On Alternative Approaches to Employment Dynamics

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Much recent work on inflation and employment theory has been characterized by the introduction of the assumption of imperfect information.[1] The thrust of much of this work is that deviations from the equilibrium employment and output levels are caused by price or wage changes which are not immediately perceived.

The present paper is an attempt to explore the behavior of a three good aggregate model (labor, commodities and money) in which information is not perfect. The analysis which follows concentrates on the effects of learning costs on households and retains the assumption of perfect information for firms. In order to make the causal relationships clear we separately consider the effects of informational difficulties concerning the price level (in part I) and the money wage (in part II).

In discussing possible disequilibrium behavior we explicitly analyze the effects of exogenous shifts in commodity demand using the assumption that employment is given by the short side of the labor market and that output is that which is produceable, given employment.

The major effect of modifying a standard model by introducing information costs occurs under conditions of excess demand; the basic pattern of behavior under conditions of excess supply is essentially unchanged by the modifications. In response to an increase in demand both imperfect price information and imperfect money wage information indicate a rise in employment and output. However, in the case of

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[1] See, for example, *Friedman*, and *Phelps*. For a recent critical evaluation see *Grossman*.

imperfect money wage information all that is required is the existence of a learning lag; in the case of imperfect price perceptions learning must take place sufficiently slowly for employment and output to rise. In addition to whatever learning lag exists, the lag of money wages behind prices also plays a crucial role.

I. False Price Perceptions

Assume, for the present, that workers have no difficulty obtaining information about money wage rates but that they may have false perceptions concerning the prevailing level of prices.[2] Consequently, the occurrence of unexpected price change (to which they have not had sufficient time to adjust) will cause workers to misperceive the real wage and to behave non-optimally.

The following notation will be used:

Y = quantity of commodities
L = quantity of labor services
W = nominal wage
P = money price of commodities
$\tilde{P}$ = perceived money price of commodities
$w = \frac{W}{P}$ = real wage
$\tilde{w} = \frac{W}{\tilde{P}}$ = perceived real wage
M = stock of nominal money balances
$\tilde{m} = \frac{M}{\tilde{P}}$ = perceived real stock of money balances

The representative consumer, maximizing utility over what he believes to be his attainable set, will simultaneously make decisions concerning the amount of labor services to provide and the amount of commodities to purchase:

$$L^S = g(\tilde{w}, \tilde{m}),\ g_{\tilde{w}} > 0,\ g_{\tilde{m}} \leq 0 \tag{I.1}$$

$$Y^D = h(\tilde{w}, \tilde{m}),\ h_{\tilde{w}} > 0,\ h_{\tilde{m}} > 0 \tag{I.2}$$

The above functions reflect the plans of the consumer based on his (perhaps faulty) perceptions. What he believes to be feasible may, in fact, not be. For example, if he provides a certain amount of labor

[2] This type of mechanism is contained in *Friedman*.

based on a perception of the real wage which is too high he may find, when he goes into the commodities market, that his resources are insufficient to carry out his planned purchases.

We assume, in equation (I.1), that the income and substitution effects are such that labor supply is an increasing function of the perceived real wage. For most of what follows we assume no real balance effect on labor supply. Commodity demand (equation (I.2)) is taken to be an increasing function of the perceived levels of real wages and real money balances.

The firm, possessing perfect information about current prices, simultaneously decides the amount of labor which to purchase and the amount of output which it would like to sell:

$$L^D = \mathrm{f}(w), \; f' < 0 \tag{I.3}$$

$$Y^S = j(w), \; j' < 0 \tag{I.4}$$

The money wage and the price level are assumed to adjust in response to disequilibria in the labor and goods market respectively.[3]

$$\frac{\dot{W}}{W} = \alpha [f(w) - g(\tilde{w}, \tilde{m})], \; \alpha > 0 \tag{I.5}$$

$$\frac{\dot{P}}{P} = \beta [h(\tilde{w}, \tilde{m}) - j(w)], \; \beta > 0 \tag{I.6}$$

