have shown that an essential ingredient of such a non-Walrasian model must be the imperfect knowledge of the economic agents. An economic theory of learning is per definition hard to come by, but in this chapter we have opted for the Bayesian approach, which allows explicit subjective inferences based on continual updating of "theories" of the economic agents. In our basic model, the tasks of price and wage setting are performed by many identical monopolistically competitive producers and trade unions. A number of conclusions can be drawn from this model:

(i) In the short-run, i.e. within the period, prices and wages are fixed and the familiar fixed price model is very relevant in the sense that quantity adjustment performs the short run equilibration. This price-wage fixity is not due to <u>unexploited</u> gains from trade, but rather to <u>unexploitable</u> gains from trade, in the sense that the agents simply do not possess the necessary information and are consequently not aware of the existence of these profit opportunities. In fact, the thus unreaped gains from trade can be regarded as information costs associated with learning.

(ii) In the long-run, when learning on the part of all agents has ceased, an equilibrium materializes in which all markets clear. This equilibrium is not necessarily the "true" equilibrium, however, so that it may turn out that "agents are right, but for the wrong reasons". This result obtains because, as we have seen in the text, agents do not update the structure of their generally incorrect theories. In the long-run equilibrium, no signals exist which could inform the agents about the incorrectness of their theories, however.

Finally, we would like to point out the main deficiencies still present in the analysis of this chapter.

(i) Imperfect competition is still inherent in the model, whereas it would be more satisfying if the model would also allow for a pure Walrasian solution, with price and wage taking behaviour on the part of all agents, much along the lines suggested by Hahn (1978).

(ii) All firms and unions respectively are identical in all respects, whereas it would be interesting to investigate what effect pessimistic and optimistic agents have on the resulting equilibrium.

(iii) The Bayesian learning mechanism introduced is of an extremely simple form, and a more satisfying model would certainly have to include a more general application of Bayesian decision theory.

V. CONCLUDING REMARKS

In this thesis we analyze the usefulness of the recent "disequilibrium" or "non-Walrasian" literature in economics, both from an empirical and a purely theoretical point of view. Since our main interest lies in the field of macroeconomics, the emphasis of our investigations has been at a highly aggregated level. In fact, it seems that especially in the field of macroeconomics, non-Walrasian theory has the largest role to play in view of the pressing problem of persistent high unemployment in the Western economies. The theory we have encountered in this thesis does have a consistent neoclassical answer to those problems, one that is radically different from the one provided by proponents of the New Classical school. The argument in this thesis proceeds along the following lines.

In chapter 2 we examine the literature on non-Walrasian economics as it has been developed since the mid sixties. It is shown that this body of literature can be divided into two groups. In the first group, which is also the earliest, the price-wage vector is assumed to be fixed altogether, and quantity adjustment performs the short-run equilibration. The main theoretical objection that has been raised against the literature in this group is the fact that this price-wage inflexibility is not explained within the model, and implies unexploited gains from trade. To this effect, the literature in the second group, which is mostly of a more recent nature, establishes a link with the imperfect competition literature of the thirties. In these models, prices and wages are explicitly set by economic agents in conditions of disequilibrium, which alleviates the problems associated with the early non-Walrasian literature.

In chapter 3 we attempt to fill an astonishing lacuna in the literature in the first group, where disequilibria are caused by fixed prices and wages. It seems that very little has been done empirically with these models, and therefore we estimate a simple disequilibrium model with quantity spill-overs from the goods market to the labour market and vice versa. It is also argued that econometric "evidence" should be treated with care since it can never transcend the level of mere "circumstantial evidence" against or in favour of the usefulness of different hypotheses. In order to increase the informativeness of our empirical exercise, all results obtained from the disequilibrium hypothesis are compared with the ones derived on the basis of the "competing" equilibrium hypothesis. It is shown that the Canadian data, and to a certain extent U.S. data as well, suggest that the disequilibrium approach deserves as much attention from applied econometricians as the equilibrium approach.

In chapter 4 we present our attempt at the development of a more satisfactory non-Walrasian model. To this effect, we follow the most recent literature by introducing explicit price and wage setting into the model. Furthermore, it is assumed that agents by nature possess only imperfect knowledge of their economic surroundings. Although the model of this chapter cannot be seen as anything more than the prototype of a more general model to be developed later, a number of interesting conclusions can nevertheless be drawn from it. As it turns out, the fixed price model is embedded in our model in the short-run. The existence of unexploited gains from trade results from the agents' inability to perceive such profit opportunities, not from an arbitrarily fixed price-wage vector. In the model, the link between short-run and long-run behaviour is established by having agents learn about their environment in a Bayesian fashion. In the long-run, when learning on the part of all agents has ceased, an equilibrium situation results in which all markets clear. Even though the agents' models are incorrect, there exist no market signals to this effect, so that agents are effectively "right for the wrong reasons." We hope to have shown in this chapter that it is possible to construct a non-pathological model which *implies* quantity constraints in the short-run, and "bootstrap" or "self-fulfilling" equilibria in the long-run, without imposing ad hoc price-wage fixity or unexploited gains from trade.

In a number of appendices to the thesis, some of the more subsidiary details of the argument are presented. Appendices A, C, and E deal with the somewhat longer derivations of results mentioned in the text. Appendix B reports on a series of Monte Carlo experiments we performed for the iterative estimators developed tc handle the switching regressions case. Appendix D reproduces all data used, together with their exact sources, whereas appendix F surveys the different methods proposed in the econometric literature to test between the disequilibrium and equilibrium hypothesis.

Avenues for further Research.

As was pointed out in chapter 1, we view this thesis as a mere progress report. Consequently, the research commenced here will be continued. We have already indicated in the conclusions to the different chapters the directions we envisage future research could profitably take. Specifically, these are:

(i) The development and estimation of an intrinsically dynamic disequilibrium model. Since the empirical results of chapter 3 indicate that the static disequilibrium model does not fully capture the Canadian "data generating mechanism," the development of such a dynamic model would shed additional light on the usefulness of the disequilibrium hypothesis. Again the relevant comparison is between disequilibrium and equilibrium.

(ii) Additional circumstantial evidence for the disequilibrium hypothesis can be produced by using data on different highly industrialized countries, for example the O.E.C.D. member countries. In such a comparative study, important questions of international linkages and spill-overs could fruitfully be addressed.

(iii) In the theoretical model of chapter 4, imperfect competition is still intrinsically present, wheras it would be more satisfying if the traditional Walrasian equilibrium is at least a <u>possible</u> outcome as well. Furthermore, the introduction into the model of differences of opinion among the different agents deserves first priority, Finally, a more general Bayesian learning mechanism would strengthen the model's conclusion substantially.

THE END

APPENDIX A: DERIVATIONS OF SOME RESULTS FROM CHAPTER 2

In this appendix some derivations corresponding with the prototype disequilibrium model discussed in chapter 2 are reported in detail.

(1) Coincidence of Cd=Cs and Cde=Cs.

The line Cde=Cs=Co is obtained by using (2.13), (2.20) and (2.23):

$$\text{(1)} \qquad Co = \frac{a1*Mi}{(a1+a3)*p} + \frac{a1*Co}{a1+a3}$$

or:

$$\text{(2)} \qquad \frac{a1*Mi}{a3*p} = Co = c2*(w/p)^{b2/(b2-1)}$$

Similarly, the line Cd=Cs can be written as:

$$\text{(3)} \qquad Co = \frac{a1*Mi}{a3*p}$$

Hence the two lines coincide in region C. By similar reasoning one can show that the lines Lse=Ld and Ls=Ld coincide.

(2) The line Lde=Ls lies to the right of Ld=Ls.

Write Ld=Ls and Lde=Ls as follows, using (2.17):

(4) $$Ld = T - \frac{a2*Mi}{a3*p} \quad \text{and} \quad Lde = T - \frac{a2*Mi}{a3*w}$$

Multiply both expressions by (w/p) to obtain:

(5) $$Lde*(w/p) = T*(w/p) - (a2/a3)*(Mi/p)'$$

(6) $$Ld*(w/p) = T*(w/p) - (a2/a3)*(Mi/p)''$$

As Ld>Lde for any given (w/p) different from its Walrasian market clearing level we must have that:

(7) $$(Mi/p)' < (Mi/p)''$$

so that the Lde=Ls line lies to the right of the Ld=Ls .

(3) Coincidence of Lde=Ls and Cse=Cd.

In the Keynesian case WD represents the line Lde=Ls . Formally, using (2.17) and (2.25), this line can be written as follows:

(8) $$(Co/b1)^{1/b2} = T - \frac{a2*Mi}{a3*w}$$

In view of (2.23) and (2.26) we also know that:

(9) $$Co = \frac{a1*Mi}{a3*p}$$

In the case of Repressed inflation WD represents the line Cse=Cd which, in view of (2.27) and (2.18) can be written as follows:

(10) $$Lo = (a1*Mi/a3*b1*p)^{1/b2}$$

Using (2.28) and (2.29) this can be written as:

(11) $$(a1*Mi/a3*b1*p)^{1/b2} = T - \frac{a2*Mi}{a3*w}$$

But in view of (9) the LHS of (10) can be written as:

(12) $$(Co/b1)^{1/b2} = T - \frac{a2*Mi}{a3*w}$$

which is identical to (8). Hence, the two lines coincide.

APPENDIX B: A MONTE CARLO STUDY OF SOME INTERATIVE SWITCHING REGRESSIONS ESTIMATORS

1: INTRODUCTION.

It is a well recognized fact that estimation of models which obey different regimes at different instances in time will only be fairly straightforward if one knows the correct regime classification.[1] However, in our disequilibrium model we will have to estimate the correct regime classification, together with the other parameters of the model. There is a fair amount of literature available on the single market case,[2] and a start has been made on the multi market case.[3] Unfortunately, almost all the methods proposed to deal with endogenously switching regime regressions are ML methods. The advantages of ML methods are well known, and include such (asymptotic) properties as

----

[1]In such a case, it is sufficient to group the observations belonging to the same regime together and, in the absence of lagged dependent variables, OLS can be run. If lagged dependent variables are present, more efficient estimation may entail ML, as it may be the case that the data on the dependent variable contain discontinuities. A similar problem and its suggested solution is analyzed in appendix C, where a test for first order autocorrelation is proposed in the presence of missing observations. Still, the ML method discussed there is straightforward.

[2]Fair and Jaffee (1972), Amemiya (1974), Fair and Kelejian (1974), Maddala and Nelson (1974), Goldfeld and Quandt (1975), Laffont and Garcia (1977), and Bowden (1978a, 1978b) are the best known of these.

[3]Ito (1980), Gourieroux et al. (1980), Kooiman and Kloek (1980a, 1980b, 1981), Sneessens (1981).

asymptotic unbiasedness as well as consistency.[4] The main disadvantage, however, is also obvious. As is well known, the computational costs of nonlinear ML methods are quite considerable, even in the simplest cases. In the methods proposed to deal with switching regression estimation, matters tend to get exponentially more complicated. For instance, in a recent article, Ito derives the likelihood function for the <u>simplest</u> two market case, which turns out to be extremely complicated, involving double integrals (1980, pp. 109-112). This likelihood function cannot be maximized analytically so that numerical optimization techniques have to be employed. Furthermore, as was indicated by Ito, inter alia, the ML methods proposed to deal with switching regressions have <u>unbounded</u> likelihood functions. If one of the variances of the error terms goes to zero, then regardless of the observations and the truth of the model, the likelihood goes to infinity (1980, pp. 115-116).[5] It is far from clear what is gained with all these complications. For instance, the numerical optimization

----

[4] Hartley and Mallela show that the ML estimator proposed by Maddala and Nelson (1974) is strongly consistent and asymptotically normal (1977, pp. 1215-1217). For this result they assume the existence of an interior solution, which may not exist due to the unboundedness of the likelihood function referred to in the text.

[5] See also Kooiman and Kloek (1980a, pp. 25-26; 1981; pp. 12-14). In their practical applications of Ito's FIML estimator they impose constraints on "acceptable" values of the variances of the error terms, forcing the numerical routines away from the unbounded regions (1980a, p. 33; 1981, p. 14). An alternative way out of this unboundedness problem is discussed by Swamy and Mehta (1975) for the two regime case.

techniques discussed by Goldfeld and Quandt (1972, pp. 1-38) do not guarantee finding the global optimum of the likelihood surface. Furthermore, as was pointed out by Zellner, it is not clear when a sample size is "truly large enough" to accept desirable asymptotic properties as a justification of estimators (1979, p. 631). Therefore we propose an alternative estimator that is theoretically less attractive, but computationally cheap and hence very practical. Its small sample properties will be illustrated in a Monte Carlo sampling experiment.

2: AN ITERATIVE ESTIMATOR.

The estimator was proposed by Siebrand in the context of single market disequilibrium models (1979, pp. 52-55).[6] Suppose the demand for aggregate output can be written in the following linear fashion:

(1) $$Yd(t) = a1 + a2*X1(t) + U1(t)$$

Here X1(t) is some exogenous variable, Yd(t) is demand for aggregate output, and U1(t) is an error term, assumed to be independently and identically (iid) normal with mean zero and variance S1. Similarly, the supply of goods can be written as follows:

----

[6]In an earlier publication, Lenderink and Siebrand use a similar iterative method in a disequilibrium study of the Dutch labour market (1976, pp. 15-21).

(2) $$Ys(t) = b1 + b2*X2(t) + U2(t)$$

Here, again, X2(t) is some exogenous variable, Ys(t) denotes the supply of goods, and U2(t) is another iid normal error term with mean zero and variance S2. The actual quantity traded, Y(t), is assumed to be the <u>minimum</u> of the quantity supplied and the quantity demanded:[7]

(3) $$Y(t) = MIN \{ Yd(t), Ys(t) \}$$

Define a dummy variable that has the following characteristics:

(4)
$$D\{Z(t)\} = 0 \text{ iff. } Y(t) = Yd(t)$$
$$D\{Z(t)\} = 1 \text{ iff. } Y(t) = Ys(t)$$

Here Z(t) is some exogenous index variable that can be ignored for the time being. Now equations (1) to (3) can be rewritten as follows:

----

[7]The fact that equations (1) and (2) do not explicitly contain a price term follows from the assumption of completely inflexible prices. Hence, the price is exogenous and does not play any role in this market.

(5) $Y(t) = D(.)*\{b1 + b2*X2(t) + U2(t)\} + (1-D(.))*\{a1 + a2*X1(t) + U1(t)\}$

An expression like (5) is also used by Goldfeld and Quandt (1972, p. 263). It cannot yet be estimated in this form, as the values of the dummy variables are unknown and the number of observations does not allow us to estimate them.[8] Goldfeld and Quandt overcome this problem by assuming an unknown cut-off value (Zo) for Z(t), such that if Z(t)<Zo, the value of D(Z(t))=1, and vice versa if Z(t)>Zo then D(Z(t))=0. Furthermore, they approximate this discontinuous step function by the cumulative normal distribution with parameters Zo and V, denoted by F(Zo,V) (1972, pp. 263-264). Figure 1 illustrates this for two different values of V, such that V1>V2. Now, instead of T values of the dummy, only two parameters, Zo and V, need to be estimated in order to fully characterize the series of D(.) observations. Goldfeld and Quandt derive the likelihood function for this case and estimate the model in this manner (1972, p.264).

