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DISEQUILIBRIUM DYNAMICS WITH INVENTORIES AND ANTICIPATORY PRICE-SETTING*

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1. Introduction

The microeconomic foundation of macroeconomics has two fairly well-articulated paradigms. The neo-classical paradigm maintains that 'markets are working': competitive behavior achieves a Pareto optimal outcome under the guidance of the price system. Authorities should interfere as little as possible with this allocation mechanism as long as competitive behavior is maintained. The lack of future and contingent markets pointed out by some has been overcome through the assumption of rational expectations. The Keynesian paradigm on the contrary maintains that 'markets are not working'. Price rigidities, even with competitive behavior, lead to a misallocation of resources which can be partially remedied by government interventions. This malfunctioning of the price system is explained by informational considerations in the absence of a complete set of markets. The Keynesian paradigm has recently received an extreme formalization in the work of Barro and Grossman (1971), Benassy (1975), Drèze (1975), Malinvaud (1977) and others, through the theoretical construct of fixed-price equilibria.

Although the assumption of fixed prices provides a reasonable explanation of a number of short-run phenomena, such as the multiplier effect or the accelerator principle, it is incomplete in that it fails to provide a theory to determine the level at which prices are fixed. The short-run equilibria attained will be markedly affected by the mechanism used to describe price formation. Via this route, the dynamics of macroeconomic fluctuations are affected by the price change process as well.

The basic assumption of this paper is an attempt to be specific about price formation while retaining a fixed-price, quantity-constrained equilibration in

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the short-run. We assume that prices are fixed at the beginning of the period at the level which would be the Walrasian equilibrium if all random factors in the economy had their average levels. We will refer to this as *anticipatory pricing*. Thus there is a tendency toward market clearing, but short-run disturbances continually keep it from being achieved.

This assumption should be contrasted with that previously used in the disequilibrium literature where measured excess demands were responsible for price changes in the following period. Anticipatory pricing has the advantage of being simpler, especially in the analysis of the stochastic evolution of the system. Furthermore, as the empirical evidence does not provide support for the hypothesis that excess demand is a principal determinant of price changes, we felt that it was necessary to explore an alternative. Our assumption is somewhat intermediate between the Walrasian (flexible prices) and Keynesian short-run (fixed prices) models, and it has a certain 'rational expectations' flavor.[1]

The second theme of this paper is the role of inventories in macrodynamics — a topic of long-recognized importance, but one which has not received much attention within the disequilibrium literature.[2] This is rather ironic, as it is commonplace to assert that the role of such stocks is to cushion the effects of unforeseen fluctuations in demands and supplies, presumably those that are undesired at the prevailing prices. We will analyze how the level of inventories interacts with the level of prices and wages, and how the spillover effects in a fixed-price equilibrium produce certain testable characteristics in macro time series data. We will argue that these can be used to discriminate between a model of the type we study and the analogous flexible-price system.

In section 2 we set out the basic model and discuss its assumptions. Section 3 derives the short-run quantity-constrained equilibrium as it depends on initial inventory stocks and on the random disturbances within the period. Section 4 presents, for comparison purposes, the analagous results under conditions of full price flexibility after these shocks are realized.

Sections 5 and 6 are the heart of the paper. We first derive the probabilistic nature of the equilibrium as it depends upon the underlying

[1]It is not, however, a full 'rational expectations' model because the rational forecasts of future prices do not enter the current notional demand curves. This will be discussed further in the next section.

[2]Blinder and Fischer (1979) have examined flexible price models with inventories in which the rate of interest is a determinant of the desired level of inventory stocks. They do not address the stochastic nature of the dynamics explicitly, whereas this is our principal focus. Blinder (1977) has examined a Keynesian model with inventories and a price dynamics that responds to lagged excess demands. Muellbauer and Portes (1978) have a short-run quantity constrained model with inventories based on explicit maximization by rational agents. They derive the effective demand functions to which our specification can be regarded as a first-order approximation. Although they have obtained many short-run comparative statics results they have not linked the successive quantity-constrained equilibria together in a dynamic analysis.

stochastic disturbances. The probabilities of different types of quantity constrained equilibria can be compared. Then, we use these results to present the dynamics of inventory behavior and the statistical relationships between real wages, inventories and employment. We emphasize the possibility of using this type of analysis to test the disequilibrium hypothesis with anticipatory pricing, against the market-clearing assumptions.

2. The model

2.1. Basic structure

The model to be described below has two stores of value, money and inventories, which interact together with the flow demands and supplies on the labor and output markets to determine a short-run equilibrium. Successive short-run equilibria are linked together by the dynamics of inventory movements and the prices and wages which result from them.

Before deriving the stochastic structure of this dynamic disequilibrium process, we should discuss the nature of the model — and especially the central role to be played by inventories and the price formation mechanism. Inventories are accumulated as the result of an excess of output over sales to consumers.[3] It is assumed that such sales of output are entirely consumed; the inventories are owned exclusively by firms. Similarly, money balances are held only by households. They are used to finance purchases of goods in excess of labor income. Both inventory levels and real money balances are desired because they provide the individual decision makers with flexibility in case they are unable to fully execute their desired transactions. In the aggregate, therefore, we will assume a positive desired inventory stock and that the level of real balances enters the demand and supply function of households.[4,5]

Because firms wish to maintain some inventories, part of planned production may be intended for inventory accumulation. An increase in inventory stocks is not, by itself, enough to indicate that firms could not sell

[3]Blinder (1978) offers an extensive discussion of inventories as inputs, but finally assumes that their role as residual output is dominant, as we do.

[4]It should be mentioned, or rather confessed, at the outset, that this formulation does not treat the role of firms' profits and their imputation back to the household sector in a consistent fashion. Implicitly, any money balances accumulated by firms are immediately transferred back to the household sector, but these profits are not anticipated at all. Under competitive conditions — that is with many households, each of whom treats profit income as independent of their own actions — this formalization is consistent with a 100% profits tax and a monetary policy designed to keep the nominal stock of money constant.

[5]Rational agents should recognize the influence of firms' inventories on their future profit income, but we have neglected that as well. In future work we will address savings and asset markets, particularly the relation between money and claims to capital as stores of value, in disequilibrium.

all they wanted to. The actual variation in these stocks is a composite of the intended and unintended changes.

The price-setting process is conceptualized as follows: Time is measured in discrete intervals. The level of inventories is known at the beginning of each period. Further the expected values of demands and supplies of goods and labor as functions of the nominal prices and the stocks of money and inventories are known. These functions may differ from their expected values because of unforeseeable, random events. Prices are set during the period at the values that would clear the market if these expectations were all realized. During the period they remain rigid, and it is this inflexibility which is the source of the disequilibrium dynamics that we will be studying.

Obviously the extreme nature of this process is not to be justified on the grounds that it precisely represents the workings of any economy. Moreover, the length of the period affects the extent of the disequilibrium generated by the temporarily frozen price levels in a serious way, and no one choice can really be defended. Nevertheless we believe that the study of this model can provide useful insights and that it can be viewed as an approximation to an actual economy in which a variety of disequilibrium adjustments are taking place simultaneously. After giving an algebraic statement of the model, we will return to such a discussion.