Households adjust their perceptions of the price level as follows:

$$\frac{\dot{\tilde{P}}}{\tilde{P}} = \varrho (w - \tilde{w}), \; \varrho < 0 \tag{I.7}$$

Consumers, attempting to carry out their plans in the goods market, will soon find out if their perception of the real wage (and, hence, of the price level since we assume that the money wage is correctly perceived) is correct or not and will make revisions in the right direction. We assume that consumers' perceptions of the price level are based on some indication of purchasing power (the real wage) rather than on direct observation of the price level itself.[4]

[3] We do not include a trend (for example in the form of the expected rate of price change). Unless the trend entered directly into the demand and supply relations it would have little effect and would require an additional differential equation.

[4] A learning mechanism based on direct observation of the price level would not involve any qualitative change in the characteristics of the model.

In equilibrium (when $\dot{W} = \dot{P} = \dot{\tilde{P}} = 0$) markets are cleared and there are no false perceptions.

Stability conditions for the above system are worked out in appendix A. We note that ϱ large and $\alpha\beta$ small are stabilizing. This seems reasonable since excess demands are functions of the perceived price level. If the markets adjust rapidly and learning proceeds slowly then stability is less likely.

Assume that the demand for goods is excessive because, say, real balances are above their equilibrium level. In Figure 1 the disturbance would shift the $\dot{P} = 0$ locus (and the $\dot{w} = 0$ locus) down; equilibration involves these loci shifting back up to intersect at point A. The patterns of motion are such that, out of equilibrium, the location of the real wage and the perceived real wage will be in the triangle $\overline{ABC}$ (which becomes smaller as the system equilibrates); the system will be characterized by excess demand in both the commodity and labor markets and, since learning takes place with a lag, households perceive the real wage to be higher than it actually is.

Given the way Figure 1 is drawn, out of equilibrium the following will be true: $w < w^* < \tilde{w}$. Both labor demand and labor supply will rise implying that employment and output will rise. This is consistent with *Friedman's* statement that "the simultaneous fall ex poste in real wages to employers and rise ex ante in real wages to employees is what enabled employment to increase."[5]

This sequence of events is dependent on learning being sluggish relative to adjustments in the labor market. The slope of the $\dot{\tilde{w}} = 0$ locus may be positive or negative:

$$\left.\frac{dw}{d\tilde{w}}\right|_{\dot{\tilde{w}}=0} = \frac{\alpha g_{\tilde{w}} - \varrho}{\alpha f' - \varrho} \gtreqless 0 \quad \text{as} \quad f' \gtreqless \frac{\varrho}{\alpha}$$

Picture Figure 1 with a positively sloped $\dot{\tilde{w}} = 0$ locus (i. e., $f' > \frac{\varrho}{\alpha}$). The disequilibrium would look the same except that $\tilde{w} < w^*$. As a consequence labor supply would fall and, assuming employment is given by the short side of the labor market, employment and output

* This illustration can be drawn differently and still be consistent with the assumptions of the model (e. g. the relative slopes of the curves may be reversed). The interpretation would remain the same.

[5] *Friedman*, p. 10.

