Lecture Notes in
Economics and
Mathematical Systems 475

Leo Kaas

Dynamic Macroeconomics with Imperfect Competition

Springer

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Library of Congress Cataloging-in-Publication Data

Kaas, Leo, 1969-
Dynamic macroeconomics with imperfect competition / Leo Kaas.
p. cm. -- (Lecture notes in economics and mathematica systems ; 475)
Includes bibliographical references (p.).
ISBN 3-540-66029-1 (softcover :alk. paper)
1. Competition, Imperfect--Mathematical models.
2. Macroeconomics--Mathematical models. 3. Equilibrium (Economics)--Mathematical models. I. Title. II. Series.
HB238.K33 1999
338.6'048--dc21 99-34450
CIP

ISSN 0075-8442
ISBN 3-540-66029-1 Springer-Verlag Berlin Heidelberg New York

Typesetting: Camera ready by author
SPIN: 10699851 42/3143-543210 - Printed on acid-free paper

Preface

This thesis was stimulated throughout the time of my participation in a research project on Dynamic Macroeconomics, supported by the German Research Foundation (DFG). The starting point was the central question of how to integrate price setting firms in a dynamic disequilibrium model. Almost all recent literature on imperfect competition in macroeconomics applies the *objective demand* approach by assuming that firms know the true demand curve they are faced with. While this approach can be applied in temporary monetary equilibrium models, it proves inadequate for formulating price adjustment in a dynamic disequilibrium model, where it has to be replaced by the concept of *subjective demand.* Based on this distinction, the thesis starts out with a comparison of the concepts of subjective and objective demand in an abstract framework and surveys the literature on general equilibrium theory with imperfect competition. The objective demand approach is criticized not only on the grounds of its strong rationality requirements and existence problems, but also by the observation that it cannot be applied successfully to characterize determinate rational expectations equilibria in intertemporal macroeconomics. Finally, price setting firms using subjective demand functions are integrated in a dynamic disequilibrium model in order to study monopolistic and oligopolistic price adjustment.

In May 1998, this thesis was submitted as a dissertation at the Department of Economics of the University of Bielefeld. At this point, I would like to thank both my supervisors, Prof. Volker Böhm and Prof. Thorsten Hens, for many helpful discussions, stimulations and their criticisms

throughout all stages of research and completion. I am particularly grateful to Prof. Paul Madden, Prof. Neil Rankin, and Prof. Claus Weddepohl for valuable comments on previous working paper versions. I am also very grateful to Prof. Gerd Weinrich for helpful comments on this thesis. Parts of the thesis have been presented at workshops and conferences in Berne, Bielefeld, Oxford, Toulouse, and Vienna, whose participants I would like to thank for their feedback. Finally, I thank my former colleagues Nicole Deutscher, Eckart Jäger, Jens-Ulrich Peter, and Dr. Matthias Raith for their careful proof-reading and for useful remarks, and Uli Middelberg for his indispensable computer support. Of course, all remaining errors are my own.

Vienna, October 1998

Contents

Chapter 1

Introduction

> *"Clearly, product markets, as well as labor markets, should be modeled as imperfectly competitive."*
>
> J. Tobin (1993)

Nowadays almost all of macroeconomic theory is based on microeconomic foundations. It is the widespread opinion that a full understanding and explanation of macroeconomic phenomena like inflation, unemployment, growth, and the business cycle require a model in which economic decision units and their interaction are described explicitly. Only models with a microeconomic foundation are immune to criticism concerning "ad hoc"–assumptions of macroeconomic relationships, and only these models allow an assessment of welfare effects of policy measures.

In the 1970's, the development of macroeconomics with microeconomic foundations followed two important branches. On the one hand, Neo–Keynesian macroeconomic models[1] were introduced by Barro & Grossman (1971), Benassy (1975), and Malinvaud (1977). They follow the

[1]The term "Neo–Keynesian" was introduced by Benassy (1975). Other expressions are "disequilibrium theory" or "fixprice theory".

idea that prices are fixed in the short–run, and that trade takes place at non–Walrasian prices. The major advantage of this approach is first, that it provides a description of the concepts of the Keynesian effective demand and the multiplier in a consistent microeconomic framework, and second, that it allows a classification of different types of unemployment, Keynesian or Classical. On the other hand, New Classical models (e.g. Lucas (1972), and later the RBC literature) assume that prices in competitive markets adjust continually to equilibrate supply and demand. A fundamental principle is the hypothesis of rational expectations which claims that agents' forecasts of their future economic environment are not subject to systematic errors. According to this view, persistent unemployment is a structural phenomenon which cannot be fought by economic policy. For a detailed and critical exposition of both directions of research, refer to Felderer & Homburg (1987), for example.