2.2. *Mathematical specification*

In order to make the model tractable we will impose a linear structure on the supply and demand functions. Following Barro–Grossman (1971) and Malinvaud (1977) the amount by which an agent is constrained below his desired level of purchase or sale in one market enters into the determination of his desired trade in the other market. These 'spillover effects' are also assumed to be linear. For the production sector we have

$$x_t^s = \alpha_0(s_t - \bar{s}) + \alpha_1 p_t + \alpha_2 w_t + a(l_t - l_t^d) + \varepsilon_t^1, \tag{2.1}$$

$$l_t^d = \gamma_0(s_t - \bar{s}) + \gamma_1 p_t + \gamma_2 w_t + c(x_t - x_t^s) + \varepsilon_t^3, \tag{2.2}$$

where, in period t,

- x_t^s = desired level of supply (i.e. of actual sales) to the household sector,
- l_t^d = desired level of labor demand,
- p_t, w_t = logarithm of price level and wage rate, respectively,
- x_t, l_t = actual, market-determined sales and employment,
- s_t = inventory stocks at the start of the period,
- $\bar{s}$ = desired level of inventory stocks in a steady-state,
- $\varepsilon_t^1, \varepsilon_t^3$ = random errors.

One should note that if the firm is interested in maximizing the present value of its profits, expressed in real terms in units of ouput, it follows that

$$\alpha_1 = -\alpha_2 > 0, \tag{2.3}$$

and

$$\gamma_1 = -\gamma_2 > 0. \tag{2.4}$$

Suppose that the marginal product of labor is $g > 0$, and that it is regarded as a constant over the range of variation we are considering. It is natural to assume that if the sales are rationed by an additional unit, that is if $x_t < x_t^s$ and x_t decreases by one unit, then the decreased demand for labor would be such as to decrease actual output by less than one unit, the residual being used for inventory accumulation. Thus we have

$$0 < c < 1/g. \tag{2.5}$$

This can be derived from the second-order conditions for the firm's problem. Similarly an extra unit constraint on labor demand should be absorbed partially by a reduction in inventory stocks and partially by a decrease in the volume of goods offered for sale,

$$0 < a < g. \tag{2.6}$$

Finally, an extra unit of inventory should result in a mixture of sales increase and labor demand decrease. However, since the adjustment made within one period is only partial,

$$\alpha_0 - g\gamma_0 < 1, \tag{2.7}$$

with

$$\alpha_0 > 0, \qquad \gamma_0 < 0. \tag{2.8}$$

[For a formal derivation of similar restrictions, see Blinder and Fischer (1978).]

For households we have the behavioral relations

$$x_t^d = \beta_1 p_t + \beta_2 w_t + b(l_t - l_t^s) + \varepsilon_t^2, \tag{2.9}$$

$$l_t^s = \delta_1 p_t + \delta_2 w_t + d(x_t - x_t^d) + \varepsilon_t^4, \tag{2.10}$$

where x_t^d and l_t^s are the demand for goods and offer of labor services, respectively.

The theory of household behavior differs from the theory for firms because it is the households who hold money balances. Since we will treat the case of a constant money stock throughout, nominal prices and price expectations are sufficient to specify the level of real balances. Because we take the view that the unit of time is rather short compared with the planning horizon of the household, the principal determinant of the households' demand for real balances as its expectation of future prices and wages. It will be shown below that prices in any period depend solely on the predetermined inventory level. Moreover, because inventories will follow a stationary Markov process, in the long run the average level of prices and wages is known. Under these conditions the price and wage expectations relevant to demands at any moment in time can, to a first approximation, be regarded as exogenous and fixed. Thus (2.9) and (2.10) include prices and wages because of their short-run effects, but need include neither expectations nor money balances explicitly.[6]

The standard theory of consumer behavior over time would give us a zero degree homogeneity of market behavior in prices and wages for the current and all future periods. If nominal prices in the short run were to increase, the constancy of long-run expectations would imply a negative 'real-balance effect'.

Assuming that consumption and leisure are all normal goods, we have that

$$\beta_1+\beta_2<0, \tag{2.11}$$

and

$$\delta_1+\delta_2>0. \tag{2.12}$$

Further,

$$\beta_1<0, \qquad \beta_2>0 \tag{2.13}$$

follows from standard considerations of demand theory. The signs and magnitudes of δ_1 and δ_2 cannot be derived from such considerations; but we will sometimes assume that they are both relatively small, as empirical evidence suggests.

Using these conditions to simplify the system we have that

$$\underset{(+)}{x_t^s=\alpha_0(s_t-\bar{s})}+\underset{(+)}{\alpha_1(p_t-w_t)}+\underset{(+)}{a(l_t-l_t^d)}+\varepsilon_t^1, \tag{2.14}$$

[6]Since (p_t, w_t, s_t) will follow a Markov process, future values of (p_t, w_t) can be forecasted from present ones. Thus prices and wages enter (2.9) and (2.10) in their role as predictors as well as through intertemporal substitution effects.

$$x_t^{\mathrm{d}} = \underset{(-)}{\beta_1} p_t + \underset{(+)}{\beta_2} w_t + \underset{(+)}{b}(l_t - l_t^{\mathrm{s}}) + \varepsilon_t^2, \tag{2.15}$$

$$l_t^{\mathrm{d}} = \underset{(-)}{\gamma_0}(s_t - \bar{s}) + \underset{(+)}{\gamma_1}(p_t - w_t) + \underset{(+)}{c}(x_t - x_t^{\mathrm{s}}) + \varepsilon_t^3, \tag{2.16}$$

$$l_t^{\mathrm{s}} = \underset{(-)}{\delta_1} p_t + \underset{(+)}{\delta_2} w_t + \underset{(+)}{d}(x_t - x_t^{\mathrm{d}}) + \varepsilon_t^4, \tag{2.17}$$

where the signs indicate the assumptions being made on the indicated parameter.

Finally, to close the model, we make the standard disequilibrium theoretic assumption that actual quantities are determined by the 'short-side' of each market,

$$x_t = \min(x_t^{\mathrm{d}}, x_t^{\mathrm{s}}), \tag{2.18}$$

$$l_t = \min(l_t^{\mathrm{d}}, l_t^{\mathrm{s}}). \tag{2.19}$$

While these quantity adjustment rules can be criticized on several grounds, they have the great advantage of providing analytical tractability. They also lead to a theory that can, in principal, be tested against a corresponding equilibrium theory.