Siebrand, instead of structuring the dummy variables in a certain way, makes use of an iterative scheme together with "first guesses" for the values of the dummy variables (1979, p.

---

[8]In equation (5), T+6 parameters, namely a1, a2, b1, b2, S1, S2, and D(t) (t=1,T) have to be estimated with only T observations, which is clearly impossible.

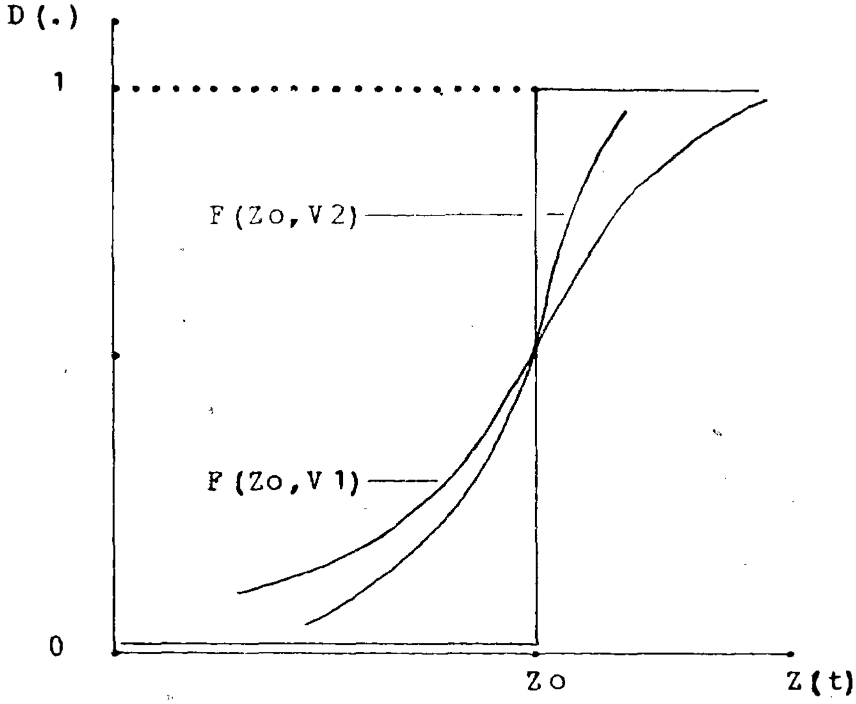


Figure 1: Step Function and its Cumulative Normal Approximations.

54). This first guess is either obtained by exploiting some sort of *extraneous* information or, alternatively, by using *intraneous* information. Both methods will be dealt with below.[9] In the

---

[9]As examples of possible information to be used as first guesses, Siebrand mentions unfilled orders, capacity utilization, unintended stocks, unfilled vacancies, overtime, involuntary unemployment, etc. (1979, p. 59). Whether this information is extraneous or intraneous is of course dependent on the market one is analyzing. Kooiman (1982) presents an interesting analysis in which business survey data such as the average degree of capacity utilization etc. are used in a systematic way. In a recent paper, Lee and Porter (1984) develop an estimation procedure in which extraneous *imperfect* sample separation information is explicitly introduced. They also point out that it is risky to assume the direction of price and wage changes to be *perfect* sample separation information, a point which we also make in appendix F (Lee and Porter, 1984, p. 392).

first case, when extraneous information is used, we could for instance assume that the dummy variables are functionally related (through Okun's Law) to the unemployment rate. In other words, we can now interpret Z(t) as the unemployment rate. By appropriate choice of r, equation (3) can be approximated by a CES function of the following kind:

$$(6) \qquad Y(t) = \{(a*Yd(t)^{-r} + (1-a)*Ys(t)^{-r}\}^{-1/r}$$

As this CES function is homogeneous of degree 1, we can apply Euler's theorem (Varian, 1978, p. 269) to obtain the following expression:

$$(7) \qquad Y=F1(Yd,Ys)*Yd+f2(Yd,Ys)*Ys$$
$$=D(.)*Yd+\{1-D(.)\}*Ys$$

where F1(.) and F2(.) are the partial derivatives that are homogeneous of degree 0 (Varian, 1978, p. 270), so that they can be rewritten as F1(Yd/Ys,1)=f1(Yd/Ys) and F2(Yd/Ys,1)=f2(Yd/Ys). For the CES function it is easily verified that:[10]

[10]It is straightforward to show that the partial derivatives are:

$$(a) \qquad f2(Yd/Ys)=(1-a)^{-1/r} *\{1+(a/(1-a))*(Yd/Ys)^{-r}\}^{-((1+r)/r)}$$

$$(8) \qquad \lim_{r\to\infty} f1(.)=1-f2(.) = \begin{cases} 0 \text{ iff. } Yd>Ys \\ 1 \text{ iff. } Yd<Ys \end{cases}$$

Hence, we can interpret f1(.) as the dummy variable in equations (5) and (7). This function has been drawn in Figure 2. In comparison to the Goldfeld and Quandt (1972) formulation, this will lead to us having two parameters less to estimate, namely Zo and V of their cumulative normal distribution.

Assuming some linear relationship between the goods market and the labour market we have that:

$$(9) \qquad Ys(t)/Yd(t) = b*(1-Z(t)), \qquad b<0$$

Where Z(t) could, for instance, be thought of as the deviation of actual unemployment from the frictional or natural rate of unemployment. For the purpose of this appendix it suffices to realize that extraneous information is being extracted from the labour market, in order to generate an initial guess for the values of the dummy variables.

----

[10] (cont'd) and:

$$(b) \qquad f1(Yd/Ys)=a^{-1/r} *\{1+((1-a)/a)*(Yd/Ys)^{-r}\}^{-((1+r)/r)}$$

from which the results in the text follow.

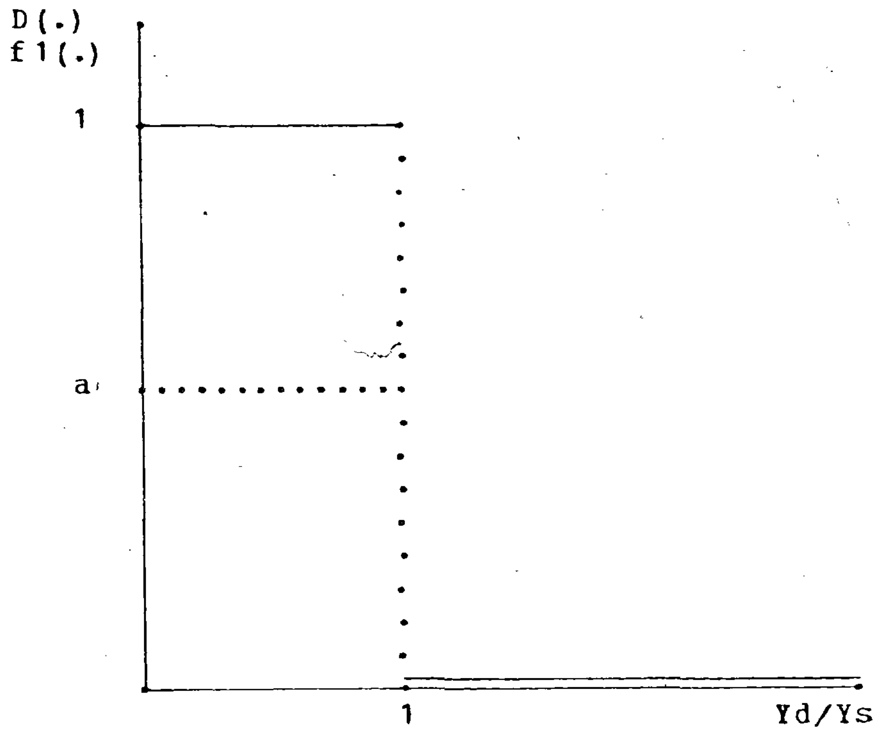


Figure 2: The Dummy Generating Function.

The Iterative Least Squares Estimator (ILSE) can now be described. In the first iteration, actual data on Z(t) are used to obtain the weights in equation (7). Then based on those weights, we have an explicit time series for the dummy variable (D(Z(t)), and we can estimate equation (5) by running OLS. This will give us first round estimates of the parameters. With these estimates and all the data, we can create fitted values for Yd(t) and Ys(t), denoted by Yd(t) and Ys(t). Then these fitted values can be plugged into equation (7) to obtain new values of the dummy variables, so that equation (5) can be re-estimated using this new sample separation. The procedure continues until convergence is attained. Siebrand (1979, p. 156) notes the similarity of this estimator to the so-called fix-point estimators of Wold (1966). As is obvious, the statistical properties of the ILSE cannot be derived analytically, which makes the method suspect in the eyes of some econometricians. Siebrand, however, shows that for one of his applications the results obtained with ILSE are not dramatically different from the corresponding ML estimates (1979, p. 66). Furthermore, its small sample properties are quite good, as is shown in a small scale Monte Carlo study (Siebrand, 1979, pp. 66, 71).

A slightly different application of the ILSE uses, instead of extraneous information in the form of labour market data, intraneous information. For example, we could use the fitted values of the following two regressions as the first round estimates of Yd(t) and Ys(t):[11]

(10) $$Y(t) = a1 + a2*X1(t) + U1(t)$$

(11) $$Y(t) = b1 + b2*X2(t) + U2(t)$$

---

[11] Note that this approach can only be used if the system of equations is "identified" in the sense that equation (10) contains exogenous variables that are not included in (11) and vice versa. The Monte Carlo study performed below considers such an identified system.

Note that these regressions are run using all T observations. Then, on the basis of the fitted values we can obtain a first round sample separation, and proceed as described above.

3: MONTE CARLO STUDY FOR ILSE IN THE SINGLE MARKET CASE.

As is clear from the discussion of the ILSE method above, we cannot readily obtain its statistical properties. Therefore, we will examine the small sample properties of ILSE by performing a number of sampling experiments.[12] The true model is assumed to be as follows.[13]

(12) $$Ys(t) = 1.0 + X(t) + 0.5*Z(t) + U1(t)$$

(13) $$Yd(t) = 8.5 - X(t) + 0.75*W(t) + U2(t)$$

(14) $$Y(t) = MIN\{Ys(t), Yd(t)\}$$

----

[12] An excellent introduction to the application of Monte Carlo experiments in econometrics is Smith (1973).

[13] We could interpret X(t) as the price level in this market. It is exogenous, however, and therefore does not introduce simultaneity problems.

Here $Y(t)$, $Yd(t)$, and $Ys(t)$ are endogenous and $X(t)$, $Z(t)$, and $W(t)$ are exogenous variables. The error terms, $U1(t)$ and $U2(t)$, are distributed identically, independently normal, such that:

$$(15) \qquad E\{Ui(t)\}=0, \quad E\{Ui(t)*Uj(t)\} = \begin{cases} 0 & \text{iff. } i \neq j \\ Si & \text{iff. } i=j \end{cases}$$

$$i,j \in \{1,2\}$$

The exogenous variables were generated using uniform distributions. As we expect Yd and Ys to be relatively close (on average) in the real world, we designed the experiments such that about half of the observations are on the demand equation, and the other half on the supply equation. Table 1 summarizes the nature of the different cases that we have examined. The experiments are limited to cases in which the stochastic variance does not play a dominant role in the switching. This can be seen by comparing the non-error variance, which is about 9.25, with the different assumed error variances in Table 1.[14] In situations where the error and non-error variances are close in magnitude, the traditional ML estimator may be better. In the

----

[14]The non-error variance of net excess supply can be calculated by using equations (12) and (13). Since the exogenous variables X, Z, and W are independent, the expression for the variance is:

$$V(Ys-Yd)=2*V(X)+0.25*V(Z)+0.563*V(W)$$

Using the information in Table 1, this variance can be calculated to be roughly equal to 9.25.

real world, however, one would expect the error variance to play a subsidiary role in the switching, so that the iterative estimator does have some applicability. We can now describe the experiments in more detail:[15] (i) the true model is assumed to be made up of equations (12), (13), and (14); (ii) vectors of random numbers U1(t) and U2(t) are generated from a distribution characterized by equation (15); (iii) the model is solved with the given true parameters and the exogenous variables, and the generated error terms are added, obtaining T observations on Y(t) by invoking the minimum transaction rule (14); (iv) ILSE is run, without using any extraneous information;[16] (v) this procedure is repeated 100 times and the resulting estimates are evaluated in the light of the true model (and possibly the results one would have obtained had one used OLS), using test statistics like bias, variance, mean square error, etc.; (vi) this is done for the 5 cases reported in Table 1.

The results of the different experiments are reported in Tables 2, 3, and 4, which report the mean square errors (MSE), average bias, and the mean sum of absolute deviations (MSAD) of the estimated parameters. The results are rather impressive in that the bias in the coefficients is practically zero everywhere. Of course, since we do not compare ILSE with any other procedure, we cannot judge how good this estimator is

---

[15]This follows the exposition of Smith (1973, p. 16).

[16]For the first round, starting values are generated by running equations (12) and (13), using all T observations, and replacing Yd and Ys by the observable Y.

Table 1: Characteristics of the Experiments.

Case	T	Range of X(t)	Range of Z(t)	Range of W(t)	S1	S2
(1)	60	5-10	5-10	10-20	1.0	1.0
(2)	30	5-10	5-10	10-20	1.0	1.0
(3)	120	5-10	5-10	10-20	1.0	1.0
(4)	60	5-10	5-10	10-20	1.0	2.0
(5)	60	5-10	5-10	10-20	2.0	2.0

relative to these alternative methods. It seems that only in the case of the intercepts, is ILSE severely biased. The "interesting" parameters, i.e. the slope coefficients, are estimated in a much less biased manner. For the estimated variances the bias is consistently negative but of moderate size. Increasing the sample size has its expected effects in that the MSE drop uniformly. The rest of the tables are self-explanatory. For reference purposes, the relative performance of ILSE and OLS on MSE criteria are reported in Table 5.[17]

[17]The OLS results are obtained by running equations (12) and (13), using all data. Since the coefficients in these equations are identified this is a legitimate procedure.

Table 2: MSE of ILSE Estimates: The Single Market Case.

True Values of the Parameters:

	1.000	1.000	0.500	8.500	-1.000	0.750	S1*	S2*
1)	4.187	0.048	0.023	4.149	0.047	0.010	0.063	0.101
2)	9.463	0.149	0.069	12.704	0.115	0.038	0.365	0.221
3)	[illegible].340	0.025	0.010	1.359	0.022	0.005	0.039	0.035
4)	5.288	0.070	0.026	8.517	0.098	0.020	0.080	0.460
5)	13.643	0.204	0.057	11.328	0.142	0.022	0.287	0.432

*) See Table 1 for the different values these variances assume in the different experiments.

Table 3: Bias of ILSE Estimates: The Single Market Case.

True Values of the Parameters:

	1.000	1.000	0.500	8.500	-1.000	0.750	S1*	S2*
1)	0.530	-0.085	-0.002	-0.897	0.106	-0.005	-0.076	-0.086
2)	-0.181	-0.013	0.036	-1.531	0.140	0.011	-0.084	-0.063
3)	0.410	-0.075	0.001	-0.571	0.096	-0.025	-0.105	-0.083
4)	0.882	-0.137	-0.008	-1.298	0.135	0.005	-0.014	-0.271
5)	0.960	-0.139	-0.009	-1.892	0.225	-0.013	-0.268	-0.190

*) See Table 1 for the different values these variances assume in the different experiments.

