NON-RENEWABLE RESOURCES AND DISEQUILIBRIUM MACRODYNAMICS

Robert Marks

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ROBERT MARKS

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Preface

Robert Marks's book provides a full and careful analysis of an economy in which there are three markets—for labor, for energy and for produced output —whose prices are given and, at least temporarily, fixed. In consequence, some actions are impossible, even if they are desirable and feasible in budgetary terms: at these prices, some buyers may be unable to buy as much as they would like and can afford, and some sellers may be unable to sell as much as they would like and can produce. Even so, some kind of order is possible, and the job of the economist is to describe the possibilities.

Those unsatisfied demands and frustrated supplies will no doubt put some pressure on "fixed" disequilibrium prices, and eventually they may move. They may even move in the general direction of conventional supply--equals--demand equilibrium, though we do not know that. Nevertheless, if prices adjust slowly, real economies will spend a lot of time in disequilibrium situations, with some unsatisfied buyers and sellers, and analysis like that in this book will be useful in understanding what is going on.

I think that is the case, and I thought so in the 1970s when "disequilibrium" economics of this kind captured the interest and imagination of economists, including obviously Robert Marks. I thought it was a mistake when that interest dwindled, and little or no further development occurred. Why was that? Well, prices are not fixed. Disequilibrium theory needed to be completed by a theory of slow price-- change. But that is a tall order, and even more difficult in a model world in which there are latent ("notional") demands and supplies not easily expressed. That theory has not yet appeared. In addition, the fashion in economics was swinging toward more optimistic equilibrium--based versions of macroeconomics. (Opinions differ about whether that was such a good idea.) And there may have been other reasons; lines of causation in intellectual history are not usually very clear.

In any case, here is Marks's work revived, and at a time when the energy sector of the economy carries a lot of interest. Between climate change and the need to reduce the burning of fossil fuels on one side, and the uncertain development of renewable energy sources on the other side, here at least is an economic model that aims to deal with disequilibrium in energy markets.

Professor Emeritus Robert M. Solow, Nobel Laureate,
Massachusetts Institute of Technology, Cambridge, Mass.
14 April 2017

Introduction to the 2017 re-issue

As Professor Emeritus Robert M. Solow remarks in the Preface, there are fashions in economic theory. In the 1970s and early 1980s, a number of theorists, starting with Barro and Grossman (1971), began to examine general-equilibrium models that included non- market-clearing exchange. The motivation for this was that prices do not move instantaneously from one full-employment equilibrium position to another, while trade nonetheless occurs in the meantime. As my dissertation explores, allowing economic agents to buy and sell at non-market-clearing prices (or before prices have adjusted to equilibrium, if they ever do), leads to separate regimes, characterised by whether each market is a buyers' (excess supply) or a sellers' (excess demand) market. A macro model with three markets — two inputs, labour N and resource (energy) R, and one output Y — results in eight possible regimes, as outlined in Table 3.1 in the dissertation.

An agent's behaviour in one market may be constrained by the states of the other two markets he is trading in. These spillovers mean that the comparative statics of these regimes differ, so that it is not possible for agents in a constrained market to choose their position on a choice-theoretic supply or demand function.

In a survey of New Keynesian Economics published in 1990, twelve years after this dissertation was finished, Gordon (1990) remarks that: "An interesting aspect of recent U.S. new-Keynesian research is the near-total lack of interest in the general equilibrium properties of non-market-clearing models." In the U.S. "that effort is viewed as having reached a quick dead end after the insights yielded in the pioneering work" of Barro and Grossman (1971, 1976), building on the earlier contributions of Patinkin (1965), Clower (1965), and Leijonhufvud (1968).

Gordon explains this lack of interest as the consequence of a research focus, instead, on explaining sticky wages and/or prices by combining rational expectations with maximizing behaviour at the level of the individual agent. As he puts it, "Any attempt to build a model based on irrational behaviour or sub-optimal behaviour is viewed as cheating." U.S. theorists, he says, believed that it was premature to examine the broader theoretical considerations of

non-market-clearing trading before the partial equilibrium problems of sticky prices are solved. Another fashion?

