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Abstract

The rational expectations hypothesis (REH) is based on two assumptions. The first is that, economic agents learn through experience how to avoid systematic errors. The second is that these errors are identified with reference to a model. Imperfect information may lead economic agents to misperceive changes in nominal economic variables as real but they learn from their mistake, change their behavior and will not make the same mistake again. Therefore, relations estimated from historical data may not hold after economic agents learned about the effects of, say, expansionary macroeconomic policies (the Lucas critique). Repeating the policy will affect nominal variables (prices) but not the real economy (policy ineffectiveness hypothesis).

Policy ineffectiveness is derived from models based on neoclassical micro-foundations, claimed to be the basis for rigorous science. In this paper we investigate the learning process rigorously. When pulled into employment by misperceived expansionary macroeconomic policy, what do workers actually learn? Do they actually experience the long-run solution of the neoclassical model? After the introduction we discuss learning in the context of rational expectations. We then analyze the workers' experience and the learning process, strictly applying neoclassical micro-foundations. We focus on two inconsistencies. First, unless unearned income is indexed, inflation will unambiguously cause labor supply to expand. Second, employers will respond to the macroeconomic impulse –misperceived or not-- with capacity expansion rather than pure price reactions. We conclude that the predictions of the REH do not hold if neoclassical micro foundations are rigorously applied.

1. The Policy Ineffectiveness Hypothesis

The REH has shaped the views on macro-economic policies: "Monetary policy is neutral for the real economy," "nominal variables do not affect real variables," "unemployment is structural and cannot be pushed below its 'natural' level by expansionary fiscal or monetary policy." These are the main conclusions of the REH or natural rate theory, widely accepted among central bankers, politicians, and many economists (see consensus e.g. Blanchard 2000, Abel, Bernanke and Croushore 2010, Mishkin 2010). The theory is has also guided the current policies of structural reform and austerity in the European Union.

High inflation and stable unemployment in the 1970s was claimed by Robert Lucas and Thomas Sargeant (1978) to be evidence of the failure of Keynesian economics, or "econometric failure on a grand scale" (Lucas and Sargeant 1978: 57). "That these predictions were wildly incorrect, and that the doctrine on which they were based is fundamentally flawed, are now simple matters of fact, involving no novelties in economic theory" (Lucas and Sargeant 1978: 49). "This conclusion is based in part on the spectacular recent failures of these models, and in part on their lack of a sound theoretical or econometric basis: (Lucas and Sargeant 1978: 69).¹ The core of the "Lucas critique" is changing coefficients in a macro economic model in response to economic agents' learning. Instead of responding to policy impulses in a consistent manner, economic agents vary their reactions according to their experience, i.e. as they learn about the consequences of macro-economic policies. As in the *New Microeconomics* (Phelps et al. 1970) imperfect information causes frictions which require time to be overcome. In Phelps' (1970) island parable, unemployed workers travel among information islands, which are local labor markets, to collect wage information and in this way complete their initially imperfect information. Lucas applied this reasoning to the macro economy. Imperfect information (i.e. incomplete knowledge about the effects of expansionary macro-economic policies) leads workers to confuse changes in nominal variables for real ones² and allow them to accept jobs. Information will be completed through experiential learning. After learning about their misperceptions –ignoring inflationary processes and interpreting nominal variables as real- workers correct their behavior. Once the knowledge is completed, workers form their expectations about macroeconomic stimuli

¹ Alan Blinder (1988) responded to the Lucas/Sargeant (1978) paper arguing that supply shocks can well explain the coexistence of unemployment and inflation in the Keynesian model in the 1970s. He also doubted that high public deficits in that period can be identified as expansionary policy as Lucas and Sargeant did. We agree with Blinder's theoretical arguments but here we will focus on the internal consistency of the Lucas/Sargeant-model.

² In the neoclassical model only real variables are assumed to influence economic behavior.

rationally and do not repeat their mistakes. Erroneous behavior will be random but not systematic and consequently deviations of predicted from actual values would be random but not systematic.