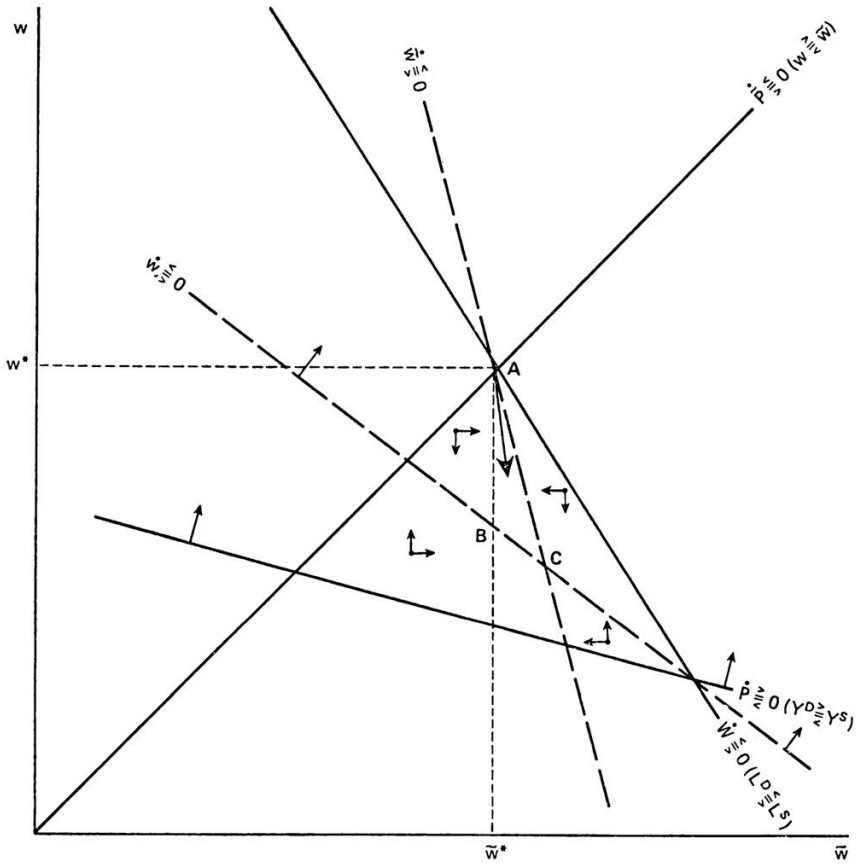

Figure 1

would fall. In the limit, as learning becomes instantaneous $w = \tilde{w}$. (As to the effect of these parameters on the stability of the model, note that they involve only sufficient conditions.)

In summary, the introduction of imperfect price information will result in output and employment rising in response to an expansionary disturbance provided that learning is sufficiently sluggish relative to labor market adjustment. Only if this condition is satisfied will there exist a short run tradeoff between employment and price change.

In response to a contractionary disturbance it can be seen (that referring to Figure 1) the $\dot{P} = 0$ locus and the $\dot{w} = 0$ locus would shift up (from point A). As a consequence the real wage would rise from its equilibrium level. Hence, regardless of what happens to the perceived

wage and labor supply, labor demand, employment and output would fall. The introduction of faulty price perceptions does not have any effect on this pattern of behavior.

II. Money Wage Expectations

Assume now that workers have correct perceptions concerning the price level but that information concerning the prevailing level of money wage rates is costly. In the short run any change in wages may be taken to be job specific and information gathering is necessary to determine opportunities elsewhere.[6]

Define $\overline{W}$ as the expectation of the "normal" money wage and let $\overline{w} = \frac{\overline{W}}{P}$.

Assume the following labor supply function:

$$L^S = g\left(\frac{w}{\overline{w}}, \overline{w}, m\right), \quad g_1 > 0, g_2 = g_3 = 0 \; . \tag{II.1}$$

Labor supply is an increasing function of the ratio of the current real wage to the expectation of the "normal" real wage. If the current wage drops relative to expectations of the normal wage some workers quit to search for new employment. The second argument in the labor supply function represents the labor-leisure tradeoff and we assume that the income and substitution affects cancel each other.[7] In addition we assume that the real balance effect in the labor supply function is negligible.

Commodity demand is written as follows:

$$Y^D = h\left(\frac{w}{\overline{w}}, \overline{w}, m\right), \quad h_1 > 0, h_2 > 0, h_3 > 0 \; . \tag{II.2}$$

As the wage declines relative to the expected wage and workers quit in order to search their demand for commodities will decline. In addition we assume demand is an increasing function of the expected normal real wage and of real balances.

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[6] This type of mechanism is suggested in *Phelps* in his island parable (p. 6) and *Alchian*.

[7] The purpose of this assumption is to focus on search-learning mechanism and its effect on labor supply.