In the past two decades, important efforts have been made to improve and to bring together these approaches of macroeconomic theory. Most of the relevant literature, commonly summarized under the heading of "New Keynesian macroeconomics,"[2] follows the New Classical hypothesis of rational expectations, but deviates in one way or another from the paradigm of market efficiency by assuming market imperfections of one form or another.[3] The most important imperfection is the assumption of imperfect competition in labor or output markets.[4]

There were early studies incorporating imperfectly competitive agents in a macroeconomic model by Benassy (1977) and Negishi (1979). Their models adopted the so–called "subjective demand approach" which

[2]Dixon & Rankin (1995) prefer the expression "New Macroeconomics", since these models need not necessarily have Keynesian features.

[3]Mankiw (1990) goes so far as to claim that "*the axiom of rational expectations is as firmly established in economic methodology as the axioms that firms maximize profit and households maximize utility.*"

[4]Others are implicit wage contracts, efficiency wages, or credit market imperfections. For surveys and references, see Mankiw & Romer (1991), Mankiw (1990), and Dixon & Rankin (1995).

claims that price–setting agents have a subjective perception of their demand curve which passes through the equilibrium price/quantity–pair but is arbitrary beyond the equilibrium. Since this high degree of arbitrariness leads to a large number of possible equilibrium allocations, and since subjective demand perceptions have been criticized for not being "perfectly rational", the whole subjective demand approach has been abandoned. A breakthrough has been achieved by various studies applying the "objective demand approach" in macroeconomic general equilibrium models. The basic idea is that imperfectly competitive agents know the "true" demand curve of the competitive sector of the economy. The articles of Hart (1982) and Blanchard & Kiyotaki (1987) have been most influential in this direction. They contain static models incorporating money[5] as argument in the utility function, which describe equilibrium situations where firms are imperfect competitors on the output market, while unions or workers are imperfect competitors on the labor market. Clearly, such equilibria are typically inefficient with an output level below the perfectly competitive one, and they may display involuntary unemployment. These models share some Keynesian as well as Classical features in the sense that fiscal policy can raise the output, while monetary policy is neutral, as long as real money balances enter the utility function.[6]

More recent work has focused on intertemporal macroeconomics with imperfect competition. In some models, price setters face price adjustment costs and have to decide on the optimal timing and level of price changes (Ball & Romer (1989)). Other models incorporate imperfect competition in OLG models (Schultz (1992)), RBC models (Rotemberg & Woodford (1992)), and in models of endogenous growth (Romer (1990)). All of these have in common that they restrict attention to rational expectations equilibria.

[5]Hart refers to a "nonproduced good" instead of "money".

[6]This corresponds to unit–elastic price expectations in an underlying temporary equilibrium model.

Dixon & Rankin (1995) emphasize the "*coherence of the New Macroeconomics,*" and indeed it appears to be one of the major contributions of microeconomic foundations to have established a broad consensus among macroeconomic theorists. However, there are two important objections against the recent contributions to intertemporal macroeconomics with imperfect competition.

First, there is an objection from a purely microeconomic perspective concerning static as well as dynamic models.[7] Most of the work mentioned above is confined to specific parameterizations of technologies and preferences. While this may be a useful guideline for didactic purposes, it must be emphasized that a general theory - even for the simplest types of macroeconomic models - cannot be developed since an equilibrium with objective demand need not exist.[8] Since the early 1960s, much effort has been undertaken to extend the Arrow–Debreu general equilibrium model to imperfect competition. However, various complications in these models led Bonanno (1990) to emphasize that "*unfortunately we are still far from a satisfactory theory of general equilibrium with imperfect competition.*" At any rate, the whole theory of macroeconomics with imperfect competition is very wobbly on its microeconomic legs. One might argue that such objections are irrelevant for macroeconomists who are primarily interested in simple models suited for econometric tests.[9] But from a theoretical perspective the whole microeconomic "foundation" must be questioned if it rests on such specific assumptions.