What do economic agents actually learn when they are erroneously pulled into employment by expansionary macroeconomic policy? Well, in new classical macroeconomics they are assumed to learn what the underlying model predicts as the long-run solution: that macroeconomic stimuli do not affect the real economy. With rational expectations and the long-run equilibrium of the neoclassical model they will then behave as if the long-run has already arrived –with some random disturbances. They cut off time, they take the future immediately into the present (Schettkat 2010). Here, the request for microeconomic foundations and theoretical rigor is important in claiming that the true model is the new-classical model assumed to be universally applicable and that all (representative) economic agents discover this model as the true description of the real economy and thus follow its predictions. It is claimed that rigorous (neoclassical) micro-foundations are required as they most accurately describe the true economy. Accordingly workers are assumed to achieve maximum utility and the economy is assumed to be in general equilibrium.³ Unanticipated expansionary macroeconomic policy would disrupt the assumed equilibrium (misperception) but the economy will return to the (real) initial equilibrium, although at a higher price level.⁴

Is expansionary macroeconomic policy ineffective? Does the REH hold? One way to answer these questions is to investigate the assumptions of the model.⁵ However, we investigate the claim of macroeconomic ineffectiveness applying neoclassical micro foundations rigorously, but we analyze the learning process of economic agents in detail.⁶ Learning is “the alteration

³ See Blinder and Solow (1973).

⁴ This reasoning, a short-run quantity reaction of the economy but a return to the initial equilibrium in the long-run is described in almost all contemporary textbooks (see e.g., Blanchard 2000; Mishkin 2010; Abel, Bernanke and Croushore 2010).

⁵ Whether individuals actually behave rationally is investigated in a large literature (e.g., Kahnemann and Tversky 1979, Thaler 1994). In addition, information asymmetries have been widely explored as a mechanism to prevent markets to maximize economic welfare (e.g. Akerlof 1970). We do not discuss the rationality of individual decision making or information asymmetries in this paper, but instead we investigate the issue strictly applying the underlying assumptions of the REH.

⁶ This kind of learning is different from the creation of new knowledge, leading to new products and new production processes. Schumpeterian or Arrow-type learning may induce a dynamic process into the economy. Learning has become a core issue also in growth theory explaining continues productivity growth as shifts of the production function as seminally emphasized by Arrow (1962), a paper which is often regarded as the start of “new growth theory.” Schumpeter (1911) also relates growth to change, the ‘destruction’ of old technologies and products by new products and production processes. These are disequilibria situations in which profits are generated which eventually disappear through imitation.

of behaviour as a result of individual experience” (*Encyclopedia Britannica* 2013). Thus, learning requires time. We focus on the learning process asking the natural question, how economic agents gain information about the model -- assumed to replicate the true behavior of the actual economy -- and its parameters. In Lucas, learning is used simply as a metaphor for discovering the long run outcome of the neoclassical model assumed to be the true model. Economic agents simply learn by experience but it remains unclear what they actually discover.

Will their experience be consistent with the long-run equilibrium of the assumed model; will it be the same as the starting position? What do workers learn when confronted with a macroeconomic stimulus? Do workers think that they have been deceived in a boom, do they regret the boom and their decision, which brought them into employment and do they learn that they have made a mistake, as the Lucas analysis claims? Or is their experience different from what Lucas claimed? What do agents experience? What do they learn if the economy is pushed out of the long-run equilibrium by expansionary macroeconomic policy?

Lucas argued that economics analyses behavior in or close to equilibrium (Lucas 1986). But what actually happens if economic agents are "fooled" by an expansionary policy - fiscal or monetary – and raise labor supply, take jobs, hire or invest? In other words, do short-run reactions in real economic variables – even if undertaken in error – affect the real economy? Can interim responses of economic agents change the real economy?

We investigate two core arguments. First, strictly applying the neoclassical labor supply model, are workers withdrawing from employment after inflation ate up the nominal wage gain which had drawn them into employment? Second, even if the assumption of full employment equilibrium (i.e. the optimal use of all resources) is assumed, does the inflationary process proceed as predicted even strictly within neoclassical microeconomics?