The basic assumption of our model is that p_t and w_t are set in advance at the level that would clear the market if there were zero errors in each of the behavioral equations. Defining these levels as p_t^*, w_t^*, we have

$$\alpha_0(s_t - \bar{s}) + \alpha_1(p_t^* - w_t^*) = \beta_1 p_t^* + \beta_2 w_t^* \equiv X_t \tag{2.20}$$

$$\gamma_0(s_t - \bar{s}) + \gamma_1(p_t^* - w_t^*) = \delta_1 p_t^* + \delta_2 w_t^* \equiv L_t \tag{2.21}$$

yielding

$$p_t^* = (s_t - \bar{s})\left[\frac{\alpha_0(\delta_2 + \gamma_1) - \gamma_0(\beta_2 + \alpha_1)}{(\beta_1 - \alpha_1)(\delta_2 + \gamma_1) - (\delta_1 - \gamma_1)(\beta_2 + \alpha_1)}\right], \tag{2.22}$$

$$w_t^* = (s_t - \bar{s})\left[\frac{\gamma_0(\beta_1 - \alpha_1) - \alpha_0(\delta_1 - \gamma_1)}{(\beta_1 - \alpha_1)(\delta_2 + \gamma_1) - (\delta_1 - \gamma_1)(\beta_2 + \alpha_1)}\right]. \tag{2.23}$$

Let

$$\begin{aligned} \Delta &= (\beta_1 - \alpha_1)(\delta_2 + \gamma_1) - (\delta_1 - \gamma_1)(\beta_2 + \alpha_1) \\ &\equiv \gamma_1(\beta_1 + \beta_2) - \alpha_1(\delta_1 + \delta_2) + \beta_1\delta_2 - \delta_1\beta_2. \end{aligned} \tag{2.24}$$

Prices are fixed at these levels at the beginning of the period, then the values of random variables $(\varepsilon_t^1, \varepsilon_t^2, \varepsilon_t^3, \varepsilon_t^4)$ are realized so that (p_t^*, w_t^*) is not a Walrasian equilibrium price system in general. We study a fixed-price equilibrium in which the quantities x_t and l_t serve as the equilibrating variables. That is, one can imagine sales and employment varying until, at their equilibrium levels, the system of equations given by (2.14)–(2.19) is satisfied.

2.3. Discussion of the model

Although there is no firm microeconomic foundation for our assumption that prices are fixed at their anticipated Walrasian levels, and are then frozen there for the ensuing period, we had several reasons for adopting such a formulation. It is clear that in any macroeconomic model that deals with sufficiently short time periods, neither the assumption of perfect price flexibility nor the assumption of quantity flexibility would be reasonable. The world is in continual disequilibrium to a much greater extent than either pure formalization admits. In this paper we will emphasize quantities as the equilibrating variables, while recognizing that this is but one extreme among a continuum of possibilities. In any context where one adopts either the strict price-flexibility or quantity-flexibility paradigms, the length of the period in question makes a big difference as to whether the model does or does not approximate the reality.

Our choice of the price level at the anticipated Walrasian equilibrium should be compared with several other possibilities. Most of the literature on disequilibrium macroeconomics[7] has assumed that prices adjust from their lagged values according to the lagged value of excess demand. In our model, one of the impacts of previous disequilibria is to alter the level of stocks. Therefore prices in our model will be higher after a period of excess demand for goods, as in these systems. The analogous property does not apply to the wage rate, as labor services are not durable, nor is there explicitly intertemporal substitution of labor for leisure over individuals' lifetimes.

These two price adjustment hypotheses are hard to compare on empirical grounds. One reason why prices are likely to appear responsive to lagged excess demands is the auto-correlation of errors. However, such an observation would not contradict the basic motivation for having an anticipatory pricing process. For contractual reasons, or because of the difficulty of monitoring and responding to the current state of disequilibrium,

[7] In the econometrics literature, both adjustment of prices to past excess demands and partial adjustment to current excess demands have been used [see for example Fair and Jaffee (1974), Laffont and Garcia (1977)]. In the economic theory literature adjustment to past excess demands has been the rule [see Honkapohja (1979), Laroque (forthcoming)].

the firms and workers might try to use pricing rules designed to approximate an efficient market-clearing system.[8]

In planned economies there is some evidence that prices are set so as to approximate equilibria that are forecasted. This may provide a justification of our anticipatory pricing assumption in modelling such systems.

3. The short-run equilibrium under quantity rationing

With p_t^* and w_t^* fixed by (2.22) and (2.23) and after the realization of ε_t^1, ε_t^2, ε_t^3, ε_t^4, the system (2.14)–(2.19) can be solved. It is easiest to describe the dependence of the solution on the ε's by separately analyzing the four cases in which they are linear.

Regime 1. Excess supply in both markets: Keynesian Unemployment

$$x_t^s > x_t^d = x_t, \qquad l_t^s > l_t^d = l_t. \tag{3.1}$$

We can rewrite (2.14)–(2.17) as

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & -b & b \\ c & -c & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_t^s \\ x_t^d \\ l_t^d \\ l_t^s \end{bmatrix} = \begin{bmatrix} X_t + \varepsilon_t^1 \\ X_t + \varepsilon_t^2 \\ L_t + \varepsilon_t^3 \\ L_t + \varepsilon_t^4 \end{bmatrix},$$

yielding

$$\begin{aligned} x_t^s &= X_t + \varepsilon_t^1, \quad x_t^d = x_t = X_t + \frac{-bc\varepsilon_t^1 + \varepsilon_t^2 + b(\varepsilon_t^3 - \varepsilon_t^4)}{1-bc}, \\ l_t^s &= L_t + \varepsilon_t^4, \quad l_t^d = l_t = L_t + \frac{-c(\varepsilon_t^1 - \varepsilon_t^2) + \varepsilon_t^3 - bc\varepsilon_t^4}{1-bc}. \end{aligned} \tag{3.2}$$

[8]To take one alternative, we might suppose that prices are set at the mathematical expectation of the ex post equilibrium. The difficulty with this assumption is that the bias of these prices away from (p_t^*, w_t^*) depends upon the distribution of the disturbances ε_t. Therefore a complicated pair of non-linear equations would have to be solved to find the prices and wages, in contrast to the simple system (2.20)–(2.21).

Another price-setting mechanism is that prices are only incompletely flexible within the period. They end up somewhere between their lagged values and the location of the market-clearing equilibrium. This amounts to an adjustment in response to current, rather than lagged, excess demands. This hypothesis is attractive in that the length of the period can be reflected in the specification of the adjustment speed. Unfortunately we were unable to obtain tractable dynamic results.