Forty years later, the profession understands, from behavioural economics, that irrational expectations and non-optimal behaviour are widespread, and partial equilibrium models incorporating these are emerging. But the results from the work on non-market- clearing exchange from forty years ago has not been revisited and insights from this work have been lost; no general-equilibrium models, such as the model presented in this work, have been developed recently.

Following Barro and Grossman's work, the line of research evolved in the hands of Malinvaud (1977), Mueller and Portes (1978), Benassy (1975), Grandmont (1982) and Marks (1979, 1983). Almost all of these researchers are Europeans, even if they studied at U.S. universities. But in treating this line of research with disdain (in Gordon's words), and instead focussing on the "micro foundations models as the prerequisite for macro discourse," U.S. theoreticians have, argues Gordon, overlooked the central message of the non-market-clearing trade models, which is that the failure of one market to clear imposes spillover constraints on agents in other markets.

For example, when firms in a recession experience a fall in sales at the going price, this excess supply of output spills over into a fall in labour demanded at the going real wage and a fall in resource (energy) demanded at the going real price of resource (energy). (Assuming zero short-run elasticity of substitution of resource for labour in production.)

In such a model, agents are not in a position to choose the amount they work or produce as output varies over the business cycle, and so the constrained amount that they do work or produce cannot be interpreted as tracing movements along a choice-theoretic labour supply curve or production function. This also holds for the suppliers of resource in our model with three markets.

Traditional theory holds that prices adjust quickly to excess supplies or demands, resulting in the rapid disappearance of any disequilibrium. But Leijonhufvud [1968] and Malinvaud [1977] questioned the adequacy of this theory in describing the short-run behaviour of modern market economies. The work below is my contribution to studies on the consequences of relaxing the assumption of rapid price adjustment.

The model includes three markets (for output, labour, and resource flow), with the assumption that quantity adjustment in each market in response to unbalanced supply and demand is much more rapid than price adjustment: in his survey of temporary general equilibrium theory, Grandmont (1982) characterises this kind of model as an example of "temporary equilibrium with quantity rationing," since adjustments take place in every period at least partially by quantity rationing. (Solow and Stiglitz [1968] describe a model in which quantity and price adjustments occur at comparable speeds.) In Chapter 3, we do not consider price adjustment, but treat prices as given: the speed of adjustment of prices in response to excess demand or supply can be

thought of as being imperceptible in the period under analysis. (The analysis resembles that of the "fix-price" method of Hicks' [1965].)

The purpose of this model was to develop a "quasi-equilibrium" where real prices were constant, while nominal prices changed, in order to model a market for non- renewable (exhaustible) energy — such as oil. The Hotelling criterion (Hotelling 1931) was another fashion in economic theory, overtaken perhaps by concern about the finite nature of the natural environment to absorb the by-products of the combustion of fossil fuels for energy.

Clower [1965] and Barro and Grossman [1971, 1976] built models which relax the assumption of market-clearing exchange, that the amount supplied or demanded ex ante by each economic agent at the going price in each market equals ex post the actual amount traded. Exchange can occur at "false," or non-market-clearing prices. This relaxation means, first, that quantities traded cannot be determined simply by reference to market-clearing conditions (rather, the actual trading process must be examined), and, second, that agents will in general be constrained in any market by conditions they experience in other markets: their demand (and supply) functions will no longer be unconstrained, notional schedules, but will be constrained, effective schedules (Clower [1965]), and quantities will be rationed.

There is no reason to expect that the effective schedules of any agent constrained in different markets will be mutually consistent: in an economy with rationing, ex ante supplies and demands are tentative, and it is no longer optimal for the agent to determine all his schedules at a stroke. Following Benassy [1975], we let the effective demand (supply) schedule of an agent in a market be the demand (supply) he will choose by maximizing his expected utility or profit subject to his budget constraint and to the quantity constraints he perceives in the other markets: he does not take into account any constraints he might experience in the market considered.