Table 4: MSAD of ILSE Estimates: The Single Market Case.

True Values of the Parameters:

							S1*	S2*
	1.000	1.000	0.500	8.500	-1.000	0.750	S1*	S2*
1)	1.616	0.179	0.119	1.589	0.175	0.074	0.211	0.246
2)	2.335	0.260	0.206	2.813	0.268	0.152	0.383	0.348
3)	0.942	0.128	0.077	0.934	0.122	0.056	0.168	0.153
4)	1.853	0.2[illegible]	0.127	2.319	0.248	0.110	0.226	0.552
5)	2.695	0.313	0.184	2.685	0.305	0.117	0.443	0.512

*) See Table 1 for the different values these variances assume in the different experiments.

Table 5: The Relative MSE Performance of OLS and ILSE.

True Values of the Parameters:

	1.000	1.000	0.500	8.500	-1.000	0.750	S1*	S2*
1)	0.054	0.039	0.256	0.485	0.058	0.074	0.001	0.015
2)	0.084	0.083	0.515	4.674	0.193	0.184	0.004	0.021
3)	0.018	0.021	0.101	0.138	0.028	0.043	0.001	0.005
4)	0.069	0.057	0.277	0.936	0.120	0.145	0.001	0.089
5)	0.179	0.167	0.582	1.170	0.174	0.159	0.005	0.053

*) A value of less than unity indicates that ILSE outperforms OLS. See Table 1 for the different values the variances of the error terms assume in the different experiments.

4: ESTIMATION OF MULTIMARKET SWITCHING REGRESSION MODELS.

In the case of more than one market we not only have switching regressions, as in the case discussed above, but also simultaneity in our estimation problem. Consider the following model of the interaction between the labour market and the market for goods, which was developed by Ito (1980, p.102).

(16) $$Yde(t)=a1*X1(t)+a2*\{L(t)-Ls(t)\}+U1(t)$$

(17) $$Yse(t)=b1*X2(t)+b2*\{L(t)-Ld(t)\}+U2(t)$$

(18) $$Y(t)=MIN\{Yde(t),Yse(t)\}$$

(19) $$Lde(t)=c1*Z1(t)+c2*\{Y(t)-Ys(t)\}+U3(t)$$

(20) $$Lse(t)=d1*Z2(t)+d2*\{Y(t)-Yd(t)\}+U4(t)$$

(21) $L(t)=MIN\{Lde(t),Lse(t)\}$

Here, as in chapter 3, the subcript "e" denotes effective quantities. The excgenous variables are X1, X2, Z1, and Z2. The error terms are U1, U2, U3, and U4, as well as U5, U6, U7, and U8 below. The noticnal schedules are defined as follows:

(22) $Yd(t)=a1*X1(t)+U5(t)$

(23) $Ys(t)=b1*X2(t)+U6(t)$

(24) $Ld(t)=c1*Z1(t)+U7(t)$

(25) $Ls(t)=d1*Z2(t)+U8(t)$

The error terms are assumed to be distributed as follows:

$$(26) \qquad E\{Ui(t)\}=0, \quad E\{Ui(t),Ui(t')\} = \begin{cases} 0 & \text{iff } t \neq t' \\ Si & \text{iff } t = t' \end{cases}$$

$$E\{Ui(t)*Uj(t)\} = \begin{cases} 0 & \text{iff } i \neq j \\ Si & \text{iff } i = j \end{cases}, \quad i,j \in \{1,8\}$$

It is clear that in the absence of deterministic knowledge regarding the correct sample separation, the above system cannot be estimated without considerable difficulty.[18] The additional complication as compared to the single market case is the simultaneity caused by the spill-over effects in equations (16), (17), (19), and (20). Using the FIML approach, Ito is able to derive the likelihood function, which turns out to be of a particularly awkward form, including double integrations, making its practical application computationally bothersome (1980, p.112).

An alternative way of estimating the above simultaneous system can be described as follows. Using an approach very similar to the ILSE of Siebrand (1979), we propose a Two Stage version of the iterative estimator, which will be called Two Stage Iterative Least Squares Estimator (TSILSE). Combining equations (16), (17), (24), and (25), taking account of (18), gives us the following set of equations:

----

[18]Note that in this two market system there will be 4 instead of 2 different regimes.

(18) $$Y(t)=MIN\{Yde(t), Yse(t)\}$$

(27) $$Yde(t)=a1*X1(t)-a2*d1*Z2(t)+a2*L(t)-a2*U8(t)+U1(t)$$

(28) $$Yse(t)=b1*X2(t)-b2*c1*Z1(t)+b2*L(t)-b2*U7(t)+U2(t)$$

This system is similar to the one encountered in the single market case, but for the fact that one of the regressors, L(t), cannot be regarded as exogenous. Similarly, combining equations (19), (20), (22), and (23), taking account of (21), yields a system which includes the endogenous level of actual trades on the goods market, Y(t).

(21) $$L(t)=MIN\{Lde(t), Lse(t)\}$$

$$(29) \qquad Lde(t)=c1*Z1(t)-c2*b1*X2(t)+c2*Y(t)-c2*U6(t)+U3(t)$$

$$(30) \qquad Lse(t)=d1*Z2(t)-d2*a1*X1(t)+d2*Y(t)-d2*U5(t)+U4(t)$$

Now we can use either one of two approaches: (i) treat the two systems as if they were independent, and use actual values of L(t) and Y(t) when running the above ILSE procedure; (ii) take account of the simultaneity of L(t) and Y(t) by using the following Instrumental Variables method. Run L(t) and Y(t) on all the appropriate exogenous instruments:

$$(31) \qquad L(t)=D1*\{g1*X2(t)+g2*Z1(t)\}+(1-D1)*\{g3*X1(t)+g4*Z2(t)\}$$

$$(32) \qquad Y(t)=D2*\{h1*X1(t)+h2*Z2(t)\}+(1-D2)*\{h3*X2(t)+h4*Z1(t)\}$$

Where the dummies are defined as follows:

$$D1 = \begin{cases} 0 & \text{iff. } Lde > Lse \\ 1 & \text{iff. } Lde < Lse \end{cases}$$

$$D2 = \begin{cases} 0 & \text{iff. } Yde > Yse \\ 1 & \text{iff. } Yde < Yse \end{cases}$$

In the first round, equations (31) and (32) can be run using <u>all</u> the exogenous instruments, i.e by setting D1=D2=0.5 for all observations. In the next iterations information obtained in the previous round is used to create new instrumental variables through equations (31) and (32). In each iteration, we can use the fitted values of these two regressions and run ILSE for the two systems separately.[19] The two procedures, ILSE and TSILSE, have advantages over the FIML method developed by Ito (1980) in that they are computationally very simple and cheap. A less appealing feature of this method is that it uses up a large number of degrees of freedom, and multicollinearity problems may be unavoidable. This is because, for example the quasi reduced form for the effective demand for goods (eq. (29)) contains <u>all</u> the exogenous variables of both the notional demand for goods

---

[19]As is evident from equations (18), (21), (27), (28), (29), and (30), all the parameters of the system are overidentified. Our TSILSE (like any other two stage estimator) does not impose the cross equation restrictions, whereas the FIML method by Ito (1980) does. It must be noted that this should not cause too much unrest as it has been shown in the literature that the full system methods (like FIML) are highly sensitive to specification and measurement errors, which tends to make their practical application limited (e.g. Intriligator, 1978, pp. 419-420).

and the notional labour supply. Therefore, long data series and parsimony in in parameters are a necessity when using the method.[20] The major drawback, however, lies in the fact that their sampling properties cannot be established analytically. Therefore, we have designed another sampling experiment, this time for the two market case.

5: MONTE CARLO STUDY FOR ILSE AND TSILSE IN THE TWO MARKET CASE.

In the sampling experiments performed in this section, the parameters of the system composed of equations (16) to (26) are reported in Table 6. This implies the following "quasi" reduced form of the system:[21]

(33) $$Yde(t)=0.5*X1(t)-0.3*Z2(t)+0.3*L(t)+W1(t)$$

---

[20]As is shown below, the same can be said for the TSLS method developed by Ito (1980) for the two market case.

[21]The Wi(t) are the transformed error terms from equations (27) to (30). The variances of these transformed error terms are denoted by SWi, and can be calculated as follows:

(a) $$\begin{cases} SW1=(a2)^2 * S8 + S1; & SW2=(b2)^2 * S7 + S2 \\ SW3=(c2)^2 * S6 + S3; & SW4=(d2)^2 * S5 + S4 \end{cases}$$

Hence, the distribution of the transformed error terms, in view of eq. (26), is Wi~N(0,SWi), i=1,4, where N(.) is the normal distribution.

Table 6: The Parameters of the True Model.

Structural Parameters:	Variances of Error Terms:	Ranges of Exogenous Variables:
a1=0.5	S1=S8=1	X1 = [10 - 20]
a2=0.3		X2 = [10 - 20]
b1=0.5	S2=S7=	Z1 = [10 - 20]
b2=0.3	1 or 2	Z2 = [10 - 20]
c1=1.0	S3=S6=	X1 ~U{15, 8.34}
c2=0.25	1 or 2	X2 ~U{15, 8.34}
d1=1.0	S4=S5=	Z1 ~U{15, 8.34}
d2=0.25	1 or 2	Z2 ~U{15, 8.34}

(34) Yse(t)=0.5*X2(t)-0.3*Z1(t)+0.3*L(t)+W2(t)

(18) Y(t)=MIN{Yde(t),Yse(t)}

(35) Lde(t)=1.0*Z1(t)-0.125*X2(t)+0.25*Y(t)+W3(t)

(36) Lse(t)=1.0*Z2(t)-0.125*X1(t)+0.25*Y(t)+W4(t)

(21) $L(t)=MIN\{Lde(t), Lse(t)\}$

Again, as in section 3, the exogenous variables were generated by using uniform distributions with parameters Mi and Vi, denoted by U(Mi,Vi). Table 6 reports the respective ranges of the different exogenous variables, as well as their means and variances. In Table 7 the main characteristics of the different cases are described. Due to the spill-over effects in the system, an iterative method had to be employed in order to generate the data, Y(t) and L(t), for each drawing of the error terms. The magnitude of the spill-over effects was chosen such that convergence was very quick.[22] Furthermore, the values of the coefficients were chosen such that - on average - equilibrium prevails, in the sense that each regime is allocated a roughly equal number of observations. Again, as was indicated in section 3 above, the non-error variances dominate the error variances, so that the latter do not play a prominent role in the switching.

The comparison in the sampling experiment is between ILSE, which ignores the simultaneity, and TSILSE, which takes account of it in the manner described above. Table 8 reports the relative performance of the two methods on the basis of the MSE

[22] Ito (1980, p. 103) states sufficient conditions for convergence. If we denote spill-over coefficients by a(i), then convergence is guaranteed if $a(i)>0$ and $a(i)*a(j)<1$, for all i,j such that i and j refer to different markets.

Table 7: The Characteristics of the Different Experiments.

Case	T	SW1	SW2	SW3	SW4
(1)	60	1.09	1.09	1.063	1.063
(2)	30	1.09	1.09	1.063	1.063
(3)	120	1.09	1.09	1.063	1.063
(4)	60	1.09	2.18	1.063	2.126
(5)	60	1.09	1.09	2.126	2.126

criterion. In this table, a value of larger than unity indicates that ILSE outperforms TSILSE, which is the case for most parameters in the sampling experiments we conducted. Tables 9, and 10 report the bias and MSE associated with the naive ILSE method. The bias seems to be fairly moderate in almost all cases. Comparison with Table 11, which reports the bias associated with the TSILSE method, reveals that the spill-over coefficients are estimated with considerably less bias if TSILSE is used. Hence, even though ILSE tends to dominate TSILSE on MSE criteria, the latter method should be preferred over the former if less biased estimates of the spill-over coefficients are desired. Again, as expected, the MSE drop uniformly as the sample size grows. Another salient feature of ILSE is that the variances are in all cases under-estimated, which leads to underestimation of the standard errors of the parameters. The TSILSE method does not seem to suffer from this defect. The rest of the tables are self-explanatory.

Table 8: The Relative MSE Performance of ILSE and TSILSE: The Two Market Case.

True Values of the Parameters:

	0.500	-0.300	0.300	0.500	-0.300	0.300	SW1*	SW2*
1)	0.9	2.0	1.3	1.3	2.1	1.9	0.7	0.9
2)	1.3	1.8	1.3	1.9	2.1	1.6	1.1	0.6
3)	1.3	1.5	1.0	1.3	1.7	1.3	0.6	1.3
4)	0.9	1.8	1.1	1.5	2.1	2.1	2.0	0.7
5)	1.0	2.5	1.6	1.3	2.4	2.9	0.9	1.1

True Values of the Parameters:

	1.000	-0.125	0.250	1.000	-0.125	0.250	SW3*	SW4*
1)	1.3	1.8	1.1	0.8	1.3	1.0	1.2	1.3
2)	1.7	2.2	2.5	1.8	1.3	1.6	1.0	1.2
3)	1.0	1.3	0.7	0.7	3.0	0.7	1.1	1.4
4)	1.3	1.7	1.1	0.9	1.4	1.1	1.8	0.9
5)	1.3	1.7	0.9	0.7	1.3	0.9	0.9	0.9

*) See Table 7 for the different values these variances assume in the different cases. A value larger than unity indicates that ILSE outperforms TSILSE.

Table 9: Bias of ILSE Estimates: The Two Market Case.

True Values of the Parameters:

	0.500	-0.300	0.300	0.500	-0.300	0.300	SW1*	SW3*
1)	-0.039	-0.002	0.033	-0.013	-0.014	0.022	-0.251	-0.233
2)	-0.016	0.012	-0.004	-0.015	-0.036	0.058	-0.264	-0.322
3)	0.029	-0.018	0.041	-0.022	-0.004	0.017	-0.217	-0.197
4)	-0.047	0.001	0.031	-0.021	-0.029	0.049	-0.075	-0.645
5)	-0.037	0.002	0.025	-0.014	-0.012	0.022	-0.262	-0.222

True Values of the Parameters:

	1.000	-0.125	0.250	1.000	-0.125	0.250	SW3*	SW4*
1)	-0.019	-0.043	0.147	-0.024	-0.016	0.085	-0.180	-0.151
2)	-0.002	-0.030	0.088	-0.032	-0.006	0.081	-0.243	-0.173
3)	-0.023	-0.038	0.140	-0.036	-0.010	0.096	-0.165	-0.115
4)	-0.016	-0.047	0.145	-0.036	-0.028	0.142	-0.126	-0.394
5)	-0.035	-0.082	0.272	-0.044	-0.033	0.167	-0.492	-0.404

*) See Table 7 for the different values these variances assume in the different cases.

Table 10: MSE of ILSE Estimates: The Two Market Case.

True Values of the Parameters:

	0.500	-0.300	0.300	0.500	-0.300	0.300	SW1*	SW2*
1)	0.007	0.004	0.007	0.006	0.007	0.009	0.110	0.140
2)	0.013	0.009	0.015	0.017	0.012	0.030	0.269	0.305
3)	0.003	0.004	0.005	0.004	0.003	0.003	0.073	0.078
4)	0.008	0.005	0.009	0.011	0.013	0.015	0.088	0.719
5)	0.006	0.004	0.007	0.006	0.007	0.008	0.110	0.133

True Values of the Parameters:

	1.000	-0.125	0.250	1.000	-0.125	0.250	SW3*	SW4*
1)	0.007	0.008	0.040	0.004	0.003	0.022	0.098	0.066
2)	0.014	0.017	0.046	0.010	0.004	0.028	0.240	0.133
3)	0.003	0.003	0.029	0.003	0.001	0.013	0.059	0.044
4)	0.007	0.009	0.040	0.007	0.005	0.041	0.089	0.310
5)	0.013	0.018	0.105	0.009	0.006	0.054	0.448	0.324

*) See Table 7 for the different values these variances assume in the different cases.