Regime 2. Excess supply on the good market and excess demand on the labor market: Underconsumption

$$x_t^{\mathrm{s}} > x_t^{\mathrm{d}} = x_t, \qquad l_t^{\mathrm{d}} > l_t^{\mathrm{s}} = l_t. \tag{3.3}$$

The structural equations are

$$\begin{bmatrix} 1 & 0 & a & -a \\ 0 & 1 & 0 & 0 \\ c & -c & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_t^{\mathrm{s}} \\ x_t^{\mathrm{d}} \\ l_t^{\mathrm{d}} \\ l_t^{\mathrm{s}} \end{bmatrix} = \begin{bmatrix} X_t + \varepsilon_t^1 \\ X_t + \varepsilon_t^2 \\ L_t + \varepsilon_t^3 \\ L_t + \varepsilon_t^4 \end{bmatrix},$$

yielding

$$\begin{aligned} &x_t^{\mathrm{s}} = X_t + \frac{\varepsilon_t^1 - ac\varepsilon_t^2 + a(-\varepsilon_t^3 + \varepsilon_t^4)}{1-ac}, \quad x_t^{\mathrm{d}} = x_t = X_t + \varepsilon_t^2, \\ &l_t^{\mathrm{s}} = l_t = L_t + \varepsilon_t^4, \quad l_t^{\mathrm{d}} = L_t + \frac{-c(\varepsilon_t^1 - \varepsilon_t^2) + \varepsilon_t^3 - ac\varepsilon_t^4}{1-ac}. \end{aligned} \tag{3.4}$$

Regime 3. Excess demand in both markets: Repressed Inflation

$$x_t^{\mathrm{d}} > x_t^{\mathrm{s}} = x_t, \qquad l_t^{\mathrm{d}} > l_t^{\mathrm{s}} = l_t. \tag{3.5}$$

The structural equations are

$$\begin{bmatrix} 1 & 0 & a & -a \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ -d & d & 0 & 1 \end{bmatrix} \begin{bmatrix} x_t^{\mathrm{s}} \\ x_t^{\mathrm{d}} \\ l_t^{\mathrm{d}} \\ l_t^{\mathrm{s}} \end{bmatrix} = \begin{bmatrix} X_t + \varepsilon_t^1 \\ X_t + \varepsilon_t^2 \\ L_t + \varepsilon_t^3 \\ L_t + \varepsilon_t^4 \end{bmatrix},$$

yielding

$$\begin{aligned} &x_t^{\mathrm{s}} = x_t = X_t + \frac{\varepsilon_t^1 - ad\varepsilon_t^2 + a(-\varepsilon_t^3 + \varepsilon_t^4)}{1-ad}, \quad x_t^{\mathrm{d}} = X_t + \varepsilon_t^2, \\ &l_t^{\mathrm{s}} = l_t = L_t + \frac{d(\varepsilon_t^1 - \varepsilon_t^2) - ad\varepsilon_t^3 + \varepsilon_t^4}{1-ad}, \quad l_t^{\mathrm{d}} = L_t + \varepsilon_t^3. \end{aligned} \tag{3.6}$$

Regime 4. Excess demand on the good market and excess supply on the labor market: Classical Unemployment

$$x_t^{\mathrm{d}} > x_t^{\mathrm{s}} = x_t, \qquad l_t^{\mathrm{s}} > l_t^{\mathrm{d}} = l_t. \tag{3.7}$$

We have

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & -b & b \\ 0 & 0 & 1 & 0 \\ -d & d & 0 & 1 \end{bmatrix} \begin{bmatrix} x_t^s \\ x_t^d \\ l_t^d \\ l_t^s \end{bmatrix} = \begin{bmatrix} X_t+\varepsilon_t^1 \\ X_t+\varepsilon_t^2 \\ L_t+\varepsilon_t^3 \\ L_t+\varepsilon_t^4 \end{bmatrix},$$

yielding

$$\begin{aligned} &x_t^s = x_t = X_t + \varepsilon_t^1, \quad x_t^d = X_t + \frac{-bd\varepsilon_t^1 + \varepsilon_t^2 + b(\varepsilon_t^3 - \varepsilon_t^4)}{1-bd}, \\ &l_t^s = L_t + \frac{d(\varepsilon_t^1 - \varepsilon_t^2) - bd\varepsilon_t^3 + \varepsilon_t^4}{1-bd}, \quad l_t^d = l_t = L_t + \varepsilon_t^3. \end{aligned} \tag{3.8}$$

Within each regime we can study the stability of the natural quantity adjustment processes

$$\dot{x}_t = h_1(\min(x_t^d, x_t^s) - y_t), \quad \dot{l}_t = h_2(\min(l_t^d, l_t^s) - l_t), \tag{3.9}$$

where h_1 and h_2 are sign-preserving functions. It follows from an examination of the linear systems (3.2), (3.4), (3.6) and (3.8), that this dynamic adjustment process would be locally stable provided that

$$1-bc>0, \quad 1-ac>0, \quad 1-ad>0, \quad 1-bd>0. \tag{3.10}$$

For example, suppose that an equilibrium in Regime 1 were disturbed by a small upward perturbation in sales of Δx_t. This would produce a lower level of constraint in the supply of goods and hence an increase of $c\,\Delta x_t$ in the demand for labor. The change would give rise to more demand for goods by $bc\,\Delta x_t$. Summing up the induced increase in demands, stability requires $1-bc >0$.

Now, when we consider the entire equation system in which these regimes are juxtaposed, it has been shown by Gourieroux, Laffont and Monfort (1980) that the existence and uniqueness of the quantity-constrained solution is implied when these local stability properties hold within each regime.

Let us compute the constraints on the ε's such that the realized values of demands and supplies satisfy the definition of each of the regimes. For example, assuming that we are in Regime 1, x_t^d, x_t^s, l_t^d, l_t^s are given by (3.2) and if they are to satisfy (3.1) we must have that

$$\varepsilon_t^1 - \varepsilon_t^2 - b(\varepsilon_t^3 - \varepsilon_t^4) > 0, \quad c(\varepsilon_t^1 - \varepsilon_t^2) - (\varepsilon_t^3 - \varepsilon_t^4) > 0, \tag{3.11}$$

and conversely, if (3.11) is satisfied, then the solution to (3.2) will lie in Regime 1. Pursuing this method for the other regimes we find that they are realized if the ε's lie in the following regions:

Regime 2

$$\varepsilon_t^1-\varepsilon_t^2-a(\varepsilon_t^3-\varepsilon_t^4)>0, \quad c(\varepsilon_t^1-\varepsilon_t^2)-(\varepsilon_t^3-\varepsilon_t^4)<0. \tag{3.12}$$

Regime 3

$$\varepsilon_t^1-\varepsilon_t^2-a(\varepsilon_t^3-\varepsilon_t^4)<0, \quad d(\varepsilon_t^1-\varepsilon_t^2)-(\varepsilon_t^3-\varepsilon_t^4)<0. \tag{3.13}$$

Regime 4

$$(\varepsilon_t^1-\varepsilon_t^2)-b(\varepsilon_t^3-\varepsilon_t^4)<0, \quad d(\varepsilon_t^1-\varepsilon_t^2)-(\varepsilon_t^3-\varepsilon_t^4)>0. \tag{3.14}$$

A direct comparison of (3.11)–(3.14) reveals that, under the conditions (3.10), these regions form a partition of the space of all $(\varepsilon_t^1, \varepsilon_t^2, \varepsilon_t^3, \varepsilon_t^4)$ vectors. Let

$$v_t^1=\varepsilon_t^1-\varepsilon_t^2, \qquad v_t^2=\varepsilon_t^3-\varepsilon_t^4. \tag{3.15}$$

One can see directly that the four different regimes can be represented in the (v_t^1, v_t^2) space (see fig. 1).