Firms (possessing perfect information) perform their profit maximization calculations which yield the following:

(II.3) $$L^D = f(w),\ f' < 0$$

(II.4) $$Y^S = j(w),\ j' < 0$$

The money wage and the price level respond to disequilibria in the labor and goods markets respectively:

(II.5) $$\frac{\dot{W}}{W} = \alpha \left[f(w) - g\left(\frac{w}{\overline{w}}, \overline{w}, m \right) \right], \quad \alpha > 0$$

(II.6) $$\frac{\dot{P}}{P} = \beta \left[h\left(\frac{w}{\overline{w}}, \overline{w}, m \right) - j(w) \right], \quad \beta > 0$$

Expectations of the "normal" wage adjust according to an adaptive expectations mechanism:

(II.7) $$\frac{\dot{\overline{W}}}{\overline{W}} = \gamma (W - \overline{W}), \quad \gamma > 0$$

In equilibrium (when $\dot{W} = \dot{P} = \dot{\overline{W}} = 0$) markets are cleared and the prevailing wage is considered "normal".

Stability conditions for this system are worked out in Appendix B. Again, rapid adaptation (γ large) is stabilizing (α, β small are also stabilizing); again note that these are not necessary conditions.

A rise in demand, illustrated in Figure 2, will shift the $\dot{P} = 0$, $\dot{w} = 0$ and $\dot{\overline{w}} = 0$ loci and equilibration will involve these loci shifting back to intersect at point A. While out of equilibrium the system will be in the area $\overline{ABCD}$ (which gets smaller as the system reequilibrates). Starting from point A the pattern of motion is indicated in Figure 2.

The area of disequilibrium is characterized by excess demand in both markets and by the real wage being above its expected level ($w > \overline{w}$), and below its equilibrium level ($w < w^*$). The decline in the real wage indicates a rise in labor demand and the rise in $\frac{w}{\overline{w}}$ indicates a rise in labor supply. Consequently employment and output will rise. The assump-

* This illustration can be drawn differently and still be consistent with the assumptions of the model (e. g. the relative slopes of the curves may be reversed). The interpretation would remain the same.