2. Rational Expectations

Who admits having irrational expectations about the economic future? Indeed, it was widely accepted that economic agents use available information and form expectations of future trends rationally.⁷ Forward-looking decisions based on rational expectations substituted adaptive expectations based on past trends in economic theory, agents were assumed to learn (i.e. forming expectations to avoid systematic errors). To identify errors, however, requires a reference, a model of the true economy. Rational expectations, are according to John Muth (1961) informed predictions of future events and they are essentially the same as the predictions of the relevant economic theory. "I should like to suggest that expectations, since they are informed predictions of future events, are essentially the same as the predictions of the relevant economic theory" (Muth 1961: 316.) Economic agents form their expectations as if they know the economic process, which generates an equilibrium. By this standard, however, also predictions based on other than the neoclassical model (e.g., a model allowing for a response to nominal variables) could be applied in rational expectations analysis. Therefore, rational expectations as used in the economic literature requires more than just the informed formation of expectations, it requires a reference to judge whether deviations of expected and actual values are systematic. Lucas and others claimed this reference to be the neoclassical model, defining the application of neoclassical micro foundations as rigorous science discarding other approaches. As commonly used in economics, rational expectations are expectations, which fit the solution of a specific model assumed to present the true economic relations.

Although new-classical macroeconomics assumes quick responses of prices – a major distinction from new Keynesians who regard price adjustments as slow- and that equilibrium is reached quickly, a natural question is, what happens in the meantime? What happens if the economy is out of equilibrium (shifted away from the initial state assumed to be optimal)? In textbooks, comparative static analysis dominates and it is usually shown that a shift in the aggregate demand function along the aggregate supply function leads initially to a substantial quantity effect and to a partial price effect (see e.g., Blanchard 2000, Abel, Bernanke and Croushore 2010; Mishkin 2010). After a while, however, it is assumed that the aggregate

⁷ For a test on the use of easily available information on expectation see Friedman 1980.

supply function shifts up and that equilibrium is reached at the initial quantity but at a higher price level.⁸

If errors are not just the deviation of actual values from predicted values but if they are identified as systematic, this requires a reference, a model. How do economic agents learn that decisions suffer from systematic errors? They learn by experience. "Economics has tended to focus on situations in which the agent can be expected to 'know' or to have learned the consequences of different actions so that his observed choices reveal stable features of his underlying preferences" (Lucas 1986: 218). But what do workers experience, and what do they learn from expansionary macroeconomic shocks?

Lucas uses the long-run equilibrium of the neoclassical model as reference but abstracts from time, from the experience that leads agents to learn about the long-run equilibrium. Learning is simply taken as a metaphor for acquiring knowledge about the model without investigating the learning process. George Akerlof (1970) showed in "The Market for Lemons" that overcoming incomplete information on the buyers' side (asymmetric information) through learning about the quality of used cars offered in the market leads to the extinction of the market. Once the buyer learned that all of the used cars offered were lemons, she adjusted her expectations and lowered her reservation price, which was then followed by a further decline in the quality of used cars offered. In Akerlof's model, learning about the quality of used cars leads to the decline in the reservation price, which causes a decline in quality. Positive feedback leads to equilibrium when the market is exhausted. Under REH, potential buyers would also have to learn about the quality of used cars. But once economic agents understood imperfect (here asymmetric) information, the market for used cars would be exhausted immediately. Thus, what happens if expansionary policies are applied the first time? What will workers learn about the underlying true model of the economy?

However, learning requires time, workers need time to discover that they were misguided by nominal variables and that they erroneously accepted jobs, which drove them away from their utility maximizing position. Employers need to learn that they erroneously hired additional workers and that they probably erroneously invested. But what is occurring while additional workers are in employment? Is the economy unchanged or may intermediate action create a new equilibrium?

⁸ For a criticism of this reasoning see Schettkat and Sun 2010.

3. Micro-foundations and Learning

Starting from a situation where workers maximized their utility, (unemployed workers choose not to work and only a wage rise can bring them into employment) Lucas and Sargeant (1978) argued that workers may misunderstand the effects of expansionary macro policy but that they will quickly learn that such policies affect nominal variables only (prices) and thus lead to inflation only. Therefore, an expansionary macro policy may initially affect the real economy as derived from the Keynesian model but when repeated, workers have learned that – eventually-- their nominal wages increase but their real wages return to the initial level.⁹ Workers will respond to this experience, they will then form rational expectations about the effects of expansionary policy, which is assumed to be inflation only, and will no longer react to expansionary policies. That is the short-run reaction under rational expectations and is the same as the long-run equilibrium in the neo-classical model. Information imperfections are eliminated through learning. "Rational expectations theory is a stochastic form of perfect foresight" (Arrow 1986: 316).