There is thus a coordination problem: in aggregating individual schedules, we need to build a model in which there is consistency among individual actions. Malinvaud [1977] argues that there are three general properties necessary for the existence of quasi- equilibrium, in which for the given real prices quantities have no further tendency to move. First, trades balance: for each good the sum of purchases equals the sum of sales. Second, there is no involuntary exchange: no agent is forced to buy more than he demands or to sell more than he is willing to supply. Given the second property, an agent will be in one of four mutually exclusive states in a market: he will be a constrained (unconstrained) buyer if his demand exceeds (equals) his purchases; he will be a constrained (unconstrained) seller if his supply exceeds (equals) his sales. Third, there cannot exist both a constrained buyer and a constrained seller in the same market, for, were this the case, each would be able to make an advantageous trade. That is, there is one and only one market for each commodity, and all agents have free access to this market.

Given these three properties, the target amount traded in any market will be determined by the "short" side of the market (that is, it will equal the

lesser of the amounts supplied and demanded), and agents on the "long" side of the market will be constrained in their transactions, implying some means of rationing. The market for any commodity is then in one of three states: it can be balanced (with clearing and no rationing), or a sellers' market (with constrained buyers), or a buyers' market (with constrained sellers). We assume that the pattern of rationing does not affect the aggregate levels of the effective demands and supplies in the economy. (With this assumption and those of fixed supply of labour and of resource flow, we sidestep the conclusions of Hildenbrand and Hildenbrand [1978] that there is no sound foundation for the non- market-clearing comparative statics propositions derived by Malinvaud [1977].)

We assume that there is no inventory accumulation. (Blinder [1981] and Green and Laffont [1981] discussed the implications of this for non-market-clearing analysis.) Further, we assume that costs of quantity adjustment are zero, which excludes the possibility of levels of output or inputs independent of prices or sales: firms set output to be equal to sales at all times and minimize the costs of the input factors given this level of output.

There are different responses in the level of employment across the regimes. From Table 3.5 we see that a rise in the real resource (energy) price will tend to decrease employment in the regime SC (Malinvaud's "classical unemployment"), but will tend to increase employment in the regime DC (Malinvaud's "Keynesian unemployment") (at least for Cobb-Douglas technology); it will not affect employment in any other regime. (See Table 3.1 for the regime definitions.) (Malinvaud [1977] claims that this distinction was responsible for much confusion in the policy debates of the 'thirties.) In an extension of Chapter 3, Marks (1983, Table 3) shows that a fall in resource (energy) supply will tend to reduce employment in regime RC, to increase it in regime DRC, while not affecting it in other regimes; and a fall in autonomous demand for output will tend to reduce employment in regimes DC and DRC, but will not affect it in other regimes.

In Chapter 4, the dissertation does allow nominal prices to respond to unbalanced supply and demand in a closed economy, by extending the model to include Walrasian price adjustment using two possible formulations; Solow [1980] does this for an economy with completely elastic resource supply. In Chapter 5, we explore expectations of prices, the supply of resources (energy), and the Hotelling principle.

In a paper examining the implications of different assumptions concerning the relative speeds of price and quantity adjustment in the output and labour markets, Corden [1978] attempts to allocate "responsibility" for unemployment—whether the government or households (through the autonomous demand for output), or "big business" (through the price of output), or trade unions (through the wage). In an analogous manner we could ascribe unemployment in, say, the SC regime of classical unemployment to the cost of input factors: if either the real wage or the real resource price fell, output and employment would increase; a fall of the real wage in regimes DC (of

Keynesian unemployment) and RC would likewise increase employment. But it is difficult in our model, with two variable input factors, to ascribe "responsibility" for unemployment to any single group. Rather, the regime in which the economy finds itself is a function of the supplies and real prices of resource and labour, the exogenous demand for output, and the degree of leakage of aggregate demand.