Table 11: Bias of TSILSE Estimates: The Two Market Case.

True Values of the Parameters:

	0.500	-0.300	0.300	0.500	-0.300	0.300	SW1*	SW2*
1)	-0.005	0.006	-0.012	0.015	0.007	-0.034	-0.052	-0.004
2)	0.019	-0.003	-0.018	0.049	-0.026	-0.022	-0.129	-0.112
3)	-0.001	-0.004	-0.004	0.013	-0.007	-0.017	0.023	0.039
4)	-0.019	0.023	-0.027	0.023	0.017	-0.055	0.227	-0.289
5)	-0.009	0.011	-0.015	0.019	0.009	-0.040	0.038	0.080

True Values of the Parameters:

	1.000	-0.125	0.250	1.000	-0.125	0.250	SW3*	SW4*
1)	0.031	-0.036	0.015	0.011	-0.016	0.005	0.079	0.073
2)	0.044	-0.069	0.091	-0.014	-0.011	-0.008	-0.096	0.043
3)	0.019	-0.017	-0.011	0.016	-0.015	-0.009	0.098	0.131
4)	0.027	-0.040	0.029	0.005	-0.016	0.012	0.144	0.044
5)	0.030	-0.056	0.059	0.001	-0.017	0.019	0.004	0.020

*) See Table 7 for the different values these variances assume in the different cases.

6:A TSLS METHOD FOR THE TWO MARKET CASE WITH QUANTITATIVE EXTRANECUS INFORMATION

In some circumstances it may be advantageous to use quantitative extraneous information to determine the correct sample separation. One form of such information has been used extensively in the econometric literature on disequilibrium models and consists of assuming nominal prices and wages - or rather their rates of change - to yield information about the regime in which the economy finds itself.[23] For example, Ito (1980, p. 107) assumes the following adjustment mechanisms:

$$(37) \qquad \Delta P = \begin{cases} e1*(Yde-Yse) & \text{if } Yde \geq Yse \\ e2*(Yde-Yse) & \text{if } Yde \leq Yse \end{cases} \quad ; \; e1,e2 \geq 0$$

$$(38) \qquad \Delta W = \begin{cases} e3*(Lde-Lse) & \text{if } Lde \geq Lse \\ e4*(Lde-Lse) & \text{if } Lde \leq Lse \end{cases} \quad ; \; e3,e4 \geq 0$$

Where P and W are the nominal price level and wage rate

---

[23]As we have shown above in chapter 2, disequilibrium theorists are not entirely charmed with this re-instatement of the auctioneer. It was shown there that disequilibrium trading must imply some sort of imperfectly competitive behaviour in which the auctioneer has no place.

respectively. These equations, together with the system (16)-(25) can be estimated by using a TSLS method developed by Ito (1980, p. 116). Using (18), (21), (37), and (38) we can write the following (Ito, 1980, p. 113):

(39) $$Yde=Y+(1/e1)*d_P^+ \quad \text{or,} \quad Y=Yde-(1/e1)*d_P^+$$

(40) $$Yse=Y-(1/e2)*d_P^- \quad \text{or,} \quad Y=Yse+(1/e2)*d_P^-$$

(41) $$Lde=L+(1/e3)*d_W^+ \quad \text{or,} \quad L=Lde-(1/e3)*d_W^+$$

(42) $$Lse=L-(1/e4)*d_W^- \quad \text{or,} \quad L=Lse+(1/e4)*d_W^-$$

Where the following definitions hold:

(43) $$d_P^+ = \begin{cases} \Delta P & \text{if } \Delta P>0 \\ 0 & \text{if } \Delta P<0 \end{cases}$$

(44) $$d_P^- = \begin{cases} 0 & \text{if } \Delta P>0 \\ \Delta P & \text{if } \Delta P<0 \end{cases}$$

(45) $$d_W^+ = \begin{cases} \Delta W & \text{if } \Delta W>0 \\ 0 & \text{if } \Delta W<0 \end{cases}$$

(46) $$d_W^- = \begin{cases} 0 & \text{if } \Delta W>0 \\ \Delta W & \text{if } \Delta W<0 \end{cases}$$

Using equations (39)-(46) we can derive the following four equations in which only observable variables occur and which can therefore be estimated:

(47) $$Y = a1*X1-a2*d1*Z2+a2*L-(1/e1)*d_P^+ + W1$$

(48) $$Y = b1*X2 - b2*c1*Z1 + b2*L + (1/e2)*\bar{d}_P + W2$$

(49) $$L = c1*Z1 - c2*b1*X2 + c2*Y - (1/e3)*\overset{+}{d}_W + W3$$

(50) $$L = d1*Z2 - d2*a1*X1 + d2*Y + (1/e4)*\bar{d}_W + W4$$

In order to take account of simultaneity, fitted values must be obtained by running the endogenous variables (Y, L, and the d's) on <u>all</u> the exogenous variables (X1, X2, Z1, and Z2). These fitted values can then be used as instruments in eqs. (47)-(50). Ito points out that this method is consistent but not asymptotically efficient (1980, p. 116). Another drawback of this method, one we have already hinted at in the discussion of our iterative estimators above, is that it does use up a large number of degrees of freedom. This is a remediable problem that can be solved by working with long data series and parsimony in the parameters. It can be verified that the structural parameters can be identified even in the case where, for example, notional goods demand and labour supply have "common" regressors.[24] In that case the parameters for those common regressors in the equation for the effective demand for goods can be identified by incorporating the parameter estimates in the equation for the effective labour supply and vice versa, i.e. eqs. (47) and (50) identify each others coefficients. The same alsc holds for eqs. (48), and (49).[25]

7: CONCLUSIONS.

In this appendix, we discussed a number of estimators proposed by Siebrand (1979) in the context of switching regression models. These estimators are all iterative as opposed to the usual ML estimators developed by Maddala and Nelson (1974) and Ito (1980). The advantage of our estimators is their computational simplicity. The main disadvantage lies in the fact that the statistical properties of iterative estimators of this kind cannot be established theoretically. Therefore, we performed a number of sampling experiments in order to establish whether severe problems are likely to occur with these

---

[24]Within the context of the static neoclassical framework underlying much if not all of the non-Walrasian literature, consumers and labour suppliers are essentially the <u>same</u> people, so that exactly the same exogenous variables should enter as regressors in both the notional labour supply and the notional goods demand. Prices and wages are assumed to be fixed at the outset of the period. Hence, they are predetermined and for estimation purposes can be treated in the same way as exogenous variables.

[25]It turns out that identification is guaranteed if the spill-over coefficients satisfy the conditions alluded to above in footnote 22 of this appendix.

estimators. The conclusion from these sampling experiments is that the iterative estimators perform well if the non-error variance dominates the error variance. This does not seem to be an unreasonably restrictive assumption to impose on the real world data.

APPENDIX C: ESTIMATION OF THE DURBIN-WATSON STATISTIC WHEN THE VECTOR OF ESTIMATED RESIDUALS CONTAINS MISSING OBSERVATIONS

In this appendix we present a relatively simple way of testing for first order autocorrelation in the switching regression case. Assume the simplest case, where a single market switching regression model is used to estimate the demand and supply equation (e.g. Rosen and Quandt, 1978). Due to the fact that some observations are used to estimate the demand equation and others are used to estimate the supply equation, the vectors of estimated residuals will contain "gaps". Hence, the ordinary Durbin-Watson statistic (d) cannot be directly calculated. If the sample has size T, then D observations estimate the demand equation, and (T-D) estimate the supply equation. Hence, in order to test whether the errors of the demand equation are autocorrelated we could use the estimated sample errors (e(i) : i=1,..,D) and fit the following regression:

$$(1) \qquad e(t) = r * e(t-1) + v(t), \qquad v(t) \sim N(0,S)$$

However, the vector of estimated error terms will in general contain discontinuities as not all e(i) will be in consecutive time periods. Calculating the Durbin-Watson statistic in the ordinary fashion would imply that observations following a gap could not be used. A more efficient way of estimating r would consist of "jumping over the gap" by repeated substitution of

(1), such that missing values are expressed in terms of available past observations. For example, in the case of only one missing observation, say e(t-1), we can express e(t) as follows:

$$(2) \qquad e(t) = r^{2}*e(t-2) + r*v(t-1) + v(t)$$

The last two terms on the RHS of (2) can be seen as a transformed error term (w(t)):

$$(3) \qquad w(t) = r*v(t-1) + v(t), \qquad w(t) \sim N(0,(1+r^{2})S)$$

In general, we can express e(t) following an n-period gap as follows:

$$(4) \qquad e(t) = r^{n}*e(t-n) + \sum_{i=0}^{n-1} r^{i}*v(t-i)$$

Or:

(5) $$e(t) = r^{n} * e(t-n) + w(n,r,t)$$

where the last term on the RHS of (5) is the transformed error term, (w(n,r,t)), whose distribution is as follows:

(6) $$w(n,r,t) \sim N(0, (\sum_{i=0}^{n-1} r^{2i}) S)$$

Hence, the likelihood of an observation following an n-period gap is simply:

(7) $$L(S,r|e(t)) = (2\pi)^{-.5} * \{(\sum_{i=0}^{n-1} r^{2i}) S\}^{-.5} *$$

$$* \exp\{- \frac{(e(t) - r^{n} * e(t-n))^{2}}{2(\sum_{i=0}^{n-1} r^{2i}) S}\}$$

The likelihood function can be simplified further by concentrating S out, replacing it by its ML estimate, denoted by $\hat{S}$:

$$\hat{S} = \frac{\{e(t) - r^{n} * e(t-n)\}^{2}}{\sum_{i=0}^{n-1} r^{2i}} \qquad (8)$$

By substituting equation (8) into (7), the logarithm of the likelihood function can be written as follows:

$$\log\{L(r|e(t))\} = C - (.5) * \log\{e(t) - r^{n} * e(t-n)\}^{2} \qquad (9)$$

Where C is a constant. Because the transformed error terms are serially uncorrelated, the total log-likelihood function can be obtained by combining the appropriate individual functions, depending on the amount and nature of the gaps in the vector of estimated residuals. This total log-likelihood function can be maximized by using a grid search over plausible values of the autocorrelation coefficient (e.g. $|r|<1$). This gives us the ML estimate of r, denoted by $\hat{r}$. For sufficiently large samples we can use the following approximation (Maddala, 1977, p. 87):

$$d = (1 - \hat{r}) * 2 \qquad (10)$$

which can then be used to test for first order autocorrelation in the usual fashion.

APPENDIX D: DATA SERIES AND DEFINITIONS

In this appendix all data used are reported, together with their exact sources. Unless otherwise indicated the time series are intertemporally compatible. In the collection of recent observations we have aimed at incorporating the most up to date figures available.

The variable measuring the real user cost of capital (PKAP) was constructed in the following fashion:[1]

$$(1) \qquad PKAP = \frac{PINV}{PR71} * (R10 + d - (100 * \Delta \log(PINV)))$$

The variable measuring the index of average number of hours worked per week (HIND) was constructed by using information on the average number of hours worked in manufacturing industries which is available for the period 1945-1970. The following curve was fitted through the available data:

---

[1]See Wallis (1979, p. 99) for a discussion of this concept. The parameter d represents the technical rate of depreciation of the capital stock. In our calculations we have assumed a 7 percent depreciation rate so that d=7.

$$(2) \qquad \log(H) = \underset{(51.78)}{3.83458} - \underset{(-2.72)}{0.008764}*TIME + \underset{(2.18)}{0.000102}*TIME^2$$

$$- \underset{(-2.05)}{0.016718}*\log(LFU/LF)$$

$\bar{R}^2 = 0.845$

Here TIME is a simple linear time trend starting at 1 in 1926. The unemployment rate was included in an attempt to capture the cyclical fluctuations in the average number of hours worked.[2] Using the estimates of equation (2), fitted values for H, denoted by Hf, were obtained for the entire period 1926-1982. These observations were then reduced to index numbers by using the fitted value for 1971 as the base unit, hence:

$$(3) \qquad HIND_t = (Hf_t / Hf_{1971})*100$$

---

[2]See Evans (1969, p. 259) and Choudhry et al. (1972, pp. 44, 65).

Table 1: Description, and Definitions of Symbols used in Chapter 3.

Symbol:	Description:	Definition in terms of the data matrices in Table 2 below:
A	Non-labour income in terms of the CPI	NLINC/(PRICE*POP)
Cp′	Per capita personal expenditure on consumer goods and services in constant 1971 dollars	C71/POP
Cpf	Fitted values of Cp, used in the disequilibrium estimation	See appendix B
D1	Dummy capturing the 1946 labour market definition changes	D1=0 for 1926-1945, D1=1 for 1946-1982
D2	Dummy capturing the 1966 labour market definition changes	D2=0 for 1926-1965, D2=1 for 1966-1982
D3	Dummy capturing the effects of wars on the labour market	D3=1 for 1939-1945 and 1952-1953, and D3=0 otherwise
Dp′	Deviation of the rate of change of Py from its average	See equation (3.60)
Dppf	Fitted values of positive Dp's	See appendix B
Dpnf	Fitted values of negative Dp's	See appendix B
Dw	Deviation of the rate of change of Wh from its average	See equation (3.61)
Dwpf	Fitted values of positive Dw's	See appendix B
Dwnf	Fitted values of negative Dw's	See appendix B
K	Mid-year net capital stock of industrial sector in real 1971 dollars	KAP
Kf	Fitted values of the Capital stock, obtained by running the regression in equation (E.7)	See appendix E
L	Employment of the Civilian labour force	LFE

Lh	Same as L, but corrected for average weekly hours worked	LFE*HIND/100
Lhf	Fitted values of Lh, used in the disequilibrium estimation	See appendix B
Lp	Participation rate of the Civilian non-institutional population in terms of employment	LFE/P14
Lph	Same as Lp, but corrected for average weekly hours worked	LFE*HIND/(P14*100)
Lphf	Fitted values of Lph, used in the disequilibrium estimation	See appendix B
Lsp	Participation rate of the Civilian non-institutional population in terms of the labour force	LF/P14
Lsph	Same as Lsp, but corrected for average weekly hours worked	LF*HIND/(P14*100)
Pk	Real users' cost of capital	See this appendix
Pkw	Real users' cost of capital in terms of the nominal wage rate, i.e. Pkw=(Pk/Wp)*100	
Pm	Price index of imports in terms of the CPI	PIMP/PRICE
Py	Implicit price index for GNE, 1971=100	PR71
py	Average of the rates of change in Py over the period 1927-1982	$\sum \Delta$ log(PR71)* (1/56)
Rc	Real rate of interest in terms of the CPI	R10-100* (Δ log(PRICE))
T	Simple linear time trend, 1926=1	
Wc	Real wage rate in terms of the CPI	WAGE/(PRICE*LFE)
Wch	Same as Wc, but corrected for average weekly hours worked	WAGE/(PRICE*LFE*HIND/100)
Wh	Nominal wage rate corrected for average weekly hours worked	WAGE*100/ (HIND*LFE)
wh	Average of the rates of change in Wh over the period 1927-1982	$\sum \Delta$ log(Wh)* (1/56)
Wp	Real wage rate in terms of the GNP deflator	WAGE/(PR71*LFE)

Wph	Same as Wp, but corrected for average weekly hours worked	WAGE/(PR71*LFE*HIND/100)
Y	Gross National Expenditure in constant 1971 dollars	GNE71
Yf	Fitted values of Y, used in the disequilibrium estimation	See appendix B

Table 2: Data Series

GNE71

GROSS NATIONAL EXPENDITURE IN CONSTANT (1971) DOLLARS, ANNUALLY FROM 1926. - MILLIONS OF DOLLARS

1926	14086.	15423.	16831.	16894.
1930	16174.	14118.	12654.	11811.
1934	13245.	14279.	14912.	16410.
1938	16545.	17774.	20277.	23194.
1942	27497.	28604.	29736.	29071.
1946	28292.	29498.	30231.	31388.
1950	33762.	35450.	38617.	40605.
1954	40106.	43891.	47599.	48718.
1958	49844.	51737.	53231.	54741.
1962	58475.	61487.	65610.	69981.
1966	74844.	77344.	81864.	86225.
1970	88390.	94450.	100248.	107812.
1974	111678.	113005.	119612.	121988.
1978	126347.	130362.	131675.	136114.
1982	130069.			