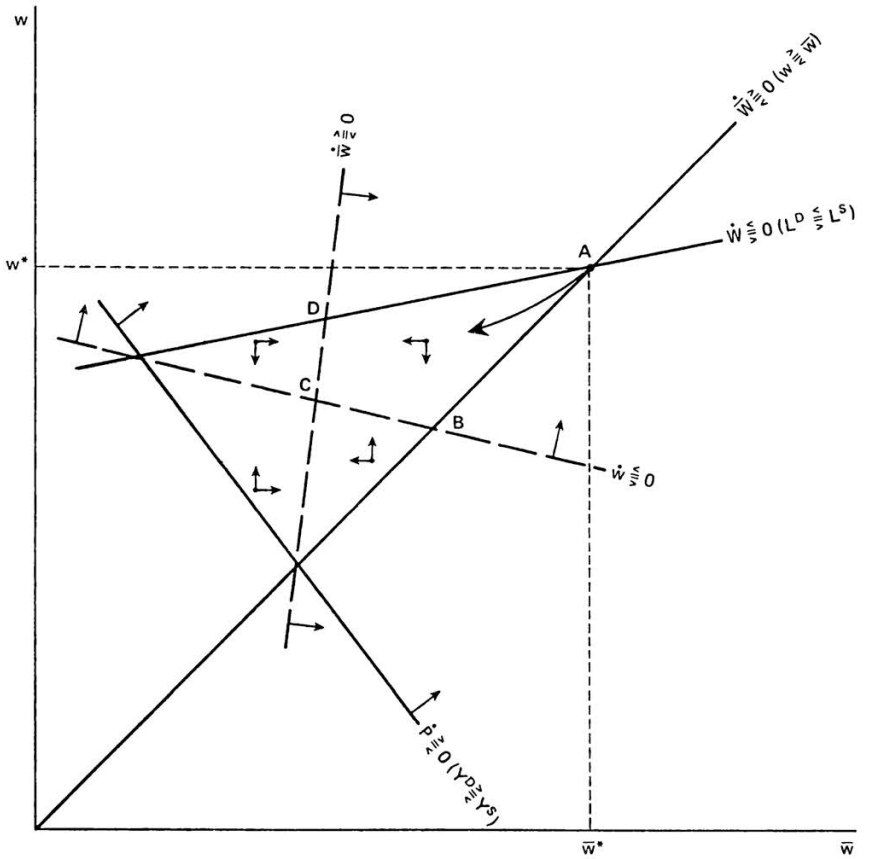

Figure 2

tion of incomplete wage information allows employment and output to rise. Note that in this case the existence of a learning lag assures the result and that it is not dependent on the length of the lag; as long as learning is not instantaneous a short run tradeoff between employment and price change exists.

Alchian, discussing a similar model, indicates that it is the learning lag rather than the lag of money wages behind prices which is important. In the present model both are necessary in explaining deviations from equilibrium since both demand and supply must change. In addition, as can be seen from Figure 2, a disequilibrium path along which the real wage is constant, is not consistent with the model presented here.

An analogous picture can be drawn showing a decline in demand. In this case (as in the model previously discussed) the rise in the real wage will cause labor demand, employment and output to decline. The disequilibrium will be characterized by excess labor supply and, consequently, what happens to labor supply will not be important in explaining the actual deviation from equilibrium; the existence of a learning lag will have no effect.

III. Concluding Remarks

In this paper we have analyzed, within the context of a three good aggregate model, two assumptions of imperfect information which occur in the literature. The major effect of introducing these assumptions occurs under conditions of excess demand. This is the result of combining the short-side domination of disequilibrium with the assumption that firms are perfectly informed. Misinformation only affects households and theirs is the short side of the labor market only under excess demand. Thus, the disequilibrium dynamics under excess supply are not affected. The introduction of imperfect information on the part of households in this sort of model does not contribute to explaining the decline in output and employment which results from a decline in demand.

The introduction of a learning lag on the part of households does provide an explanation for the short run rise in output and employment which results from an increase in demand. When misinformation concerns the money wage the mere existence of a learning lag assures this result. The rise in demand will result in a decline in the real wage and also, as long as any lag exists, in a decline of household expectations of the wage relative to its actual value. Thus, demand for labor by firms and supply of labor by households will rise.

When the misinformation concerns the price level the result is dependent on the length of the lag. Learning must be sufficiently sluggish relative to the speed of adjustment in the labor market. In order for employment to rise the wage perceived by households must rise while the wage paid by firms falls. This may not happen if learning is rapid relative to labor market adjustment.

An additional observation can be made concerning both models discussed; that is that they imply countercyclical movements of employment and the real wage, a pattern of behavior which, apparently, does not correspond to reality.[8]

The analysis contained in this paper necessarily concentrates on the disequilibrium behavior of the models since full information is an equilibrium condition. Without a better developed disequilibrium theory such an analysis contains a certain arbitrary element because the framework being used is essentially an equilibrium framework. However, with that proviso the results hold.

References

1. A. *Alchian,* Information Costs, Pricing, and Resource Unemployment, in E. *Phelps* et al., cited below. — 2. R. *Barro* and H. *Grossman,* A General Disequilibrium Model of Income and Employment, American Economic Review 61, March 1971. — 3. M. *Friedman,* The Role of Monetary Policy, American Economic Review 58, March 1968. — 4. H. *Grossman,* Aggregate Demand, Job Search, and Employment, Journal of Political Economy, 81, November/December 1973. — 5. S. *Morley,* The Economics of Inflation, Hinsdale, Illinois, 1971. — 6. E. *Phelps* et al., Microeconomic Foundations of Employment and Inflation Theory, New York, 1970.