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Robert E. Marks
2 May 2017

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To my parents,
Joan and Leslie.

ABSTRACT

Recent research on temporary equilibria with quantity rationing has relaxed the assumption of adjustments occurring only through price movements and has examined the implications of "sticky" prices and adjustments occurring through quantity rationing for the explanation of such real-world phenomena as involuntary unemployment. This study extends the earlier work by examining a simple fix-price model with three goods: output, labour, and another factor input, which will be thought of as a flow of raw materials. This is shown to lead to the possibility of eight regions of partial market clearing in the real price plane. The appropriate fiscal policy to alleviate unemployment or to stimulate production will vary depending on the relevant region.

The study continues by examining the question of whether a competitive economy can efficiency allocate a stock of non-renewable natural resources through time. Long-run analyses of competitive economies with such resources have concluded that, without perfect foresight or a complete set of futures markets extending infinitely far into the future, there is no economic mechanism to guarantee that the initial price is set so that the economy converges to the socially desirable path of balanced growth.

But in order to reach this conclusion, the authors of the long-run analyses have made very strong assumptions, in particular that markets clear instantaneously and that arbitrage between resource and asset markets occurs so rapidly that the rate of return on holding stocks of resource equals the return on holding other assets. This study relaxes both assumptions. It examines the existence, uniqueness, and stability of the short-run equilibrium of a simple, four-market, competitive economy, including stocks of non-renewable natural resources.

Analysis of the interdependent short-run adjustments of the markets as prices react to perceived excess demands cannot be made if market clearing is already assumed. Moreover, the behaviour of the participants in the resource stock/asset market might lead to equality of rates of return, but the question cannot be answered by assumption. A further relaxation in this study will be to examine modes of expectation formation: the only way a stock of non-renewable natural resource can produce a current return for its owner is by appreciating in value; hence the anticipated price plays an important role in the behaviour of participants in the resource stock market.

As well as the resource stock/asset market, the study includes a flow market for resources, a labour market, and a market for output, a system of markets linked by the profit-maximizing representative firm, which buys labour services and flow of resource as factor inputs in the short-run, and sells its produced output to the households, which as well as earning the wage bill are assumed to receive the net profits from industry and the return to owners of resource supply on the resource market.

Our analysis indicates that equilibrium of the three flow markets cannot exist with equilibrium of the stock/asset market for resources. Stable equilibrium can occur only with constant real resource flow price. Thus the analysis indicates that the long-run growth paths, even if eventually stable, are not supported by the micro-behaviour of the system in the short-run. This implies that it is not sufficient for efficient allocation of non-renewable natural resources that participants have perfect foresight or that a complete set of futures markets exist, since, although any long-run growth path would then be stable in the long-run sense, it would remain unstable in the short-run.

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CHAPTER I: INTRODUCTION

1.1. The economics of non-renewable natural resources.

In the past few years there has been an increasing awareness of the finite "limits" of the "Spaceship Earth." In economics this has shown itself in a renewed interest in the role of natural resources in the economic process, and the effects of the institutions and level of activity of the economy in the conservation and use of natural resources. This study is concerned with both of these aspects of the economics of non-renewable natural resources. In particular, does the existence of non-renewable natural resources in the economy have any short-run effects on the interactions of the economy--does their existence affect short-run stabilisation policies, and, if so, how? When we consider the short-run micro-foundations of economic behaviour is there any reason to believe that the competitive economy will exploit the resources at the socially desirable rate? We hope to show that the role of natural resources in the economy does lead to alterations in the conventional, Keynesian, policy prescriptions for unemployment. We hope to show that, in the short run, a necessary (but not sufficient) condition for the efficient intertemporal allocation of non-renewable natural resource, the Hotelling principle, will not be satisfied, and that the economy will tend towards a state which cannot be intertemporally optimal.