Sources: Data from 1926-1975 were taken from Statistics Canada (1983a, F55). Observations for 1976-1982 were taken from Statistics Canada (1983d, p. 9).

C71

CONSUMPTION EXPENDITURE IN CONSTANT (1971) DOLLARS, ANNUALLY FROM 1926. - MILLIONS OF DOLLARS

1926	8295.	9265.	10148.	10778.
1930	10326.	9822.	9054.	8827.
1934	9284.	9693.	10133.	10766.
1938	10613.	10915.	11717.	12512.
1942	12831.	13210.	14160.	15592.
1946	17324.	18546.	18099.	19138.
1950	20394.	20546.	21984.	23512.
1954	24375.	26456.	28440.	29504.
1958	30562.	32264.	33392.	33761.
1962	35272.	36992.	39218.	41606.
1966	43778.	45863.	48138.	50353.
1970	51526.	55616.	59841.	63879.
1974	67160.	70645.	75180.	77009.
1978	79038.	80607.	81431.	82961.
1982	81206.			

Sources: Data from 1926-1975 were taken from Statistics Canada (1983a, F33). Observations for 1976-1982 were taken from Statistics Canada (1983d, p. 7).

(Table 2, Continued.)

G71

GOVERNMENT CURRENT EXPENDITURE ON GOODS AND SERVICES IN CONSTANT (1971) DOLLARS, ANNUALLY FROM 1926. - MILLIONS OF DOLLARS.

1926	1924.	2012.	2034.	2287.
1930	2505.	2647.	2568.	2162.
1934	2282.	2382.	2397.	2423.
1938	2720.	2891.	5095.	7367.
1942	15421.	16878.	19379.	13326.
1946	6302.	4747.	4504.	4982.
1950	5367.	7000.	8624.	8890.
1954	8549.	8736.	8956.	8807.
1958	9074.	8999.	9218.	10494.
1962	10911.	11070.	11637.	12253.
1966	13388.	14343.	15429.	15993.
1970	17650.	18368.	18930.	19795.
1974	20584.	21399.	21598.	22299.
1978	22671.	22750.	22932.	23053.
1982	23175.			

Sources: Data from 1926-1975 were taken from Statistics Canada (1983a,F34). Observations for 1976-1982 were taken from Statistics Canada (1983d p. 7).

I71

GROSS FIXED CAPITAL FORMATION IN CONSTANT (1971) DOLLARS, ANNUALLY FROM 1926. - MILLIONS OF DOLLARS

1926	2619.	3235.	3845.	4254.
1930	3722.	2762.	1532.	1094.
1934	1379.	1645.	1870.	2483.
1938	2371.	2295.	2619.	3206.
1942	2923.	2371.	2486.	3182.
1946	4207.	5316.	6103.	6553.
1950	7042.	7068.	7892.	8861.
1954	8858.	9678.	11446.	12262.
1958	12126.	12191.	11790.	11748.
1962	12278.	12841.	14549.	16259.
1966	18015.	17942.	17964.	18850.
1970	18904.	20800.	21955.	24384.
1974	25694.	26661.	27731.	27606.
1978	27585.	29448.	30601.	32601.
1982	28798.			

Sources: Data from 1926-1975 were taken from Statistics Canada (1983a, F35). Observations for 1976-1982 were taken from Statistics Canada (1983d p. 7).

(Table 2, Continued.)

A71

VALUE OF PHYSICAL CHANGE IN INVENTORIES
IN CONSTANT (1971) DOLLARS, ANNUALLY
FROM 1926. - MILLIONS OF DOLLARS

1926	399.	533.	390.	311.
1930	221.	-253.	-306.	-236.
1934	81.	152.	2.	246.
1938	154.	604.	573.	245.
1942	-21.	-45.	-70.	-122.
1946	420.	672.	109.	215.
1950	789.	1025.	481.	752.
1954	-238.	410.	1144.	249.
1958	-280.	468.	523.	251.
1962	756.	764.	655.	1441.
1966	1385.	253.	771.	1518.
1970	84.	392.	515.	1346.
1974	2642.	-252.	1368.	360.
1978	129.	1766.	-663.	632.
1982	-3240.			

Sources: Data from 1926-1975 were taken from Statistics Canada (1983a, F47). Observations for 1976-1982 were taken from Statistics Canada (1983d, p. 9).

E71

EXPORTS OF GOODS AND SERVICES IN CONSTANT (1971) DOLLARS,
ANNUALLY FROM 1926. - MILLIONS OF DOLLARS

1926	3563.	3577.	4055.	3817.
1930	3319.	2967.	2748.	2774.
1934	3137.	3459.	4158.	4248.
1938	3836.	4225.	4817.	6329.
1942	5663.	7874.	7600.	7402.
1946	6208.	6170.	6375.	5997.
1950	5956.	6513.	7260.	7185.
1954	6917.	7442.	8002.	8075.
1958	8047.	8360.	8717.	9374.
1962	9744.	10631.	12058.	12606.
1966	14315.	15770.	17727.	19462.
1970	21223.	22181.	23655.	26156.
1974	25620.	23993.	26304.	28233.
1978	31207.	32141.	32753.	33685.
1982	33152.			

Sources: Data from 1926-1975 were taken from Statistics Canada (1983a, F51). Observations for 1976-1982 were taken from Statistics Canada (1983d, p. 9).

(Table 2, Continued.)

M71

IMPORTS CF GOODS AND SERVICES IN CONSTANT (1971) DOLLARS, ANNUALLY FROM 1926. - MILLIONS OF DOLLARS

1926	3443.	3804.	4274.	4670.
1930	4248.	3403.	2921.	2775.
1934	2957.	3174.	3596.	3971.
1938	3708.	3964.	4423.	5122.
1942	5500.	6553.	7760.	6173.
1946	5711.	6411.	5781.	5939.
1950	6469.	7277.	7527.	8151.
1954	7761.	8799.	10215.	10096.
1958	9386.	10357.	10347.	10559.
1962	10769.	11125.	12595.	14140.
1966	15989.	16805.	18284.	20727.
1970	20588.	22016.	24489.	27824.
1974	30538.	29684.	32274.	32798.
1978	34291.	36662.	35945.	37286.
1982	33072.			

Sources: Data from 1926-1975 were taken from Statistics Canada (1983a, F52). Observations for 1976-1982 were taken from Statistics Canada (1983d, p. 9).

PR71

IMPLICIT PRICE INDEXES OF GROSS NATIONAL EXPENDITURE, 1971=100

1926	36.5	36.1	35.9	36.3
1930	35.4	33.2	30.1	29.6
1934	30.	30.1	31.1	31.9
1938	31.9	31.6	33.1	35.7
1942	37.3	38.6	39.8	40.8
1946	42.	45.7	51.3	53.5
1950	54.8	61.	63.7	63.6
1954	64.6	65.	67.4	68.8
1958	69.8	71.2	72.1	72.4
1962	73.4	74.8	76.6	79.1
1966	82.6	85.9	88.7	92.6
1970	96.9	100.	105.	114.6
1974	132.1	146.3	160.4	172.3
1978	183.8	202.7	225.2	249.1
1982	274.2			

Sources: Data from 1926-1973 were taken from Statistics Canada (1983a, K172). Observations for 1974-1982 were taken from Statistics Canada (1983d, p. 9).

(Table 2, Continued.)

PINV

IMPLICIT PRICE INDEX GROSS FIXED CAPITAL FORMATION, 1971=100

1926	31.1	30.7	31.1	32.
1930	30.9	29.3	28.2	27.3
1934	27.6	27.8	28.4	30.4
1938	30.2	29.9	31.8	34.2
1942	36.1	38.	38.8	38.7
1946	40.	44.2	50.1	52.5
1950	54.8	62.6	64.6	64.7
1954	64.5	66.4	69.9	70.9
1958	70.4	70.9	71.9	71.4
1962	72.4	74.4	77.	81.1
1966	85.3	87.1	87.7	91.4
1970	95.3	100	105.	114.2
1974	133.3	150.2	162.	175.2
1978	190.3	206.9	226.1	251.7
1982	269.8			

Sources: Data from 1926-1970 were taken from Statistics Canada (1976, pp. 10-11, 110-111, 210-211).Observations for 1971-1982 were taken from Statistics Canada (1983d, pp. 9-8).

PKAP

REAL USER COST OF CAPITAL, INCLUDING CAPITAL GAINS, BASED UPON A 7 PERCENT ANNUAL DEPRECIATION RATE, ANNUALLY FROM 1927.
1926

1927	10.8807	8.79764	7.9314	13.1962
1931	15.0179	14.8275	13.644	9.02252
1935	9.21553	7.15445	3.20646	10.1772
1939	10.5581	3.95739	2.70538	4.50363
1943	4.8048	7.70794	9.66368	6.00571
1947	-0.400981	-2.53875	5.05443	5.49238
1951	-3.14803	7.55035	10.7073	10.4733
1955	7.39269	5.6865	9.98526	11.9193
1959	11.3144	10.7495	12.5717	10.5731
1963	9.31499	8.79072	7.19985	7.89053
1967	11.0034	12.9162	10.3122	10.5544
1971	9.13595	9.351	6.13939	0.438882
1975	4.20255	8.70302	7.9993	8.28559
1979	9.02995	10.6481	11.6139	14.086

Sources: Refer to PINV, PR71, and R10. For method of calculation see remark at the beginning of this appendix.

(<u>Table 2, Continued.</u>)

PIMP

IMPLICIT PRICE INDEX IMPORTS OF GOODS AND SERVICES, 1971=100

1926	42.8	41.5	41.1	40.6
1930	37.2	32.7	30.1	29.2
1934	31.5	32.4	35.	33.3
1938	32.9	36.4	38.4	41.9
1942	44.3	45.9	47.1	50.1
1946	56.2	56.2	62.8	64.9
1950	69.4	76.7	71.3	71.2
1954	71.4	72.6	75.	76.9
1958	78.	77.5	78.2	80.3
1962	84.	85.9	86.6	87.3
1966	89.2	90.7	93.	95.6
1970	98.2	100.	103.1	111.2
1974	134.3	153.6	156.3	175.5
1978	199.1	226.5	260.9	289.5
1982	302.			

Sources: Data from 1926-1975 were taken from Statistics Canada (1983a, K183). Observations for 1976-1982 were taken from Statistics Canada (1983d, p. 9).

PEXP

IMPLICIT PRICE INDEX EXPORTS OF GOODS AND SERVICES, 1971=100

1926	45.8	44.8	43.3	42.4
1930	38.3	32.1	28.9	29.3
1934	32.	32.6	34.	37.1
1938	35.	34.	37.3	38.8
1942	41.4	43.5	46.6	48.1
1946	52.9	59.3	63.6	66.8
1950	69.8	77.6	76.7	74.9
1954	74.3	77.3	79.4	79.
1958	78.7	79.8	80.3	81.3
1962	84.5	85.3	87.1	88.7
1966	91.1	93.	94.3	96.4
1970	99.7	100.	103.9	117.4
1974	152.2	168.6	174.1	187.1
1978	202.9	241.2	279.	298.7
1982	306.			

Sources: Data from 1926-1974 were taken from Statistics Canada (1983a, K182). Observations for 1975-1982 were taken from Statistics Canada (1983d, pp. 8-9).

(Table 2, Continued.)

PRICE

CONSUMER PRICE INDEX, 1971=100

1926	44.	43.3	43.4	43.9
1930	43.6	39.4	35.8	34.
1934	34.6	34.8	35.5	36.6
1938	37.0	36.7	38.2	40.4
1942	42.3	43.	43.3	43.5
1946	45.0	49.2	56.3	58.0
1950	59.7	66.0	67.6	67.0
1954	67.4	67.5	68.5	70.7
1958	72.6	73.4	74.3	75.
1962	75.9	77.2	78.6	80.5
1966	83.5	86.5	90.0	94.1
1970	97.2	100.0	104.8	112.7
1974	125.0	138.5	148.9	160.8
1978	175.2	191.2	210.6	236.9
1982	262.5			

Sources: Data from 1926-1975 were taken from Statistics Canada (1983a, K8). Observations for 1976-1982 were taken from Statistics Canada (1983c, p. 24).

LF

TOTAL CIVILIAN LABOUR FORCE, THOUSANDS OF PERSONS

1926	3658.	3757.	3861.	3964.
1930	4060.	4151.	4211.	4275.
1934	4338.	4402.	4466.	4526.
1938	4588.	4649.	4607.	4466.
1942	4569.	4567.	4548.	4520.
1946	4829.	4942.	4988.	5055.
1950	5163.	5223.	5324.	5397.
1954	5493.	5610.	5782.	6008.
1958	6137.	6242.	6411.	6521.
1962	6615.	6748.	6933.	7141.
1966	7493.	7747.	7951.	8194.
1970	8395.	8639.	8897.	9276.
1974	9639.	9974.	10206.	10498.
1978	10882.	11207.	11522.	11830.
1982	11879.			

Sources: 1926-1945: Statistics Canada (1983a, D128); 1946-1965: Statistics Canada (1983a, D138); 1966-1982: Statistics Canada (1983b, p. 33). See remark in chapter 3 about intertemporal compatibility.

(Table 2, Continued.)

LFE

EMPLOYMENT OF THE CIVILIAN LABOUR FORCE, THOUSANDS OF PERSONS

1926	3550.	3690.	3796.	3848.
1930	3689.	3670.	3470.	3449.
1934	3707.	3777.	3895.	4115.
1938	4066.	4120.	4184.	4271.
1942	4434.	4491.	4485.	4447.
1946	4666.	4832.	4875.	4913.
1950	4976.	5097.	5169.	5235.
1954	5243.	5364.	5585.	5731.
1958	5706.	5870.	5965.	6055.
1962	6225.	6375.	6609.	6862.
1966	7242.	7451.	7593.	7832.
1970	7919.	8104.	8344.	8761.
1974	9125.	9284.	9479.	9648.
1978	9972.	10369.	10655.	10933.
1982	10574.			