Appendix A

We now examine the local stability of the system described by equations (I.5)—(I.7). Linearizing the system in the neighborhood of equilibrium we get the following coefficient matrix (recall that in equilibrium $P = \widetilde{P}$):

$$\begin{bmatrix} \alpha \frac{W}{P}(f' - g_{\tilde{w}}) & -\alpha \left(\frac{W}{P}\right)^2 f' & \alpha \left(\frac{W}{P}\right)^2 \left(g_{\tilde{w}} + g_{\tilde{m}} \frac{M}{W}\right) \\ \beta (h_{\tilde{w}} - j') & \beta j' \frac{W}{P} & -\beta \frac{W}{P}\left(h_{\tilde{w}} + h_{\tilde{m}} \frac{M}{W}\right) \\ 0 & -\varrho \frac{W}{P} & \varrho \frac{W}{P} \end{bmatrix}$$

The following (Routh-Hurwitz) conditions are necessary and sufficient for stability:

(A) $a_i > 0$; $a_i = (-1)^i$ (sum of i^{th} order principle minors)

(B) $a_1 a_2 - a_3 > 0$

(A1) $$a_1 = -\text{ trace} = -\frac{W}{P}[\alpha (f' - g_{\tilde{w}}) + \beta j' + \varrho] > 0$$

[8] Along these lines see *Barro* and *Grossman,* and *Grossman.*

The above holds unambiguously.

(A2) $a_2 =$ sum of 2nd order principle minors

$$= \left(\frac{W}{P}\right)^2 [\alpha\beta\,(f' h_{\tilde{w}} - g_{\tilde{w}}\, j') + \beta\varrho\,(j' - h_{\tilde{w}}) - \beta\varrho\, h_m \frac{M}{W} + \alpha\varrho\,(f' - g_{\tilde{w}})] > 0$$

A sufficient condition for the above to hold is $f' h_{\tilde{w}} - g_{\tilde{w}} j' > 0$. Alternatively, ϱ large, $\alpha\beta$ small are stabilizing.

(A3) $a_3 = -$ determinant $= -\alpha\beta\varrho \left(\frac{W}{P}\right)^3 \frac{M}{W} [g_m (j' - h_{\tilde{w}}) + h_{\tilde{m}} (g_{\tilde{w}} - f')] > 0$.

This condition holds unambiguously.

$$(B) \quad a_1 a_2 - a_3 = -\left(\frac{W}{P}\right)^3 \{\alpha\beta\,(f' h_{\tilde{w}} - g_{\tilde{w}} j')\,[\alpha (f' - g_{\tilde{w}}) + \beta j' + \varrho]$$

$$+ \alpha\beta\varrho\,(j' - h_{\tilde{w}})\,[(f' - g_{\tilde{w}}) - g_{\tilde{m}} \frac{M}{W}]$$

$$+ \alpha\beta\varrho\, j'\,(f' - g_{\tilde{w}})$$

$$+ \beta\varrho\,(\beta j' + \varrho)\,[j' - h_{\tilde{w}} - h_{\tilde{m}} \frac{M}{W}] + \alpha\varrho^2\,(f' - g_{\tilde{w}}) + \alpha^2 \varrho\,(f' - g_{\tilde{w}})^2\}$$

$$> 0$$

The first and second terms of the above expression are ambiguous while the remaining terms are of the correct sign. Sufficient conditions for stability are $f' h_{\tilde{w}} - j' g_{\tilde{w}} > 0$ and $g_{\tilde{m}}$ small. Alternatively, if ϱ is sufficiently large the above condition will hold.

Appendix B

We now examine the local stability of the system described by equations (II.5)—(II.7). Linearizing the system in the neighborhood of equilibrium we get the following coefficient matrix (recall that in equilibrium $W = \overline{W}$):

$$\begin{bmatrix} \alpha (wf' - g_1) & -\alpha w^2 f' & \alpha g_1 \\ \beta (h_1/w - j') & -\beta [(h_2 - j') w + h_3 m] & \beta (h_2 - h_1/w) \\ \gamma w & 0 & -\gamma w \end{bmatrix}$$

The following are necessary and sufficient for stability:

(A1) $a_1 = -$ trace $= -\alpha (wf' - g_1) + \beta [(h_2 - j') w + h_3 m] + \gamma W > 0$

The above holds unambiguously.