4. Short-run equilibria with price flexibility

For future reference, it is useful at this point to derive the prices, wages and equilibrium quantities that would arise if prices and wages were to adjust so as to clear both markets after the realization of the disturbances. Setting (2.14) equal to (2.15), (2.16) equal to (2.17) and ignoring all the terms involving spillover effects we can derive the following expression for the equilibrium real wage:

$$\begin{aligned}\Delta\cdot(w_t^*-p_t^*)=&[\gamma_0(\beta_1+\beta_2)-\alpha_0(\delta_1+\delta_2)](s_t-\bar{s})\\&+(\beta_1+\beta_2)v_t^2-(\delta_1+\delta_2)v_t^1,\end{aligned} \tag{4.1}$$

where Δ is given by (2.24). Equilibrium employment, and hence output, are given by

$$\begin{aligned}\Delta\cdot l_t=&\{\gamma_0[\delta_2(\beta_1-\alpha_1)-\delta_1(\beta_2+\alpha_1)]+\alpha_0\gamma_1[\delta_1+\delta_2]\}(s_t-\bar{s})\\&+\Delta\cdot\varepsilon_t^4+(\delta_1+\delta_2)\gamma_1 v_t^1-[\delta_1(\beta_2+\alpha_1)-\delta_2(\beta_1-\alpha_1)]v_t^2.\end{aligned} \tag{4.2}$$

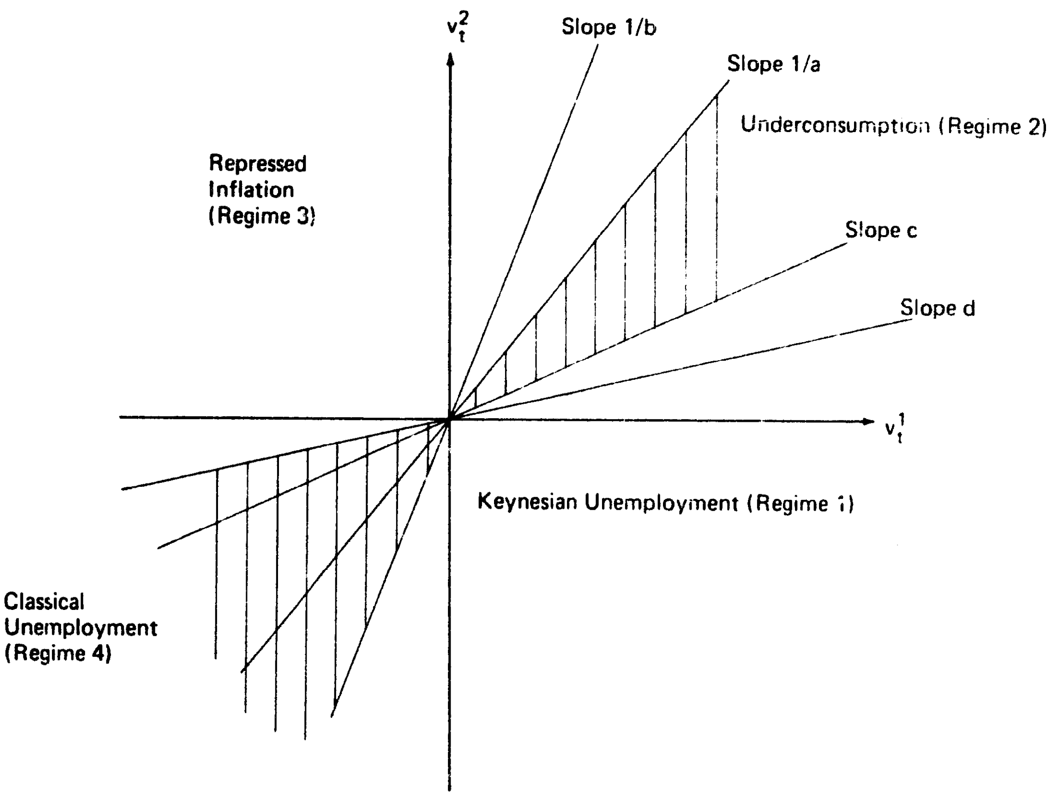

Fig. 1. Case $a>b$, $c>d$, which will be motivated in section 5.

The stability condition on the Walrasian price adjustment process where wages respond to excess demand in the labor market and prices to excess demand in the goods market implies that $\Delta<0$. These stability conditions will be satisfied whenever δ_1 and δ_2 are relatively small [see the right-hand side of (2.24)]. The comparative statics of the equilibrium model with respect to inventories and shocks can be derived in a straightforward way. It may be seen that the real wage responds negatively to initial inventories, positively to shocks that increase the excess demand for labor, and positively to shocks that increase the excess demand for goods. These comparative statics are in accordance with one's intuition that initial inventories are a substitute for labor inputs in the short-run production process.

5. Probabilistic structure of the short-run quantity constrained equilibria

The principal question answered in this section is how the stochastic specification of the model induces the probabilities that each of the four types of quantity-constrained equilibria will arise. In complete generality, the symmetry with which our model treats the goods and labor markets makes it impossible to derive specific conclusions about this distribution. But employing plausible qualitative conditions on the parameters, combined with assumptions on the relative variances of the errors, we find limitations on the forms of the disequilibria that can arise. Depending on the specification used, one or two of the regimes can be proven to be much less likely than the others.

Let us begin by considering some of the sources of the stochastic variation and noting how each implies a relationship among the four ε's that are the errors in the structural equations. A neutral shift in the production function causes ε^1 to rise while leaving the other unaffected. An increase in the marginal productivity of labor raises both ε^1 and ε^3. Another type of shift is a change in firms' expectations. This might lead to more investment (which we do not treat explicitly), that is a positive ε^2 in our context, as well as a positive ε^3 if firms hire workers in anticipation of the future.

Shocks impinging primarily on the consumers might be tax changes, and interest rates (again left out of the model), affecting ε^2 and perhaps ε^4. Unanticipated changes in exchange rates affect both sides of the market for goods. Firms may find stronger markets abroad. Higher costs of imported inputs may cause both ε^1 and ε^3 to decrease, or they may cause ε^1 to decrease and ε^3 to increase, depending upon substitution possibilities.

In general, therefore, the presence of any of these unanticipated factors will cause all of the shocks to be operative. To the extent that anticipatory pricing can remove the effects of foreseeable disturbances such as tax changes and technical progress, the principal factors among those mentioned above are likely to be expectations and real movements in exchange rates. We will see below that if expectations shifts are the dominant factor then Keynesian Unemployment and Repressed Inflation will result more often than the other two regimes. Thus, even though they are logically possible, they may not be often observed.