Almost all of the theoretical economic analyses of resource economics have been micro-economic in nature: in the past four years

there have been many efforts to extend and apply the principles of micro-economic theory to the discovery, extraction, and utilization of natural resources. In particular there have been several studies on optimal growth in an economy including exhaustible natural resources. In such a study, the long-run stability has been examined by Stiglitz (1974b), who considers an economy moving along an equilibrium path along which expectations about future prices are realized and along which markets clear at every moment. He shows that without a complete set of futures markets extending infinitely into the future there is no economic mechanism to guarantee that the initial price will be set so that the economy converges to balanced growth: if the initial price of natural resource is set too low the resource stock will be used up in a finite time; if the initial price is set too high there is always a finite amount of resource stock remaining--an inefficient situation with over-saving of resource. Stiglitz also shows that, unlike the heterogeneous capital growth model, the natural resource model exhibits long-run instability with even slow rates of adaptive expectation formation of the rate of change of resource price.

But this analysis is made with the assumption that the economy is in equilibrium with markets clearing at every "moment," where each moment is vanishingly short so that a continuous analysis can be made. In particular, the explicit assumption is made that the asset market (including stocks of non-renewable natural resource) is in equilibrium so that the return on holding stocks of natural resources (the proportional change of resource price, net of extraction costs) is equal to the rate of return on other assets (the interest rate). This, briefly stated, is

the Hotelling principle. If all markets clear, what leads to the change of resource price? Traditionally we have considered prices to change in response to an imbalance of supply and demand. We shall look more closely at this question in Chapter V.

Short-run stability is concerned with perturbations around the long-run path: if the economy suffers a shock exogenous to the model (such as a change in price expectation formation, or a change in household saving behaviour, or a new discovery of resource, or a change in government policy, or a change in production technology), will equilibrium (in the sense of markets clearing with expectations realized) be regained, and if so will the previous equilibrium path be regained? To answer these questions the short-run equilibrium must be analyzed for existence, uniqueness, and stability.

Stiglitz (1974b) suggests that it is possible in the short run that disequilibrium in the natural resource market (stemming from exogenous disturbances of the supply of resource, for instance) may be translated into disequilibria in other markets (output, asset, and labour). The consequent adjustments in these markets would affect the level of employment and the wage rate, the supply of output and the price level, and the rate of investment and the interest rate.

The linkage between the natural resource market and the asset market could be the cause of a knife-edge instability. With perfectly competitive markets we should expect the price of the flow of resources to equal the price of the stock of resources. The knife-edge occurs when people's expectations of the rate change of the resource price change: if the expected proportional rate of change of resource price

exceeds the interest rate, and if this situation is expected to continue, then traders in the asset market will attempt to increase their stocks of resources. This increase in the demand for stocks will lead to a greater increase in the resource price than would have occurred before, and since traders' expectations are fulfilled they will continue to view resource stocks as a better investment than other assets. At the same time there may be an effect downwards on the interest rate: the increase in resource price will lead to a substitution away from resource flow as a factor input, towards men and machines, which will lead to a change in the utilization of machines and hence to a change in the marginal and average products of capital, in turn leading to a change in the interest rate. If the final effect on the interest rate is downwards then there is even stronger stimulus to hold stocks of resources, and the disequilibrium is exacerbated--hence the knife-edge.

This problem is similar to other speculative "bubbles," and is similar too to the Hahn problem which occurs with heterogeneous capital goods: if the price of one capital good were initially set "too high," the price of the asset would have to rise faster, for market-clearing of the particular capital good, than it would if the price were lower, to offset the lower value of the rentals per dollar invested. Thus in the next period the price would be even further "out of line." One motivation for the following work has been to attempt to build an analytical model to study this behaviour. Insight into possible linkages in the economy between the supply schedule of the natural resource and the adjustments of the markets for output and labour will lead to more effective policy prescriptions; and the work will more fully integrate natural resources into short-run macroeconomic theory.