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[7]Another important microeconomic objection, which concerns almost all of macroeconomics with microeconomic foundations, but which will not be discussed further in this thesis, can be raised against the "representative agent approach." For an exposition of this problem, see Kirman (1992).

[8]Hart (1982) is well aware of these problems when he remarks that "*generalizing the model could be hard. For this reason, the analysis presented here should be considered more as an extended example than as a general model.*"

[9]Such an argument corresponds to Friedman's (1953) methodological position which judges economic models by its predictions instead by the realism and generality of its assumptions.

Second, almost all of the literature on intertemporal macroeconomics with imperfect competition restricts the analysis to rational expectations equilibria. One of the most popular arguments in favor of the assumption of rational expectations is the following: if the implications of certain imperfections in the economy were to be analyzed, one should keep the model free from other imperfections like non–rational expectations, for instance. Thus, rational expectations are, even though often unrealistic, understood as an idealization of the expectation formation processes of the economic agents. Nevertheless, it must be emphasized that rational expectations should appear as a special case of a dynamic economic process in which agents form expectations on the basis of the past.[10] In such a framework it should be possible to study the dynamics under learning of "boundedly rational" agents, and it should be verifiable whether such dynamics converge to a rational expectations equilibrium or not. However, it is not at all clear how such processes can be formulated in these models.

There are different possibilities to frame a dynamic macroeconomic model. The most obvious one to most economists is to apply the temporary equilibrium method as introduced by Hicks (1946) and developed in full rigor by Grandmont (1983). The general idea of this approach is to assume a dynamic economy where trade takes place sequentially in periods ("weeks" in the exposition of Hicks). At the beginning of each period (on Hicks' "Monday"), an adjustment in prices or quantities converges to a temporary equilibrium, in which the prevailing prices and trade contracts are determined for the rest of the period. This process of adjustment to the temporary equilibrium is not modeled explicitly, and it is assumed to take place infinitely fast. In other words, a temporary equilibrium is established immediately in each period. Agents form expectations using only information from the past, so that expectations need not be fulfilled.

[10] A general setting, in which this problem can be formulated, has been introduced by Böhm & Wenzelburger (1995).

The special case where expectations are realized may be called *intertemporal equilibrium* or, in Hicks' notion, *equilibrium over time.* Given a specific forecast rule of the agents, sequences of temporary equilibria can be generated as solutions of a well–defined dynamical system only if the existence of a temporary equilibrium is guaranteed *for all* variables predetermined in the past. Since it is also desirable to formulate such a dynamic process under different specifications of the forecast behavior, existence of temporary equilibria has moreover to be guaranteed for *arbitrary* specifications of the agents' forecast rules.

In the case where all agents are price–takers, Grandmont (1982) distinguishes between two main temporary equilibrium concepts. On the one hand, there is a temporary Walrasian equilibrium, in which prices are flexible and a competitive equilibrium on all spot markets is established in each period. The main weakness of this equilibrium is that its existence depends on the way agents form their expectations. More precisely, only if price expectations are bounded above and below can existence be guaranteed (see Grandmont (1983)). On the other hand, in a temporary equilibrium with quantity rationing, prices are fixed and trade takes place at a fixprice equilibrium, as defined by Drèze (1975) and Benassy (1975). While here existence of equilibria can be proven for all strictly positive price vectors and for arbitrary continuous forecast functions (cf. Benassy (1982), Chapter 8), these models have been criticized since the assumption of price rigidity and the formation of prices lack a microeconomic foundation.[11]

Under imperfect competition, a temporary equilibrium can be defined as an equilibrium with objective demand in a single period.[12] Temporary equilibrium models, which are related to the static model of Hart (1982), have been formulated by Dehez (1985), D'Aspremont, Dos Santos Fer-

[11] Of course, the second criticism affects also the concept of a competitive equilibrium. See the critique of Arrow (1959).

[12] A temporary equilibrium with subjective demand has been defined by Benassy (1982), Chapter 9.

reira & Gérard-Varet (1989) and Rankin (1992). An important feature of such models is that a characterization of intertemporal equilibria leads to unavoidable problems of indeterminacy. In particular, it turns out that there is typically a continuum of stationary equilibria. Such results have first been established by Rankin (1992) and they will be further elaborated in this thesis. Because of this indeterminacy, there is a particular need for a selection among these equilibria by learning dynamics. However, these dynamics can only be formulated if temporary equilibria exist for some specific learning scheme of the agents. As pointed out above, existence of an equilibrium with objective demand is problematic even in the static case, and one can expect that the situation gets worse in the temporary equilibrium case where expectation effects also play an important role.[13] Thus, the approach of temporary equilibria with objective demand does not seem to be appropriate for the study of dynamic macroeconomics with imperfect competition.