Sources: 1926-1945: Statistics Canada (1983a, D129); 1946-1965: Statistics Canada (1983a, D139); 1966-1982: Statistics Canada (1983b, p. 66). See LF.

LFU

UNEMPLOYED MEMBERS OF THE CIVILIAN LABOUR FORCE, THOUSANDS OF PERSONS

1926	108.	67.	65.	116.
1930	371.	481.	741.	826.
1934	631.	625.	571.	411.
1938	522.	529.	423.	195.
1942	135.	76.	63.	73.
1946	163.	110.	114.	141.
1950	186.	126.	155.	162.
1954	250.	245.	197.	278.
1958	432.	372.	446.	466.
1962	390.	374.	324.	280.
1966	251.	296.	358.	362.
1970	476.	535.	553.	515.
1974	514.	690.	727.	850.
1978	911.	838.	867.	898.
1982	1305.			

Sources: 1926-1945: Statistics Canada (1983a, D132); 1946-1965: Statistics Canada (1983a, D142); 1966-1982: Statistics Canada (1983b, p. 139). See LF.

(Table 2, Continued.)

POP

ESTIMATED POPULATION OF CANADA, THOUSANDS OF PERSONS

1925	9294.	9451.	9637.	9835.
1929	10029.	10208.	10377.	10510.
1933	10633.	10741.	10845.	10950.
1937	11045.	11152.	11267.	11381.
1941	11507.	11654.	11795.	11946.
1945	12072.	12292.	12551.	12823.
1949	13447.	13712.	14009.	14459.
1953	14845.	15287.	15698.	16081.
1957	16610.	17080.	17483.	17870.
1961	18238.	18583.	18931.	19291.
1965	19644.	20015.	20378.	20701.
1969	21001.	21297.	21568.	21802.
1973	22043.	22364.	22697.	22993.
1977	23273.	23517.	23747.	24043.
1981	24342.	24634.		

Sources: Data from 1925-1975 were taken from Statistics Canada (1983a, A1). Observations for 1976-1982 were taken from Statistics Canada (1983d, p. 93).

P14

CIVILIAN NON-INSTITUTIONAL POPULATION, THOUSANDS OF PERSONS

1926	6326.	6486.	6655.	6820.
1930	6972.	7116.	7240.	7366.
1934	7491.	7621.	7748.	7870.
1938	7997.	8122.	8140.	8056.
1942	8085.	7871.	7920.	8048.
1946	8779.	9007.	9141.	9268.
1950	9615.	9732.	9956.	10164.
1954	10391.	10597.	10807.	11123.
1958	11388.	11606.	11831.	12053.
1962	12280.	12536.	12817.	13128.
1966	13083.	13444.	13805.	14162.
1970	14528.	14872.	15186.	15526.
1974	15924.	16323.	16706.	17057.
1978	17381.	17691.	18004.	18295.
1982	18573.			

Sources: 1926-1945: Statistics Canada (1983a, D126); 1946-1965: Statistics Canada (1983a, D136); 1966-1982: Statistics Canada (1983b, p. 276).

(Table 2, Continued.)

R10

RATE OF INTEREST ON GOVERNMENT BONDS WITH A MATURITY OF LONGER THAN 10 YEARS

1926	4.8	4.5	4.45	4.85
1930	4.62	4.7	5.00	4.55
1934	3.9	3.7	2.97	3.17
1938	3.09	3.16	3.28	3.1
1942	3.06	3.01	2.99	2.93
1946	2.61	2.57	2.93	2.83
1950	2.78	3.24	3.59	3.68
1954	3.18	3.14	3.62	4.11
1958	4.11	5.07	5.18	5.05
1962	5.11	5.09	5.18	5.21
1966	5.69	5.94	6.75	7.58
1970	7.91	6.95	7.23	7.56
1974	8.9	9.03	9.18	8.70
1978	9.27	10.21	12.48	15.22
1982	14.26			

Sources: 1926-1935: Neufeld (1972, pp. 565-566); 1936-1977: Statistics Canada (1983a, J475); 1978-1981: Bank of Canada (1982, p. S58); 1982: Bank of Canada (1983, p. S62).

WAGE

WAGES, SALARIES, AND SUPPLEMENTARY LABOUR INCOME, ANNUALLY, FROM 1926, IN MILLIONS OF DOLLARS.

1926	2366.	2506.	2715.	2940.
1930	2786.	2408.	1975.	1788.
1934	1939.	2079.	2241.	2538.
1938	2515.	2601.	2959.	3608.
1942	4282.	4812.	4998.	5037.
1946	5487.	6662.	7754.	8349.
1950	8998.	10538.	11768.	12714.
1954	13043.	13930.	15696.	16988.
1958	17435.	18596.	19582.	20399.
1962	21816.	23262.	25367.	28201.
1966	31878.	35303.	38444.	43065.
1970	46706.	51528.	57570.	66757.
1974	80086.	93289.	109054.	120508.
1978	131703.	148257.	167937.	193875.
1982	208180.			

Sources: Data from 1926-1974 were taken from Statistics Canada (1983a, E1). Observations for 1975-1982 were taken from Statistics Canada (1983d, p. 5).

(Table 2, Continued.)

KAP

MID YEAR NET CAPITAL STOCK OF ALL INDUSTRIES IN CONSTANT (1971) DOLLARS, ANNUALLY FROM 1926.
- MILLIONS OF DOLLARS

1926	32618.2	33233.9	34375.	35969.6
1930	37533.1	38405.5	38297.9	37531.
1934	36730.4	36208.9	35922.1	35981.9
1938	36221.	36326.5	36720.3	37821.2
1942	39276.2	40620.2	41529.1	41997.1
1946	42704.8	44277.4	46645.1	49351.8
1950	52175.8	55319.	59126.4	63401.1
1954	67376.3	71088.2	75810.7	81797.8
1958	87502.3	92450.7	97222.9	101817.7
1962	106399.2	111203.5	116682.3	123359.4
1966	131491.7	140144.7	148117.7	155706.6
1970	163374.3	171227.4	179236.8	187990.2
1974	198012.6	208936.1	219710.9	229648.
1978	238981.	248726.7	259690.2	271682.7
1982	284039.7			

Sources: Data from 1926-71 were taken from Statistics Canada (1978b, p. 1). Observations for 1972-1982 were taken from Statistics Canada (1982, p. 2).

INC

PERSONAL INCOME, ANNUALLY, FROM 1926, IN MILLIONS OF CURRENT DOLLARS

1926	4057.	4281.	4600.	4665.
1930	4392.	3669.	3063.	2840.
1934	3175.	3398.	3602.	4070.
1938	4126.	4350.	4972.	5937.
1942	7522.	8183.	9016.	9292.
1946	9887.	10926.	12592.	13396.
1950	14262.	16791.	18592.	19550.
1954	19717.	21265.	23531.	25170.
1958	26651.	28108.	29595.	30104.
1962	32788.	34829.	37282.	41071.
1966	46094.	50579.	55677.	61804.
1970	66633.	74092.	83767.	97832.
1974	116867.	136205.	155142.	171516.
1978	191498.	215367.	244342.	287476.
1982	316284.			

Sources: Data from 1926-1975 were taken from Statistics Canada (1983a, F81). Observations from 1976-1982 were taken from Statistics Canada (1983d, p. 7).

(Table 2, Continued.)

TAX

DIRECT TAXES - PERSONS, ANNUALLY, FROM 1926, IN MILLIONS OF CURRENT DOLLARS

1926	54.	62.	62.	75.
1930	81.	72.	67.	70.
1934	67.	86.	100.	125.
1938	124.	121.	149.	332.
1942	579.	792.	938.	909.
1946	906.	927.	986.	956.
1950	915.	1279.	1588.	1748.
1954	1776.	1855.	2127.	2350.
1958	2214.	2444.	2794.	2944.
1962	3180.	3387.	3917.	4431.
1966	5792.	7009.	8244.	10055.
1970	11547.	13042.	14631.	17041.
1974	21197.	24070.	28353.	31538.
1978	33419.	37163.	42503.	52402.
1982	58137.			

Sources: Data from 1926-1975 are taken from Statistics Canada (1983a, F103). Observations for 1976-1982 are taken from Statistics Canada (1983d, p. 7).

NLINC

INTEREST, DIVIDENDS AND MISCELLANEOUS INVESTMENT INCOME, ANNUALLY FROM 1926, IN MILLIONS OF CURRENT DOLLARS

1926	348.	369.	403.	437.
1930	439.	424.	363.	384.
1934	407.	413.	378.	411.
1938	413.	423.	452.	457.
1942	447.	486.	497.	553.
1946	583.	722.	772.	828.
1950	983.	1085.	1118.	1111.
1954	1133.	1275.	1427.	1605.
1958	1694.	1886.	2029.	2183.
1962	2502.	2748.	2982.	3231.
1966	3580.	3834.	4288.	4848.
1970	5220.	5617.	7028.	8667.
1974	10914.	12058.	13704.	15660.
1978	19897.	24515.	28472.	38125.
1982	42430.			

Sources: Data for 1926-1975 were taken from Statistics Canada (1976, pp. 6-7, 106-107, 206-207). Observations for 1976-1982 were taken from Statistics Canada (1983d, p. 5).

(Table 2, Continued.)

H

AVERAGE NUMBER OF HOURS WORKED PER WEEK, MANUFACTURING INDUSTRIES

1945	44.1	42.7	42.5	42.3
1949	42.2	42.3	41.7	41.5
1953	41.3	40.7	41.0	41.0
1957	40.4	40.2	40.7	40.4
1961	40.6	40.7	40.8	41.0
1965	41.1	40.8	40.3	40.3
1969	40.0	39.7		

Sources: Data were taken from Statistics Canada (1983a, E131). See remark at the beginning of this appendix.

APPENDIX E: THE DERIVATION OF A SHORT-RUN LABOUR DEMAND FUNCTION

In this appendix we derive the short-run production function and labour demand along similar lines to Sneessens (1981, pp. 88-90). In the long-run capitalists are assumed to maximize expected profits by choice of inputs capital (K) and labour (L). The production function is assumed to be Cobb-Douglas with decreasing returns to scale:

$$(1) \qquad Y = A*e^{gt}*L^{a1}*K^{a2} \qquad a1,a2>0,\ a1+a2<1$$

Denoting the long-run expected price level, wage rate, and the users' cost of capital with Pe, We, and Ce respectively, we can write the profit maximizing programme as follows:

$$(2) \qquad \underset{\{L,K\}}{MAX}\ Z = Pe*\{A*e^{gt}*L^{a1}*K^{a2}\} - We*L - Ce*K$$

This defines the optimal long-run capital stock (Ko) and level of employment, the former of which can be written as:

$$(3) \qquad \log(Ko)_t = E - (g*D)*t + D*\log(We/Pe)_t + (1-a1)*D*\log(Ce/We)_t$$

Here, E and D are constants that are defined as follows:

$$(4) \qquad D=(a1+a2-1)^{-1} \; ; \quad E=-D*\log(a1^{a1}*A*a2^{1-a1})$$

We now postulate that the capitalists' forecast of relative prices is a weighted sum of past observations, where the weights are assumed to decline geometrically, i.e. in a Koyck fashion (Maddala, 1977, p. 360).[1] Following Lucas and Rapping (1970, p. 268) we assume the reaction parameters of the Koyck lag to be the same for both relative factor prices. Hence, we can write log(We/Pe) as follows:

----

[1] Following this procedure results in losing only one observation for estimation purposes. Sneessens effectively uses a similar method in the empirical implementation of his model in that he also imposes a Koyck type weighting scheme on the expectations mechanism (1981, p. 108).

$$(5)\qquad \log(We/Pe)_t = \sum_i (1-b)*b^i*\log(W/P)_{t-i} \qquad 0<b<1$$

$$= (1-b)/(1-bB)*\log(W/P)_t$$

Where B is the backshift operator. Similarly, we can write log(Ce/We) as follows:

$$(6)\qquad \log(Ce/We)_t = (1-b)/(1-bB)*\log(C/W)_t$$

In equations (5) and (6), W, P, and C denote actual values of the wage rate, the price level, and the users' cost of capital respectively. Substituting (5) and (6) into (3) yields the following expression for the expected long-run optimal level of the capital stock, which is denoted by Ko:

$$(7)\qquad \log(Ko)_t = (1-b)*E+b*g*D+g*D*(1-b)*t+(1-b)*D*\log(W/P)_t$$

$$+(1-a1)*(1-b)*D*\log(C/W)_t + b*\log(Ko)_{t-1}$$

For estimation purposes we can estimate the coefficients of equation (7) and use the predicted values, denoted by the superscript "e", as instruments in the short-run production function, which can then be written as follows:

$$\text{(8)} \qquad \log(Y)_t = \log(A) + g*t + a2*\log(Ko)^e_t + a1*\log(L)_t$$

In the short-run labour is the only variable input, so that the short-run labour demand is just the marginal productivity condition of labour:

$$\text{(9)} \qquad (dY/dL)_t = (W/P)_t$$

This yields the following demand for labour equation:

$$\text{(10)} \qquad \log(L_t) = F + (g/(1-a1))*t + (a2/(1-a1))*\log(Ko)^e_t + (1/(a1-1))*\log(W/P)_t$$

Here, F=log(a1*A)/(1-a1). Alternatively, we can substitute the RHS of equation (7) into (10) and regress instead:

(11) $$\log(L_t) = c1 + c2*t + c3*\log(W/P)_t + c4*\log(C/W)_t + c5*\log(Ko)_{t-1} \quad ; \; c3, c4 < 0 < c5$$

Which is the expression in the text of chapter 3.

APPENDIX F: A SURVEY OF DIFFERENT TESTS FOR DISEQUILIBRIUM

In this appendix we survey a number of methods that has been proposed in the econometric literature to test models that obey different regimes at different times. Quandt presents 5 different tests, 4 of which require ML estimation (1978, pp. 440-442). In a correction to Quandt's paper, Gourieroux et al. (1980b) show that in the particular example used by Quandt all these test procedures are nested and applicable, which is contrary to Quandt's own remark in this respect (Quandt, 1978, p. 440). The example used by Quandt makes use of quantitative information on price changes in the single market case (1978, pp. 436-437):

$$(1) \qquad P_t = P_{t-1} + a*(Yd_t - Ys_t) \qquad a \geq 0$$

Here, P denotes the nominal price level, and Yd and Ys denote demand and supply respectively. Quandt proposes the following tests of equilibrium against disequilibrium (1978, pp. 440-442):

(i) Tests based on a. If (1/a) is estimated to be close to zero, then adjustment towards equilibrium is very quick, and hence disequilibrium is very unlikely.

(ii) Tests based upon the probability that demand falls short of supply, i.e. pr(Yd<Ys), which can be estimated along with the disequilibrium model. Equilibrium would imply that pr(Yd<Ys)=pr(Yd>Ys)=1/2.