Since the analysis is concerned with disequilibrium interactions among such macroeconomic variables as output, employment, and inflation, the final model will include four markets: a market for output, a market for labour services, a market for the resource, and a market for assets. Corresponding to these four markets there will be four prices: a money price of output, a money wage, a money price of resource, and an interest rate.

1.2. Disequilibrium adjustment with non-market-clearing trading.

In order to examine the interaction of the markets during the disequilibrium adjustment, the assumption of no non-market-clearing trading will be relaxed. This traditional assumption has been explained by two equivalent descriptions of price determination: either that prices adjust to excess demands instantaneously, or that prices are determined by a Walrasian tatonnement process (or Edgeworthian recontracting process) in which no production or exchange occur until the equilibrium price vector is reached. The alternative assumption will be made that prices do not adjust instantaneously, but that production and exchange can occur at "false" (that is, non-market-clearing) prices.

As Hicks (1946) argues, trading at "false" prices leads to income effects, which will only be negligible if all traders' expenditures on a good are only a small part of their total incomes, with the market ending up very close to the equilibrium price. But in an aggregate macro model these expenditures will not be small in relation to each economic actor's total income, and the income effects from trading at "false" prices will affect the final market price, and will have to be included in the model.

Realization of this leads to Clower's (1965) "dual decision hypothesis" formulation of "income-constrained" processes, in which income as well as prices is an argument in each trader's demand (supply) function. Clower speaks of "notional" demand and supply schedules with no quantity constraints (no non-market-clearing trading), and "effective" schedules which include the quantity constraints which result from non-market-clearing trading. (The Keynesian aggregate demand function is an example of an effective demand schedule: income, as well as prices, is an argument.) Leijonhufvud (1968) stresses that income-constrained processes result whenever the speed of price adjustment is less than infinite. Thus analysis of disequilibrium adjustment requires both price and quantity adjustments.

Four markets lead to four prices and four quantities. A general disequilibrium analysis would involve explicit adjustments in these eight variables. In fact Solow and Stiglitz (1968) describe a disequilibrium macro model with explicit adjustments for employment, the money wage, and the money price of output. They define short-run equilibrium as occurring when the level of employment and the real wage rate are constant, a definition which includes not only the conventional equilibrium with all variables constant, but also Hansen's (1951) "quasi-equilibrium" in which real prices are constant but money prices are changing at equal proportional rates, with (positive or negative) excess demand resulting from lack of market clearing. But the technical problems of eight separate adjustment processes are great, and it is possible to reduce the number of independent adjustments without destroying the essential disequilibrium nature of the model.

The complexity of continuous adjustment models is a great incentive to adopt a discrete treatment of time into "periods," which requires a qualitative ranking of the adjustment speeds of the variables in the system. It is then convenient to treat variables adjusting relatively slowly as data, and to treat variables adjusting relatively rapidly as having worked out their effects. Thus the explicit adjustment processes are reduced to those of interest only. The model to be developed below makes the assumption that quantities adjust infinitely faster than prices, which Leijonhufvud (1968) asserts is the "revolutionary" element in Keynes' General Theory. With this assumption, in an ultra-short-run period or "momentary situation," all prices are given, and on the basis of these prices all plans are formulated and quantities adjust on each market according to derived rules. If at the given prices there are non-zero excess demands, then price changes will be generated at the transition from one momentary situation to the next, in which the new set of prices will lead to formulation of a new set of plans and a new set of quantities. Following Korliras (1973) and Benassy (1973), in the "short-run" period of explicit analysis price changes are accompanied by instantaneous adjustments in quantities and plans which can thus be derived from current prices.