(A2) $a_2 =$ sum of 2nd order principle minors

$$= \alpha\beta \{wf' (h_1 - h_2 w - h_3 m) + g_1 [(h_2 - j') w + h_3 m]\}$$

$$- \alpha\gamma W wf' + \beta\gamma W [(h_2 - j') w + h_3 m] > 0 .$$

A sufficient condition for the above to hold is $h_1 - h_2 w - h_3 m < 0$. Alternatively γ large, $\alpha\beta$ small are stabilizing.

(A3) $a_3 = -$ determinant $= - \alpha\beta\gamma W wmf' h_3 > 0$

This holds unambiguously.

(B) $$a_1 a_2 - a_3 = a_2 \{\beta [(h_2 - j') w + h_3 m] - \alpha (wf' - g_1)\}$$
$$+ \gamma W \{\alpha\beta [wf' (h_1 - h_2 w) + g_1 (w (h_2 - j') + h_3 m)] - \alpha\gamma W wf'$$
$$+ \beta\gamma W [w (h_2 - j') + h_3 m]\} > 0$$

Again, γ large, α, β small are stabilizing.

Zusammenfassung

Über alternative Annäherungen zum dynamischen Phänomen der Beschäftigung

Der Aufsatz vergleicht die Wirkungen von unvollständigen Informationen über Preise und Nominallöhne in einem aggregierten Drei-Güter-Modell. Wenn die Information über Preise unvollständig ist, dann wird die Beschäftigung in Reaktion auf einen expansiven Impuls vorübergehend nur solange steigen, wie der Lernprozeß langsamer verläuft als die Anpassung des Arbeitsmarktes an diesen Vorgang. Wenn die Unterrichtung über die Nominallöhne unvollständig ist, dann ist dieser kurzfristige Zusammenhang zwischen Beschäftigung und Preisveränderung nur vorhanden, solange der Lernprozeß nicht simultan vonstatten geht. Sowohl der Zeitbedarf des Lernprozesses als auch der Zeitabstand zwischen Lohn- und Preisveränderungen spielen eine Rolle. Bei einem kontraktiven Impuls hat die Annahme unvollständiger Information keinen Einfluß auf den eingeschlagenen Beschäftigungspfad.

Summary

On Alternative Approaches to Employment Dynamics

This paper compares the effects of imperfect price and money wage information in a three good aggregate model. When price information is imperfect employment will rise (temporarily) in response to an expansionary disturbance

only if learning is sluggish relative to labor market adjustment. When money wage information is imperfect, this short run tradeoff between employment and price change is obtained as long as learning is not instantaneous. Both the learning lag and the lag of wages behind prices play a role. In response to a contractionary disturbance the assumptions of imperfect information will not affect the employment path followed.

Résumé

Approches alternatives du phenomene dynamique de l'emploi

L'article compare les effets d'informations incomplètes sur les prix et les salaires nominaux dans un modèle réduit à trois biens. Lorsque l'information sur les prix est incomplète, l'emploi ne progressera provisoirement en réaction à une impulsion expansive qu'aussi longtemps que le processus d'apprentissage se déroulera plus lentement que l'adaptation du marché de l'emploi à la situation donnée. Lorsque les renseignements sur les salaires nominaux sont insuffisants, le rapport de courte durée entre l'emploi et la modification des prix n'existe que pour autant que le processus d'apprentissage ne démarre pas simultanément. Tant la durée du processus d'apprentissage que le décalage dans le temps entre les modifications des salaires et des prix ont leur importance. En période d'impulsion contractive, l'hypothèse de l'information incomplète n'a aucune influence sur la voie empruntée par l'emploi.