(iii) Tests based upon embedding procedures. This procedure, originating with the work of Cox in the case of non-nested hypotheses, takes a geometric average (with parameters b and (1-b)) of the density functions associated with the two different hypotheses and tests whether the estimate of b is close to zero or unity:

$$(2) \qquad F(y) = k*D(y)^{b}*E(y)^{1-b} \qquad 0 \leq b \leq 1$$

Given the random variable y, F(y) denotes the compound density function, D(y) and E(y) denote the density functions associated with disequilibrium and equilibrium formulations respectively, and k is a constant ensuring that F(y) is a proper density function (Judge et al., 1980, p. 438). This test can be used for non-nested as well as nested hypotheses, and has been refined by a number of subsequent authors (Judge et al., 1980, pp. 436-438).[1]

---

[1]Specifically, we can mention the work of Pesaran (1974) and Pesaran and Deaton (1978), the latter of which could be applied if the equilibrium and disequilibrium models were estimated using Ito's FIML estimation procedure (Ito, 1980). In practice, however, due to the high computational costs involved, the Pesaran-Deaton approach has not been used extensively. Recently, Davidson and MacKinnon (1981) developed a number of tests which are applicable to the non-nested case. Unfortunately, these tests are not straightforward in the switching regression case since the likelihood function is highly non-linear, and one would need to obtain ML estimates of the parameters in order to be able to use the (relevant) P-test (Davidson and MacKinnon, 1981, p. 782). See Pesaran (1982) for a comparison of the local power of the Pesaran-Deaton and Davidson-MacKinnon tests.

(iv) Tests based on the likelihood ratio (L=Le/Ld), where Le and Ld dénote the maximums of the equilibrium and disequilibrium likelihood function respectively. This test is strictly speaking only valid if the two hypotheses are nested. In that case -2*log(L) is the appropriate test statistic.

(v) Tests based on posterior odds. Quandt approximates this ratio of posterior odds by the ratio of mean likelihoods of the two hypotheses (1978, p. 442).

Quandt performs a number of sampling experiments for methods (i), (ii), (iv), and (v) which suggest that (i) and (iv) have excellent power, but also a high probability of type I errors. Furthermore, it turns out that all test procedures behave well in a qualitative sense (1978, pp. 445-447).

As was pointed out above in appendix B, the ML method, complicated as it is in the single market case, becomes a multiple more complicated in the two market case with spill-overs. This makes any test based upon ML estimation computationally burdensome and impractical (Hwang, 1980, p. 319). Quandt's test (i) is simple enough even in the two market case, but is also subject to the severe economic theoretical problems mentioned in chapter 2, namely the fact that price (and wage) adjustment equations are unfounded outside of equilibrium. Therefore, methods which use quantitative information on price and wage adjustment mechanisms, like for example Bowden (1978a, 1978b) and Ito and Ueda (1981), are all risky in that they may introduce serious misspecification. "Consequently, the test results can be very sensitive to alternative assumptions about the price [and wage] adjustment process[es]" (Hwang, 1980, p. 321). Bowden specifies the following price adjustment process (1978a, p. 713):

$$(3) \qquad P_t = m*P_{t-1} + (1-m)*Pe_t \qquad 0 \leq m \leq 1$$

Where P and Pe denote the actual and market clearing price level respectively. The null hypothesis can be tested by estimating m, which can be seen as a "measure of the drag in market clearing" (Bowden, 1978a, p. 713). If m=0, then the null hypothesis cannot be rejected.

Hwang, on the other hand, develops an interesting test in which the difference between equilibrium and disequilibrium is interpreted as a test of parameter stability, without the need of postulating a quantitative price adjustment mechanism (1980, p. 323). The maintained hypotheses are that the demand and supply equations are correctly specified and that all parameters are stable over time (p. 321). Hwang calculates the recursive residuals and uses cusum and cusum of squares tests in order to detect significant departures from stability of the estimated parameters (1980, pp. 324-325).[2] As Hwang points out, the power of these tests "is expected to decrease as the frequency of

---

[2]The standard reference for the cusum and cusum of squares tests is Brown et al. (1975)

parameter changes within a given sample increases" (1980, p. 326).

The two main objections to Hwang's method are (i) the cusum and cusum of squares tests are not applicable if the price level is endogenous (Hwang, 1980, p. 323), and (ii) if the sample size is large and the economy switches to different regimes quite frequently, then the power of the test will be low (p. 330). As in the case of <u>all</u> tests mentioned in this appendix, Hwang's tests are obviously also dependent upon the quality of the specification that is used. Although it may be conceptually possible to extend Hwang's analysis to the two market case, this would not be straightforward due to the endogenous spill-over terms in the demand and supply equations. Instead, we use the simple, and admittedly ad hoc, prediction criterion which fits in more closely with the methodological stance taken in chapter 3.

REFERENCES

Amemiya, Takeshi, "A Note on a Fair and Jaffee Model," Econometrica, July 1974, 42, 759-762.

Arrow, Kenneth J., "Toward a Theory of Price Adjustment," in M. Abramovitz et. al., eds., The Allocation of Economic Resources, Stanford: Stanford University Press, 1959.

Azariadis, Costas and Joseph E. Stiglitz, "Implicit Contracts and Fixed Price Equilibria," Quarterly Journal of Economics, Supplement, 1983, 98, 1-22.

Bank of Canada, Bank of Canada Review, Ottawa: Bank of Canada, January 1982.

Bank of Canada, Bank of Canada Review, Ottawa: Bank of Canada, January 1983.

Barro, Robert J., "A Theory of Monopolistic Price Adjustment," Review of Economic Studies, January 1972, 39, 17-26.

Barro, Robert J., "Second Thoughts on Keynesian Economics," American Economic Review, Papers and Proceedings, May 1979, 69, 54-55.

Barro, Robert J., "'Unemployment, Employment and Exports in British Manufacturing: A Non-clearing Markets Approach' by Muellbauer and Winter," European Economic Review, May 1980, 13, 411-412.

Barro, Robert J. and Herschel I. Grossman, "A General Disequilibrium Model of Income and Employment," American Economic Review, March 1971, 61, 82-93.

Barro, Robert J. and Herschel I. Grossman, Money, Employment and Inflation, Cambridge: Cambridge University Press, 1976.

Bean, C. R., "An Econometric Model of Manufacturing Investment in the UK," Economic Journal, March 1981, 91, 106-121.

Belsley, David A., Edwin Kuh, and Roy E. Welsch, Regression Diagnostic: Identifying Influential Data and Sources of Collinearity, New York: John Wiley & Sons, 1980.

Belsley, David A. and Edwin Kuh, "Comment," Journal of the American Statistical Association, September 1979, 74, 643-645.

Benassy, Jean-Pascal, "Neo-Keynesian Disequilibrium Theory in a Monetary Economy," Review of Economic Studies, October

1975, 42, 502-523.

Benassy, Jean-Pascal, "The Disequilibrium Approach to Monopolistic Price Setting and General Monopolistic Equilibrium," Review of Economic Studies, February 1976, 43, 69-81.

Benassy, Jean-Pascal, "On Quantity Signals and the Foundations of Effective Demand Theory," Scandinavian Journal of Economics, 1977, 79, 147-168.

Benassy, Jean-Pascal, "A Neo-Keynesian Model of Price and Quantity Determination in Disequilibrium," in G. Schwodiauer, ed., Equilibrium and Disequilibrium in Economic Theory, Boston: D. Reidel Publishing Company, 1978.

Benassy, Jean-Pascal, The Economics of Market Disequilibrium , New York: Academic Press, 1982.

Blanchard, Olivier J. and Charles Wyplosz, "An Empirical Structural Model of Aggregate Demand," Journal of Monetary Economics , January 1981, 7, 1-28.

Blume, Lawrence E., Margaret M. Bray, and David Easley, "Introduction to the Stability of Rational Expectations Equilibrium," Journal of Economic Theory, April 1982, 26, 313-317.

Blume, Lawrence E. and David Easley, "Learning to be Rational," Journal of Economic Theory, April 1982, 26, 340-351.

Bodkin, Ronald G. and Stephen M. Tanny, eds., CANDIDE model 1.1, Economic Council of Canada, CANDIDE project paper, no. 18, Ottawa: Information Canada, 1975.

Boland, Lawrence A., The Foundation of Economic Method, London: George Allen & Unwin, 1982.

Bowden, Roger J., "Specification, Estimation and Inference for Models of Markets in Disequilibrium," International Economic Review, October 1978a, 19, 711-726.

Bowden, Roger J., The Econometrics of Disequilibrium, Amsterdam: North-Holland Publishing Company, 1978b.

Bray, Margaret M., "Learning, Estimation, and the Stability of Rational Expectations," Journal of Economic Theory, April 1982, 26, 318-339.

Brock, William A., "On Models of Expectations that Arise from Maximizing Behavior of Economic Agents over Time," Journal of Economic Theory, December 1972, 5, 348-376.

Brown, R. L., J. Durbin, and J. M. Evans, "Techniques for Testing the Constancy of Regression Relationships over Time," Journal of the Royal Statistical Society, Series B, 1975, 37, 149-163.

Bushaw, D. W. and Robert W. Clower, Introduction to Mathematical Economics, Homewood, Ill.: Richard D. Irwin, 1957.

Choudhry, Nanda K., Yehuda Kotowitz, John A. Sawyer and John W. L. Winder, The TRACE Econometric Model of the Canadian Economy, Toronto: University of Toronto Press, 1972.

Clower, Robert W., "Some Theory of an Ignorant Monopolist," Economic Journal, December 1959, 69, 705-716.

Clower, Robert W., "The Keynesian Counterrevolution: A Theoretical Appraisal," in F. H. Hahn and F. Brechling, eds., The Theory of Interest Rates, London: Macmillan Publishing Company, 1965.

Coase, Ronald H., "The Nature of the Firm," Economica, November 1937, 4, 386-405.

Coase, Ronald H., "The Problem of Social Cost," Journal of Law and Economics, October 1960, 3, 1-44.

Cooley, Thomas F. and Stephen F. LeRoy, "Identification and Estimation of Money Demand," American Economic Review, December 1981, 71, 825-844.

Cramer, J. S., Empirical Econometrics, Amsterdam: North-Holland Publishing Company, 1969.

Cuddington, John T., "Canadian Evidence on the Permanent Income-Rational Expectations Hypothesis," Canadian Journal of Economics, May 1982, 15, 331-335.

Cyert, Richard M. and Morris H. DeGroot, "Bayesian Analysis and Duopoly Theory," Journal of Political Economy, September-October 1970, 78, 1168-1184.

Cyert, Richard M. and Morris H. DeGroot, "Rational Expectations and Bayesian Analysis," Journal of Political Economy, June 1974, 82, 521-536.

Davidson, James E. H., David F. Hendry, Frank Srba, and Stephen Yeo, "Econometric Modelling of the Aggregate Time-Series Relationship between Consumers' Expenditure and Income in the United Kingdom," Economic Journal, December 1978, 88, 661-692.

Davidson, James E. H. and David F. Hendry, Interpreting Econometric Evidence: The Behaviour of Consumers'

Expenditure in the U.K., London: International Centre for Economics and Related Disciplines, London School of Economics, June 1980.

Davidson, Paul, "Post Keynesian Economics: Solving the Crisis in Economic Theory," in D. Bell and I. Kristol, eds., *The Crisis in Economic Theory*, New York: Basic Books, 1981.

Davidson, Russell and James G. MacKinnon, "Several Tests for Model Specification in the Presence of Alternative Hypotheses," *Econometrica*, May 1981, *49*, 781-793.

Day, Richard H. and Peter E. Kennedy, "Recursive Decision Systems: An Existence Analysis," *Econometrica*, September 1970, *38*, 666-681.

Deaton, Angus S. and John Muellbauer, *Economics and Consumer Behavior*, Cambridge: Cambridge University Press, 1980.

Deaton, Angus S. and John Muellbauer, "Functional Forms for Labor Supply and Commodity Demands with and without Quantity Restrictions," *Econometrica*, November 1981, *49*, 1521-1532.

DeCanio, Stephen J., "Rational Expectations and Learning from Experience," *Quarterly Journal of Economics*, February 1979, *93*, 47-57.

DeGroot, Morris H., *Optimal Statistical Decisions*, New York: McGraw-Hill, 1970.

Drazen, Allan, "Recent Developments in Macroeconomic Disequilibrium Theory," *Econometrica*, March 1980, *48*, 283-306.

Dreze, Jacques H., "Existence of an Exchange Equilibrium under Price Rigidities," *International Economic Review*, June 1975, *16*, 301-320.

Durbin, James, "Testing for Serial Correlation in Least-Squares Regression when Some of the Regressors are Lagged Dependent Variables," *Econometrica*, May 1970, *38*, 410-421.

Eaton, Jonathan and Richard E. Quandt, "A Model of Rationing and Labour Supply: Theory and Estimation," *Economica*, August 1983, *50*, 221-233.

Evans, Michael K., *Macroeconomic Activity. Theory, Forecasting, and Control. An Econometric Approach*, New York: Harper & Row Publishers, 1969.

Fair, Ray C. and Dwight M. Jaffee, "Methods of Estimation for Markets in Disequilibrium," *Econometrica*, May 1972, *40*, 497-514.

Fair, Ray C. and Harry H. Kelejian, "Methods of Estimation for Markets in Disequilibrium: A Further Study," Econometrica, January 1974, 42, 177-190.

Feige, Edgar L., "The Consequences of Journal Editorial Policies and a Suggestion for Revision," Journal of Political Economy, December 1975, 83, 1291-1295.

Friedman, Benjamin M., "Optimal Expectations and the Extreme Information Assumptions of 'Rational Expectations' Macromodels," Journal of Monetary Economics, January 1979, 5, 23-41.

Friedman, Milton, "The Methodology of Positive Economics," in M. Friedman, Essays in Positive Economics, Chicago: Chicago University Press, 1953.

Frydman, Roman, "Towards an Understanding of Market Processes: Individual Expectations, Learning, and Convergence to Rational Expectations Equilibrium," American Economic Review, September 1982, 72, 652-668.

Gale, Douglas, "Competitive Models with Keynesian Features," Economic Journal, Conference Papers, 1983, 93, 17-33.

Goldfeld, Stephen M. and Richard E. Quandt, Nonlinear Methods in Econometrics, Amsterdam: North-Holland Publishing Company, 1972.

Goldfeld, Stephen M. and Richard E. Quandt, "Estimation in a Disequilibrium Model and the Value of Information," Journal of Econometrics, November 1975, 3, 325-348.

Gordon, Robert J., "Output Fluctuations and Gradual Price Adjustment," Journal of Economic Literature, June 1981, 19, 493-530.

Gourieroux, Christian, Jean-Jacques Laffont, and Alain Monfort, "Disequilibrium Econometrics in Simultaneous Equations Systems," Econometrica, January 1980a, 48, 75-95.

Gourieroux, Christian, Jean-Jacques Laffont, and Alain Monfort, "Tests of the Equilibrium vs. Disequilibrium Hypotheses: A Comment," International Economic Review, February 1980b, 21, 245-247.

Grandmont, Jean-Michel, "Temporary General Equilibrium Theory," Econometrica, April 1977a, 45, 535-572.

Grandmont, Jean-Michel, "The Logic of the Fix-price Method," Scandinavian Journal of Economics, 1977b, 79, 169-186.

Grandmont, Jean-Michel and Guy Laroque, "On Temporary Keynesian Equilibria," Review of Economic Studies, February 1976, 43, 53-67.

Grossman, Herschel I., "Money, Interest, and Prices in Market Disequilibrium," Journal of Political Economy, September-October 1971, 79, 943-961.

Grossman, Herschel I., "Why Does Aggregate Employment Fluctuate?," American Economic Review, Papers and Proceedings, May 1979, 69, 64-69.