Now let us discuss some of the likely relationships among the parameters of the model, and particularly among the spillover effects. It is probably reasonable to expect that firms are more sensitive to constraints than are individuals. The permanent income hypothesis in its purest form would not leave any room for spillover effects in consumption or in labor supply. Firms, although infinitely lived in principal, do not allow their inventories to serve as a complete buffer when plans cannot be carried out. Some of the impact of sales constraints is to lower production, even in the short-run. Therefore we will assume throughout the rest of this section that

$$a > b, \qquad c > d. \tag{5.1}$$

To derive the probabilities of the four regimes we use the inequality constraints defining them (3.11)–(3.14). These constraints can be written entirely in terms of $v_t^1 = \varepsilon_t^1 - \varepsilon_t^2$ and $v_t^2 = \varepsilon_t^3 - \varepsilon_t^4$.

The first specification of the errors that we will consider is the case in which they are independently distributed. It is natural then to define

$$\sigma_{v_1}^2 = \sigma_1^2 + \sigma_2^2, \qquad \sigma_{v_2}^2 = \sigma_3^2 + \sigma_4^2. \tag{5.2}$$

If in addition we postulate normality, then

$$\Pr[\text{Regime } i] = \frac{|\Sigma_i|^{-\frac{1}{2}}}{2\pi} \int_0^\infty \int_0^\infty \exp\left(-\tfrac{1}{2}[\xi_1, \xi_2] \Sigma_i^{-1} \begin{bmatrix} \xi_1 \\ \xi_2 \end{bmatrix} \right) \mathrm{d}\xi_1 \, \mathrm{d}\xi_2,$$

with

$$\Sigma_1 = \begin{bmatrix} \sigma_{v_1}^2 + b^2\sigma_{v_2}^2 & c\sigma_{v_1}^2 + b\sigma_{v_2}^2 \\ c\sigma_{v_1}^2 + b\sigma_{v_2}^2 & c^2\sigma_{v_1}^2 + \sigma_{v_2}^2 \end{bmatrix},$$

$$\Sigma_2 = \begin{bmatrix} \sigma_{v_1}^2 + a^2\sigma_{v_2}^2 & -c\sigma_{v_1}^2 - a\sigma_{v_2}^2 \\ -c\sigma_{v_1}^2 - a\sigma_{v_2}^2 & c^2\sigma_{v_1}^2 + \sigma_{v_2}^2 \end{bmatrix},$$

$$\Sigma_3 = \begin{bmatrix} \sigma_{v_1}^2 + a^2\sigma_{v_2}^2 & d\sigma_{v_1}^2 + a\sigma_{v_2}^2 \\ d\sigma_{v_1}^2 + a\sigma_{v_2}^2 & d^2\sigma_{v_1}^2 + \sigma_{v_2}^2 \end{bmatrix},$$

$$\Sigma_4 = \begin{bmatrix} \sigma_{v_1}^2 + b^2\sigma_{v_2}^2 & -d\sigma_{v_1}^2 - b\sigma_{v_2}^2 \\ -d\sigma_{v_1}^2 - b\sigma_{v_2}^2 & d^2\sigma_{v_1}^2 + \sigma_{v_2}^2 \end{bmatrix}.$$

The probabilities of the different regimes can be ranked according to the correlation coefficients, ρ_i between ξ_1 and ξ_2 as specified by the matrices Σ_i,

$$\rho_1 = (c\sigma_{v_1}^2 + b\sigma_{v_2}^2) / \sqrt{(\sigma_{v_1}^2 + b^2\sigma_{v_2}^2)(c^2\sigma_{v_1}^2 + \sigma_{v_2}^2)},$$

$$\rho_2 = -(c\sigma_{v_1}^2 + a\sigma_{v_2}^2) / \sqrt{(\sigma_{v_1}^2 + a^2\sigma_{v_2}^2)(c^2\sigma_{v_1}^2 + \sigma_{v_2}^2)},$$

$$\rho_3 = (d\sigma_{v_1}^2 + a\sigma_{v_2}^2) / \sqrt{(\sigma_{v_1}^2 + a^2\sigma_{v_2}^2)(d^2\sigma_{v_1}^2 + \sigma_{v_2}^2)},$$

$$\rho_4 = -(d\sigma_{v_1}^2 + b\sigma_{v_2}^2) / \sqrt{(\sigma_{v_1}^2 + b^2\sigma_{v_2}^2)(d^2\sigma_{v_1}^2 + \sigma_{v_2}^2)}.$$

The highest probabilities are associated with the Keynesian Unemployment (Regime 1) and Repressed Inflation (Regime 3) modes, where the correlations are positive. An intuition for this result can be derived from the observation that when errors occur one at a time only Regime 1 and 3 are possible. This point is due to the fact that the first effect of a shock is to constrain one agent (firms or consumers) in one market and by the spillover effect the other agent in the other market. The stability conditions imply that one remains then in a regime where both agents are constrained, i.e., either Keynesian Unemployment or Repressed Inflation.

The comparison between Regimes 1 and 3 and between Regimes 2 and 4 is difficult and depends on the variances and on the spillover coefficients. One possibility to obtain further results can be obtained if we are willing to make the assumption that shocks originating on the goods market are large compared to labor market shocks.[9] This can be described by letting $\sigma_{v_2}^2/\sigma_{v_1}^2$ be small. Under these conditions ρ_1 and ρ_3 can be approximated as

$$\rho_1 \approx 1-(b-1/c)^2\frac{\sigma_{v_2}^2}{\sigma_{v_1}^2}, \qquad \rho_3 \approx 1-(a-1/d)^2\frac{\sigma_{v_2}^2}{\sigma_{v_1}^2}.$$

Regime 1 will be more likely than Regime 3 if

$$(a-1/d)^2 > (b-1/c)^2.$$

Even under the maintained hypotheses (5.1) this comparison could still go either way.[10]

5.1. *Shocks from changing firms' expectations*

A particular case of dependence gives an even more definitive bias in the probability of the regimes. This is the case of deviation between firms' actual expectations and the *ex ante* beliefs that entered into the formation of prices and wages. As discussed at the beginning of this section, we have ε^2 and ε^3 with the same sign, while ε^1 and ε^4 should be zero. Using (3.11)–(3.14) we see that only Keynesian Unemployment or Repressed Inflation will be possible in this case.

5.2. *Other non-independent shocks*

Other types of perturbations may relate to technical change, foreign prices,

[9]This is the implicit assumption in much of Keynes and is made explicit in the work of Malinvaud.

[10]To confirm the further intuition of Malinvaud that Keynesian unemployment is more likely than repressed inflation, one would have to invoke a bias of the price setting mechanism away from the anticipated Walrasian levels.

or exchange rates. If, for example, the technical change is the most relevant type of uncertainty remaining unsolved between the setting of prices and the realization of the equilibrium, then, ε^1 and ε^3 will be positively correlated. The regime of the equilibrium will then depend upon their precise relationship. For example, if the entire increase in labor demand is used to produce goods that are marketed immediately, then

$$\varepsilon_t^1 = g\varepsilon_t^3,$$

and the equilibrium is necessarily in either Underconsumption or Classical Unemployment by virtue of the assumed relationships between g and the spillover parameters. The general belief that these two regimes are not prevalent may attest to the fact that technological uncertainty of this type is not the dominant form.