In order to describe a globally defined dynamic process, it seems necessary to abandon the idea that in each period an infinitely fast adjustment to an equilibrium takes place, and instead to formulate such an adjustment process explicitly. There are many different ways to model the adjustment process, as there are many different concepts of equilibrium with imperfect competition. In any case, an equilibrium should appear as a stationary state if we presume a more or less plausible learning process of the agents. For example, one may think of a process, in which firms choose their output level in advance and let an auctioneer determine the market clearing prices. If the observed price differs from a firm's expected price, it will alter its demand expectations. Intuitively, one would suspect that a Cournot equilibrium is a stationary state of this process. However, as the literature on learning in oligopoly[14] has shown, this is only one particular outcome. Moreover, a "*situation which is not a so-*

[13] Böhm & Naeve (1995) give an example of an economy where this problem arises even if there are no such expectation effects.

[14] Cf. e.g. the survey of Kirman (1995).

lution of the 'true model' but which is self-sustaining" (Kirman (1995)), or in other words an equilibrium with subjective demand, may also be a stationary state. Which equilibrium will eventually be attained, depends on the initial information and the learning process of firms, but it cannot be guaranteed that such a process converges to an equilibrium with objective demand.

In this thesis different concepts of equilibrium and dynamics in models with imperfect competition are examined. This will be done first in a static general equilibrium setting, and then in the framework of intertemporal macroeconomic models. In such models two different approaches will be contrasted, one describing sequences of temporary equilibrium with objective demand, and one in which the learning process of price–setting firms is incorporated in a dynamic model.

In detail this thesis is organized as follows:

Chapter 2 introduces a general framework which describes the interaction of agents in a dynamic model, and which allows a characterization of different equilibrium concepts as stationary states of such a dynamic process. Agents decide on their actions in each period, and they have to form expectations about the influence of their actions on payoffs. A *subjective equilibrium* is defined by a stationarity condition and by a perfect foresight condition on these expectations of agents. An *objective equilibrium* is a special case where the additional restriction on the agents' expectations is imposed that agents make no forecast errors if they deviate from their optimal decision. However, this requirement is only hypothetical and cannot be deduced from a perfect foresight condition on the expectations of agents.

In Chapter 3, this framework will be applied to general equilibrium models in which firms are imperfect competitors. This will allow a direct comparison of different equilibrium concepts in the literature with objective and subjective demand. In all these models, subjective equilibria are indeterminate due to arbitrary specifications of perceived demand

curves, while objective equilibria exist only under strong assumptions on the economy. In Section 3.2 models with quantity competition are presented. The formulation is more general than usual in the literature by including the cases where firms take the prices of some "competitive goods" or the income of consumers as given. Section 3.3 considers general equilibrium models with price competition, in which firms set some prices under their control. They are distinguished between models where firms serve all the demand addressed to them, and others where firms are able to ration their consumers.

Chapter 4 considers more specific macroeconomic models with an OLG structure following the usual approach of temporary equilibrium with objective demand. The purpose of this chapter is to show that this approach is not capable of characterizing determinate intertemporal equilibria in which agents make no forecast errors. Instead, such equilibria are highly indeterminate, and there exists in particular a continuum of stationary states. In 4.2 the basic concepts of a temporary and an intertemporal equilibrium are introduced. It is essential to make a distinction between *perfect foresight equilibria* in which agents make no forecast errors along the equilibrium path and the refinement of *rational expectations equilibria* where agents also make no forecast errors off the equilibrium path. Section 4.3 shows indeterminacy of perfect foresight equilibria and the existence of involuntary unemployment in an OLG version of the model of Hart (1982). Section 4.4 shows that such indeterminacy results in general are not due to the weaker notion of perfect foresight equilibria, but that they are also valid under rational expectations. This will be illustrated in two examples.

Chapter 5 considers a macroeconomic model which is similar to that of the previous chapter, but follows a novel and strictly dynamic approach by avoiding any usage of equilibrium concepts, neither temporary nor intertemporal. Instead, in each period the labor and the goods market open sequentially, which forces firms to decide on their goods supply