The earliest disequilibrium models were developed by Patinkin and Clower. Patinkin (1965) analyses the demand for labour in the situation where there is an excess supply of output: demand for labour is reduced and the possibility of involuntary unemployment is introduced, associated with excess (effective) labour supply. Clower (1965) analyses the other side of the coin: the demand for output and the demand for money balances subject to an employment constraint to derive effective demand functions

of the same form as the usual Keynesian consumption and saving functions. These two complementary models have been brought together by Barro and Grossman (1971) and (1976).

At a higher level of abstraction, Benassy (1973) has formalized disequilibrium economics to the level of the Arrow-Debreu model of equilibrium economics. He makes the "Keynesian" assumption of instantaneous quantity adjustment and relatively slow price adjustment, and defines a "K-equilibrium" for a set of prices as a situation in which quantities have no tendency to move, more precisely a set of self-reproducing effective demands, which generate "perceived" constraints which in turn will generate the original set of effective demands. A simplified Keynesian model is built to examine the stagflation, deflation, and inflation. Price movements in response to effective excess demands follow with an examination of long-run dynamics and the Phillips curve. Benassy extends the analysis with a chapter on monopolistic competition and finally an economy with an uncertain future and where money links successive equilibria only as a store of value.

1.3. The basic assumptions.

In order to analyse the short-run disequilibrium adjustments of economy including non-renewable natural resource, we have formulated a basic model. The model includes three goods: labour services, a homogeneous output, and resource. There are three types of economic actor: firms, households, and resource suppliers. The labour services and resources are the two variable inputs in the production process: other inputs are fixed in the short-run, and have no alternative use and zero

user cost. All current output is produced by the same technology, and can be considered to assume its specific identity according to the buyer: firms buy investment goods and households buy consumables. Monetary factors are ignored: it is assumed that the monetary authorities manage to keep the real rate of interest constant, and that the monetary variables do not influence aggregate demand. Firms demand labour and resource and supply homogeneous output. Firms are assumed to maximize profits, which can be considered as a return to non-variable inputs, of which each firm possesses a predetermined and fixed amount. Households supply labour. They demand consumables from firms and savings balances. They receive income from the sale of labour services, from the sale of resources, and from profits, all of which accrue only to households. It is assumed that the household decision to save can be characterized by the standard assumption of constant and equal marginal and average propensities to save out of income. The government taxes households' gross income and buys homogeneous output. In the basic model, resource flow and labour services are treated symmetrically.

The basic model is first analysed for the case in which no non-market-clearing trading occurs, that is, for the recontracting or tatonnement case. The analysis, following that of Barro and Grossman (1976) for a single variable factor input, considers comparative statics and dynamic stability of the market-clearing equilibrium that occurs with notional supply and demand schedules. In contrast the model is then analysed for the case of non-market-clearing trading, in which trading occurs during the adjustment process and effective supply and demand schedules result.

Dropping the assumption of trading only at market clearing has two essential implications for the determination of the quantities supplied and demanded. First, the quantities traded cannot be determined simply with reference to market-clearing conditions. There is no equivalence between actual transactions and the quantities supplied and demanded. In order to analyse quantity determination under non-market-clearing conditions, the actual trading process must be examined. The model includes the assumption of "voluntary exchange": no economic actor can be forced to buy more than he demands or sell more than he supplies. Consequently, the actual level of total transactions will be determined by the "short" side of the market (that is, by suppliers if there is excess demand, by demanders if excess supply), and economic actors on the "long" side will be constrained in their transactions.

These constraints lead to the second implication: not every economic actor will generally act as if he can buy or sell any amount which he demands or supplies at the existing price vector. In particular, economic actors on the "long" side of the market (that is, suppliers if excess supply, demanders if excess demand) will face quantity constraints on their transactions, to be taken into account when formulating their supplies and demands on other markets, leading to effective schedules. The notional schedules derived in a market-clearing model do not in general describe the economic behaviour of firms and households in a disequilibrium model (unless the economic actor finds himself on the "short" side of every market). The economic actor must derive his demand (supply) functions taking into account fully the information about the other markets.