Another example would be where

$$\varepsilon_t^1 = a\varepsilon_t^3,$$

reflecting the fact that some of the extra production would be used for inventory accumulation, here in the same proportion that a constrained level of labor hiring would induce. In this instance we would have either classical unemployment, or a borderline instance between Underconsumption and Repressed Inflation. The latter implies that the goods market clears, while labor is in excess demand. Thus there would be a systematic tendency for the goods market to have excess supply, on average, if this type of uncertainty were predominant.

In a similar fashion one can work through a variety of other special cases based on simple linear relationships assumed to hold identically among the ε's. We can see, therefore, that the nature of the shocks is an important determinant of the probability of reading any of the regimes. If direct evidence were available as to the nature of the binding quantity constraints at different points in time,[11] indirect evidence would be available as to the relative magnitude of the shocks.

6. Dynamic behavior of quantity-constrained equilibrium process

In this section we will utilize the stochastic structure derived above to study the dynamics of inventories, employment, output, the real wage and correlations among them. We will compare the results of the disequilibrium model to those arising from a system where prices are flexible after the

[11]For example, suitable unemployment/vacancy data would be relevant to the labor market. Evidence in the goods market is harder to ascertain since intended inventory movements may be confounded with flow disequilibrium.

realization of the shocks, as described in Section 3. In particular we will ask whether or not these systems are 'observationally equivalent', and we will suggest methods for testing one of these hypotheses against the other.

6.1. The dynamics of inventories

In this model inventories are entirely composed of unsold stocks of final goods. Because there is no depreciation, the change in stocks is simply the difference between production and sales. The evolution of inventories is described by

$$s_{t+1}=s_t+gl_t-x_t. \tag{6.1}$$

Eq. (6.1) is a stochastic difference equation because l_t and x_t are random variables that depend on the underlying ε's, and on the current value of s_t. Recognizing this dependence explicitly, we obtain a relation that is piecewise linear in the ε_t,

Regime

$$\begin{array}{ll} 1 & \\ 2 & \\ 3 & \\ 4 & \end{array} \qquad (s_{t+1}-s_t)=gL_t-X_t+\begin{cases} \dfrac{\varepsilon_t^1(b-g)c+\varepsilon_t^2(gc-1)+\varepsilon_t^3(g-b)+\varepsilon_t^4 b(1-cg)}{1-bc}, \\ -\varepsilon_t^2+g\varepsilon_t^4, \\ \dfrac{\varepsilon_t^1(gd-1)+\varepsilon_t^2 d(a-g)+\varepsilon_t^3 a(1-gd)+\varepsilon_t^4(g-a)}{1-ad}, \\ -\varepsilon_t^1+g\varepsilon_t^3. \end{cases} \tag{6.2}$$

Let $\phi^i(\varepsilon_t)$ denote the linear form in the ε associated with regime i, in eqs. (6.2), $i=1, 2, 3, 4$. Consider the anticipated change in inventory stocks, that is, the change that would happen if all the ε's were zero and prices were set as we have postulated,

$$gL_t-X_t=\frac{\begin{array}{c}(g\delta_1-\beta_1)[\alpha_0(\delta_2+\gamma_1)-\gamma_0(\beta_2+\alpha_1)] \\ +(g\delta_2-\beta_2)[\gamma_0(\beta_1-\alpha_1)-\alpha_0(\delta_1-\gamma_1)]\end{array}}{(\beta_1-\alpha_1)(\delta_2+\gamma_1)-(\delta_1-\gamma_1)(\beta_2+\alpha_1)}(s_t-\bar{s}). \tag{6.3}$$

Let us define the coefficient on the right hand side to be K_0, a function only of the parameters of the system. K_0 is the effect on the anticipated change in inventories due to one unit of additional initial stocks. When δ_1 and δ_2 are small, it can be verified that $-1<K_0<0$ and hence that the process is stable.

We can express the dynamics of inventories in a succinct way by defining the function $\phi(\varepsilon_t)$ to have the value of $\phi^i(\varepsilon_t)$ whenever ε_t lies in regime i. Thus $\phi(\varepsilon_t)$ is defined over the whole range of ε_t. In this notation,

$$(s_{t+1}-\bar{s})=(1+K_0)(s_t-\bar{s})+\phi(\varepsilon_t), \tag{6.4}$$

or

$$s_{t+1}=-K_0\bar{s}+(1+K_0)s_t+\phi(\varepsilon_t). \tag{6.5}$$

Eq. (6.4) can now be analyzed under a variety of conditions corresponding to particular assumptions on the joint distribution of ε_t. As the details are straightforward, we will only summarize the results here.

If the four shocks are independent, little can be said in general about the Markov process defined by (6.4). The mean value of the error term averaged over the four regimes will not be zero because they enter in a piecewise linear, rather than a linear, fashion. Therefore the long-run average for s_t will be biased away from its target $\bar{s}$.

It is interesting to ask whether the time series behavior of inventories can be used to distinguish between this model and the equilibrium model of section 4.

Using (4.1) and (4.2) we can see that the equilibrium stock adjustment equation will be of the same general form as (6.5) but the errors enter linearly. This suggests the following test of the equilibrium model. Write the equilibrium model as

$$s_{t+1}=-K_0^{\mathrm{eq}}\bar{s}+(1+K_0^{\mathrm{eq}})s_t+\phi^{\mathrm{eq}}(\varepsilon_t), \tag{6.6}$$

paralleling the notation of (6.5). The error term will have mean zero. If this equation were estimated, $K_0^{\mathrm{eq}}\bar{s}$ would be the value of the constant. Moreover, if the data were partitioned into various subsets, the same constant would be consistently estimated in each of them. This should be contrasted with the case of disequilibrium as in (6.5). If the data were partitioned according to the various regimes, a different constant, namely $K_0^{\mathrm{eq}}\bar{s}+E\phi^i(\varepsilon_t)$, with the expectation conditioned on Regime i, would be observed in each regime.

Of course it is not obvious at all which regime is operative at which point. Unlike previous work in disequilibrium econometrics, the direction of the price change in our model does not indicate anything about the effective quantity constraints. Therefore the brute force procedure would be to estimate the disequilibrium system by maximum likelihood methods separately for each of the 4^T partitions of the T data points, allowing a different constant in each regime, and then to perform a likelihood ratio test of the overall maximum likelihood among these regressions against the equation estimated with a single constant.

Of course if T is fairly large this method becomes impractical. Some economies of computation are possible, however, under more restrictive hypotheses about the joint distribution of the components of ε_t.