Grossman, Sanford J., "Equilibrium under Uncertainty and Bayesian Adaptive Control Theory," in R. Day and T. Groves, eds., Adaptive Economic Models, New York: Academic Press, 1975a.

Grossman, Sanford J., "Rational Expectations and the Econometric Modeling of Markets subject to Uncertainty," Journal of Econometrics, August 1975b, 3, 255-272.

Hahn, Frank H., "Exercises in Conjectural Equilibria," Scandinavian Journal of Economics, 1977, 79, 210-226.

Hahn, Frank H., "On Non-Walrasian Equilibria," Review of Economic Studies, February 1978, 45, 1-17.

Hahn, Frank H., "Discussion," in J. H. Kareken and N. Wallace, eds., Models of Monetary Economies, Minneapolis, MN.: Federal Reserve Bank of Minneapolis, 1980.

Hahn, Frank H., Money and Inflation, Oxford: Basil Blackwell, 1982.

Hart, Oliver, "A Model of Imperfect Competition with Keynesian Features," Quarterly Journal of Economics, February 1982, 97, 109-138.

Hartley, Michael J. and Parthasaradhi Mallela, "The Asymptotic Properties of a Maximum Likelihood Estimator for a Model of Markets in Disequilibrium," Econometrica, July 1977, 45, 1205-1220.

Hayek, Friedrich A. von, "Economics and Knowledge," Economica, February 1937, 4, 33-54.

Hayek, Friedrich A. von, "The Use of Knowledge in Society," American Economic Review, September 1945, 35, 519-530.

Heijdra, Ben J. and Anton D. Lowenberg, Why 'Micro' and 'Macro' in Economics?, mimeo, July 1983.

Helliwell, John F., Harold T. Shapiro, Gordon R. Sparks, Ian A.

Stewart, Frederick W. Gorbet and Donald R. Stephenson, The Structure of RDX2, Parts 1 and 2, Bank of Canada Staff Research Studies, No. 7, Ottawa: Bank of Canada, 1971.

Hendry, David F., "Econometrics - Alchemy or Science?," Economica, November 1980, 47, 387-406.

Hendry, David F. and Thomas von Ungern-Sternberg, "Liquidity and Inflation Effects on Consumers' Expenditure," in A. Deaton, ed., The Theory and Measurement of Consumer Behaviour, Cambridge: Cambridge University Press, 1981.

Hicks, John R., Capital and Growth, Oxford: Oxford University Press, 1965.

Hwang, Hae-Shin, "A Test of a Disequilibrium Model," Journal of Econometrics, April 1980, 12, 319-333.

Intriligator, Michael D., Econometric Models, Techniques, and Applications, Amsterdam: North-Holland Publishing Company, 1978.

Ito, Takatoshi, "Methods of Estimation for Multi-Market Disequilibrium Models," Econometrica, January 1980, 48, 97-125.

Ito, Takatoshi and Kazuo Ueda, "Tests of the Equilibrium Hypothesis in Disequilibrium Econometrics: An International Comparison of Credit Rationing," International Economic Review, October 1981, 22, 691-708.

Judge, George G., William E. Griffiths, R. Carter Hill, and Tsoung-Chao Lee, The Theory and Practice of Econometrics, New York: John Wiley & Sons, 1980.

Kawasaki, Seiichi, John McMillan, and Klaus Zimmermann, "Inventories and Price Inflexibility," Econometrica, May 1983, 51, 599-610.

Kennedy, Peter E., A Guide to Econometrics, Cambridge, Mass.: MIT Press, 1979.

Keynes, John Maynard, The General Theory of Employment, Interest, and Money, New York: Harcourt Brace, 1936.

Kirman, Alan P., "Learning by Firms about Demand Conditions," in R. Day and T. Groves, eds., Adaptive Economic Models, New York: Academic Press, 1975.

Kooiman, Peter, Using Business Survey Data in Empirical Disequilibrium Models, Working Paper of the Econometric Institute, Rotterdam: Erasmus University, March 1982.

Kooiman, Peter and Teun Kloek, An Aggregate Two Market Disequilibrium Model with Foreign Trade. Theory and Estimation with Dutch Postwar Data, Working Paper of the Econometric Institute, Rotterdam: Erasmus University, January 1980a.

Kooiman, Peter and Teun Kloek, The Specification of Spillovers in Empirical Disequilibrium Models, Report 8031/E of the Econometric Institute, Rotterdam: Erasmus University, December 1980b.

Kooiman, Peter and Teun Kloek, An Empirical Two Market Disequilibrium Model for Dutch Manufacturing, Working Paper of the Econometric Institute, Rotterdam: Erasmus University, April 1981.

Laffont, Jean-Jacques and Rene Garcia, "Disequilibrium Econometrics for Business Loans," Econometrica, July 1977, 45, 1187-1204.

Lakatos, Imre, "Falsification and the Methodology of Scientific Research Programmes," in J. Worrall and G. Currie, eds., Philosophical Papers of Imre Lakatos, Vol. 1: The Methodology of Scientific Research Programmes, Cambridge: Cambridge University Press, 1978.

Latsis, Spiro S., "A Research Programme in Economics," in S. J. Latsis, ed., Method and Appraisal in Economics, Cambridge: Cambridge University Press, 1976.

Leamer, Edward E., Specification Searches: Ad Hoc Inference with Nonexperimental Data, New York: John Wiley & Sons, 1978.

Leamer, Edward E., "Let's Take the Con out of Econometrics," American Economic Review, March 1983, 73, 31-43.

Lee, Lung-Fei and Robert H. Porter, "Switching Regression Models with Imperfect Sample Separation Information - With an Application on Cartel Stability," Econometrica, March 1984, 52, 391-418.

Leijonhufvud, Axel, "Keynes and the Keynesians: A Suggested Interpretation," American Economic Review, Papers and Proceedings, May 1967, 57, 401-410.

Leijonhufvud, Axel, On Keynesian Economics and the Economics of Keynes, Oxford: Oxford University Press, 1968.

Leijonhufvud, Axel, Keynes and the Classics. Two Lectures on Keynes' Contribution to Economic Theory, London: Institute of Economic Affairs, 1969.

Leijonhufvud, Axel, "Schools, 'Revolutions', and Research

Programmes in Economic Theory," in S. J. Latsis, ed., Method and Appraisal in Economics, Cambridge: Cambridge University Press, 1976.

Lenderink, Ruud S. G. and Jan C. Siebrand, A Disequilibrium Analysis of the Labour Market, Rotterdam: Rotterdam University Press, 1976.

Lewis, Geoffrey, "The Phillips Curve and Bayesian Learning," Journal of Economic Theory, April 1981, 24, 240-264.

Lovell, Michael C., "Data Mining," Review of Economics and Statistics, February 1983, 65, 1-12.

Lowenberg, Anton D., An Approach to the Modeling of Canadian Foreign Trade: Canada and a World Trade Model, Unpublished M. A. Project, Simon Fraser University, April 1981.

Lucas, Robert E., "Econometric Policy Evaluation: A Critique," in R. E. Lucas, Studies in Business-Cycle Theory, Cambridge, Mass.: MIT Press, 1981.

Lucas, Robert E. and Leonard A. Rapping, "Real Wages, Employment, and Inflation," in E. S. Phelps et al., eds., Microeconomic Foundations of Employment and Inflation Theory, New York: W. W. Norton & Company, 1970.

Maddala, G. S., Econometrics, Tokyo: McGraw-Hill Kogakusha, 1977.

Maddala, G. S. and Forrest D. Nelson, "Maximum Likelihood Methods for Models of Markets in Disequilibrium," Econometrica, November 1974, 42, 1013-1030.

Malinvaud, Edmond, The Theory of Unemployment Reconsidered, Oxford: Basil Blackwell, 1977.

Malinvaud, Edmond, "Econometrics faced with the Need of Macroeconomic Policy," Econometrica, November 1981, 49, 1363-1375.

Mayer, Thomas, "Economics as a Hard Science: Realistic Goal or Wishful Thinking?," Economic Inquiry, April 1980, 18, 165-178.

Mizon, Grayham E. and David F. Hendry, "An Empirical Application and Monte Carlo Analysis of Tests of Dynamic Specification," Review of Economic Studies, January 1980, 47, 21-45.

Muellbauer, John and Richard Portes, "Macroeconomic Models with Quantity Rationing," Economic Journal, December 1978, 88, 788-821.

Neary, J. Peter and Joseph E. Stiglitz, "Toward a Reconstruction of Keynesian Economics: Expectations and Constrained Equilibria," Quarterly Journal of Economics, Supplement, 1983, 98, 199-228.

Negishi, Takashi, "Monopolistic Competition and General Equilibrium," Review of Economic Studies, 1960-1961, 28, 196-201.

Negishi, Takashi, Microeconomic Foundations of Keynesian Macroeconomics, Amsterdam: North-Holland Publishing Company, 1979.

Nerlove, Marc, "Lags in Economic Behavior," Econometrica, March 1972, 40, 221-251.

Neufeld, Edward P., The Financial System of Canada: Its Growth and Development, Toronto: Macmillan, 1972.

Oksanen, Ernest H. and Byron G. Spencer, "Testing an Aggregate Consumption Model for Canada," Canadian Journal of Economics, February 1972, 5, 96-109.

Oswald, Andrew J., "The Microeconomic Theory of the Trade Union," Economic Journal, September 1982, 92, 576-595.

Patinkin, Don, Money, Interest, and Prices. An Integration of Monetary and Value Theory, New York: Harper and Row Publishing Company, 1956.

Peeters, Marcel G. C. M., Keynesian Unemployment and Inflation, Report 8303/G of the Institute for Economic Research, Rotterdam: Erasmus University, January 1983a.

Peeters, Marcel G. C. M., Keynesian Phenomena in a Sequence Economy: Unsatisfactory Equilibria and the Real Balance Effect, Unpublished paper, April 1983b.

Pesaran, M. H., "On the General Problem of Model Selection," Review of Economic Studies, April 1974, 41, 153-171.

Pesaran, M. H., "Comparison of the Local Power of Alternative Tests of Non-Nested Regression Models," Econometrica, September 1982, 50, 1287-1305.

Pesaran, M. H. and Angus S. Deaton, "Testing Non-nested Nonlinear Regression Models," Econometrica, May 1978, 46, 677-694.

Prescott, Edward C. and Robert M. Townsend, "Equilibrium under Uncertainty: Multiagent Statistical Decision Theory," in A. Zellner, ed., Bayesian Analysis in Econometrics and Statistics, Amsterdam: North-Holland Publishing Company, 1980.

Quandt, Richard E., "Tests of the Equilibrium vs. Disequilibrium Hypotheses," International Economic Review, June 1978, 19, 435-452.

Romer, David, "Rosen and Quandt's Disequilibrium Model of the Aggregate Labor Market," Review of Economics and Statistics, February 1981, 63, 145-146.

Rosen, Harvey S. and Richard E. Quandt, "Estimation of a Disequilibrium Aggregate Labor Market," Review of Economics and Statistics, August 1978, 60, 371-379.

Rothenberg, Thomas J., "The Bayesian Approach and Alternatives in Econometrics - II," in M. D. Intriligator, ed., Frontiers of Quantitative Economics, Amsterdam: North-Holland Publishing Company, 1971.

Rothenberg, Thomas J., "Comment," Journal of the American Statistical Association, September 1979, 74, 648-649.

Salmon, Mark, "Error Correction Mechanisms," Economic Journal, September 1982, 92, 615-629.

Sargan, John D., "Wages and Prices in the United Kingdom: A Study in Econometric Methodology," in P. E. Hart, G. Mills, and J. K. Whitaker, eds., Econometric Analysis for National Economic Planning, London: Butterworths, 1964.

Siebrand, Jan C., Towards Operational Disequilibrium Macroeconomics, The Hague: Martinus Nijhoff, 1979.

Sims, Christopher A., "Macroeconomics and Reality," Econometrica, January 1980, 48, 1-49.

Smith, V. Kerry, Monte Carlo Methods: Their Role for Econometrics, Lexington, Mass.: D. C. Heath & Company, 1973.

Sneessens, Henri R., Theory and Estimation of Macroeconomic Rationing Models, Berlin: Springer Verlag, 1981.

Statistics Canada, National Income and Expenditure Accounts, 1926-1974, Vol. 2: The Annual Estimates, (Catalogue 13-531), Ottawa: Information Canada, March 1976.

Statistics Canada, The Statistics Canada Quarterly Econometric Model of the Canadian Economy, Econometrics Section of the Current Economic Analysis Division, Ottawa: Statistics Canada, January 1978a.

Statistics Canada, Fixed Capital Flows and Stocks, 1926-1978, (Catalogue 13-568), Ottawa: Minister of Industry, Trade and Commerce, October 1978b.

Statistics Canada, Fixed Capital Flows and Stocks, 1982, (Catalogue 13-211), Ottawa: Minister of Supply and Services, August 1982.

Statistics Canada, Historical Statistics of Canada, Second Edition, Ottawa: Minister of Supply and Services, 1983a.

Statistics Canada, Historical Labour Force Statistics: Actual Data, Seasonal Factors, Seasonally Adjusted Data, 1982, (Catalogue 71-201), Ottawa: Minister of Supply and Services, January 1983b.

Statistics Canada, Consumer Prices and Price Indexes, October-December 1982, Ottawa: Minister of Supply and Services, March 1983c.

Statistics Canada, National Income and Expenditure Accounts, 1968-1982, (Catalogue 13-201), Ottawa: Minister of Supply and Services, November 1983d.

Swamy, P. A. V. B. and J. S. Mehta, "Bayesian and Non-Bayesian Analysis of Switching Regressions and of Random Coefficient Regression Models," Journal of the American Statistical Association, September 1975, 70, 593-602.

Thomas, J. J., "The Reporting of Empirical Work in Economics," Applied Statistics, 1967, 16, 172-176.

Tsurumi, Hiroki, "A Survey of Recent Canadian Macro-Econometric Models," Canadian Journal of Economics, August 1973, 6, 409-428.

Turnovsky, Stephen J., "A Bayesian Approach to the Theory of Expectations," Journal of Economic Theory, August 1969, 1, 220-227.

Varian, Hal R., Microeconomic Analysis, New York: W. W. Norton & Company, 1978.

Wallis, Kenneth F., Topics in Applied Econometrics, Second Edition, Oxford: Basil Blackwell, 1979.

Wold, Herman O. A., "A Fix-point Theorem with Econometric Background," Arkiv for Matematik, January 1966, 6, 209-241.

Yatchew, Adonis J., "Further Evidence on 'Estimation of a Disequilibrium Aggregate Labor Market'," Review of Economics and Statistics, February 1981, 63, 142-144.

Zarnowitz, Victor, "On the Accuracy and Properties of Recent

Macroeconomic Forecasts," _American Economic Review, Papers and Proceedings_, May 1978, _68_, 313-319.

Zellner, Arnold, _An Introduction to Bayesian Inference in Econometrics_, New York: John Wiley & Sons, 1971a.

Zellner, Arnold, "The Bayesian Approach and Alternatives in Econometrics - I," in M. D. Intriligator, ed., _Frontiers of Quantitative Economics_, Amsterdam: North-Holland Publishing Company, 1971b.

Zellner, Arnold, "Statistical Analysis of Econometric Models," _Journal of the American Statistical Association_, September 1979, _74_, 628-643.