With the assumption that shocks do not impinge upon the notional inventory, but that individuals divide shocks between money balances and flow demands, we can derive from (6.2) that $E\phi^1(\varepsilon_t)>0$, $E\phi^2(\varepsilon_t)=0$, $E\phi^3(\varepsilon_t)<0$ and $E\phi^4(\varepsilon_t)=0$ [indeed $\phi^4(\varepsilon_t)\equiv 0$]. These qualitative constraints can be used to check the maximum likelihood estimations of the four regimes: the estimated constants in Regime 1 exceed those of Regimes 2 and 4 which in turn exceed that in Regime 3. Moreover these constraints can provide an algorithm for partitioning the data, if the above hypotheses are maintained. For example, if σ_3^2 is thought to dominate σ_4^2, we know that Regimes 2 and 4 become far more likely than 1 and 3. We might therefore begin by running the unconstrained regression (6.5), ignoring the biased error term, and then assign that half of the data with the largest residuals to Regime 4 and the others to Regime 2.[12]

Another case of interest occurs where the shocks affect current notional demands and desired stocks in the same proportion as would quantity constraints. We have from (6.2) that

$$\begin{aligned}
\phi^1(\varepsilon_t)&=\frac{(g-b)(1-ac)\varepsilon_t^3+(1-cg)b\varepsilon_t^4}{1-bc},\\
\phi^2(\varepsilon_t)&=(g-b)\varepsilon_t^4,\\
\phi^3(\varepsilon_t)&=\frac{(g-a)(1-bd)}{1-ad}\varepsilon_t^4,\\
\phi^4(\varepsilon_t)&=(g-a)\varepsilon_t^3.
\end{aligned}\tag{6.7}$$

Recalling the results on the probability distribution over these regimes when $\sigma_{\varepsilon_2}^2/\sigma_{\varepsilon_1}^2$ is small we know that Regime 1 is not possible, and Regimes 2, 3 and 4 occur approximately whenever $\varepsilon^3>0$ and $\varepsilon^4>0$, $\varepsilon^3>0$ and $\varepsilon^4<0$, and $\varepsilon^3<0$ respectively. From (6.7) we see that the biases induced in the constants in Regimes 2 and 3 will be small, since $E\varepsilon^4\,|\,\varepsilon^4>0$ is small compared to $E\varepsilon^3\,|\,\varepsilon^3<0$. Thus an approximate test of the disequilibrium model is to segregate the data into two subsets, presumably those in or out of Regime 4, and test for the inequality of the constants in these separate

[12]This method is reminiscent of the Fair–Jaffee (1972) procedure.

regressions. (Of course this will be a weaker test than the full maximum likelihood procedure, but the computational advantages may be significant.)

6.1. Correlation between real wages and inventories

In the disequilibrium model we have studied, the anticipatory nature of the price adjustment process makes the real wage a function of inventories alone. Therefore, in the absence of observational errors, a perfect (negative) correlation between them would be observed.

The equilibrium model's real wage is given by (4.1). It is easy to show that the coefficient of $(s_t - \bar{s})$ is the same in this equation as it is in the disequilibrium theory. The two differ only in the presence of the error term. Because of observational errors, however, we cannot discriminate between them.

6.2. Correlation between employment and inventories

In the disequilibrium model the realized levels of employment are given by

Regime

$$l_t = L_t + \begin{cases} \dfrac{-c(\varepsilon_t^1 - \varepsilon_t^2) + (\varepsilon_t^3 - bc\varepsilon_t^4)}{1-bc}, & 1 \\ \varepsilon_t^4, & 2 \\ \dfrac{d(\varepsilon_t^1 - \varepsilon_t^2) - ad\varepsilon_t^3 + \varepsilon_t^4}{1-ad}, & 3 \\ \varepsilon_t^3. & 4 \end{cases} \tag{6.8}$$

The dependence of L_t, anticipated employment if there are no shocks, on inventories can be computed from (2.21), (2.22) and (2.23) to be

$$L_t = \frac{\gamma_0[\delta_2(\beta_1 - \alpha_1) - \delta_1(\beta_2 + \alpha_1)] + \alpha_0[\delta_1 + \delta_2]\gamma_1}{\Delta}(s_t - \bar{s}).$$

In the equilibrium model employment is given by (4.2). Note that the systematic dependence of employment on inventories is the same under either theory.

As in the case of the autocorrelation of the inventory series, the difference lies in the stochastic structure. Different constant terms in the regressions within each regime would provide evidence for the disequilibrium hypothesis.

We will not elaborate upon the possibilities under all the stochastic specifications treated previously. It is useful, however, to examine one of them again because it indicates how a combination of evidence on inventories and employment can help identify regimes and provide a sharper discrimination between these theories.

Consider the case of (5.3) and (5.5), where disturbances impinge upon notional demand for stocks in both sectors. The relations (5.8) become:

Regime

$$
l_t = L_t + \begin{cases} \dfrac{(1-ac)}{1-bc}\varepsilon_t^3, & 1 \\ \varepsilon_t^4, & 2 \\ \varepsilon_t^4, & 3 \\ \varepsilon_t^3. & 4 \end{cases} \tag{6.9}
$$

Compare these errors to the analogous terms in the inventory dynamics eq. (6.7). When $\sigma_{v_2}^2/\sigma_{v_1}^2$ is small, the sign of the errors in each of the three possible regimes is precisely the same in (6.9) as it is in (6.7). Therefore, if we identify a particular partition of the data points for one equation, then under the maintained hypotheses about the errors, the constants estimated by maximum likelihood from the other equation should stand in the same relationship across the regimes when the data are partitioned the same way.

Indeed a further check is possible using the fact that $\sigma_{v_2}^2/\sigma_{v_1}^2$ is small. We can neglect the difference between the constants estimated in Regimes 2 and 3 compared with their relation to that in Regime 4. From (6.9) and (6.7) we can see that the difference between Regime 4 and the other two in the employment regressions is $E\varepsilon_t^3 \mid \varepsilon_t^3 < 0$, and in the inventory autoregression it is $(g-a)E\varepsilon_t^3 \mid \varepsilon_t^3 < 0$. We can infer that the cross-equation difference in the constants in the inventory autoregression should be less than g times the bias in the employment regressions, because $a > 0$. (The productivity of labor, g, can be estimated as the average real wage, so this procedure is well-defined.)

6.3. Correlation between real wages and employment

Both the disequilibrium and equilibrium models predict a negative correlation between real wages and employment when $(\delta_1 + \delta_2)$ is relatively small. Tests based on the stochastic structure similar to those described above can be constructed, but we believe that they will be harder to use. There are difficulties in constructing a real wage series corrected for the changing composition of the labor force and the problem of obtaining wage rates when overtime and other considerations distort the relationship between hours of employment and total earnings.

7. Conclusion

In this paper we have put forward a new hypothesis about the pricing mechanism which involves short-run rigidities of prices while still allowing a long run Walrasian adaptation of prices. In addition to describing the dynamics of the model we have shown how this model leads to possible simple new tests of the equilibrium hypothesis. Further work will carry out these tests for various countries.

However, it should be clear that the model presented in this exploratory paper is too simplistic in many respects. Our next step in integrating it into a more satisfactory model to study short-run dynamics will involve the introduction of a capital good and of productive investment.

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