Thus, economic agents are assumed to know (or to have learned) the right model and they know the values of the parameters –which is supposed to be the new classical model-- reproducing the true relationships. This reasoning is, according to Lucas and Sargent (1978) why rising prices and high unemployment (stagflation) could be observed in the 1970s. Based on neoclassical micro-foundations, Lucas and Sargent's conclusion is not as clear-cut as their application of comparative statistics suggests. Although new-classical macroeconomics ostensibly provides consistent microeconomic foundations, the foundations are actually inconsistent with the neutrality of macroeconomic policy. Only rational expectations -- the short-cut to the long-run neoclassical solution -- solves the problem but assumes away the intermediate effects on real variables. Continuing the analysis as if the period of mistake had not happened, as it did not have any effect on the real economy (other than price changes), however, is misleading.

If workers take up jobs even if misled by nominal wage rises as a result of expansionary policy, what do they do in the period when they are misled? If employers hire additional workers, what do they have them doing? Unless productivity drops substantially when

⁹ In Lucas and Sargeant (1978: 65): 'Employers and workers are fooled into too many jobs by unexpected inflation, but only until they learn it affects other prices, not just the prices of what they sell. The reverse happens temporarily when inflation falls short of expectation. This model can scarcely explain more than transient disequilibrium in labor markets.'

additional workers enter the workforce, there will be additional (real) output. Although prices may rise, additional output will dampen inflation. In addition, what happens to unearned income -- capital or transfers-- does it rise with nominal wages?¹⁰

3.1 First inconsistency: Positive labor supply response corrected after learning about inflation? (unearned income declines in real terms)

In the Lucas model, an unexpected expansionary policy pulls unemployed workers into employment because workers mistake the rise in nominal wages as a rise in real wages. They erroneously increase labor supply and abandon their no-work-optimum. Non-employed workers were at a corner-solution, their reservation wage was higher than the achievable wage. When workers accept employment, the substitution effect is assumed to dominate the income effect. Then it is argued that an inflationary process starts, which diminishes the nominal wage increase initially perceived as a real wage rise until it disappears and real values return to the initial level, i.e. workers choose the same position as before they quit and leave employment. Neoclassical micro-foundations formulate labor supply as a choice between leisure (L) and income (consumption, C). Since more consumption (higher income) requires less leisure, the individual has to determine the utility of maximizing hours worked (h) as a function of the wage (W), unearned income (V , capital income or transfers) and the price level (P), because economic agents are assumed to base their choices on the real values (no money-illusion) of wages ($w = W/P$) and unearned income ($v = V/P$).

$$(1) \quad h = h(W, V, P); \quad h = h(w, v)$$

$$(2) \quad u = u[C(w, v), L(t-h(w, v))]$$

The effect of v on L is direct because leisure is assumed to be a normal good; in other words, consumption of L rises with income (the income effect). The effect of w , however, is ambiguous because the wage affects income but also the price of leisure. A wage rise will cause two effects: the income effect reducing h , and the substitution effect raising h . The effect that dominates of is theoretically in-determined. Only a rise in unearned income (v) affects h unambiguously and negatively.

¹⁰ Inflation will hit unearned and earned income similarly.

Because it is assumed that workers are pulled into employment by a wage rise initiated by expansionary macroeconomic policy, the wage must now be higher than the reservation wage of those workers who had previously chosen not to work. As illustrated in Figure 1 the (mis)perceived wage rise lets workers move away from the corner solution (A) into employment (B). In the neoclassical labor supply model, the substitution effect presumably dominates the income effect. Since the economy is assumed to be in equilibrium before the policy shock (i.e., all resources –capital and labor-- are assumed to be fully employed) workers' labor supply is optimal (utility maximizing), 'not working' is chosen. Bringing workers into employment requires higher (perceived real) wages.

Why should there be inflation in response to expansionary macro-economic policy? What will happen to workers erroneously pulled into employment? Will their wage rise be eaten up by higher prices? Will all income components (earned and unearned income) be affected similarly?

As prices rise, the initial wage rise (dotted line in Figure 1) will be reduced until the starting real wage is achieved again. The worker will quit employment and will return to the initial corner solution. The assumed inflationary process will compensate for the initial rise in nominal wages. However, since prices do not rise immediately, there will be a real wage gain, at least for some time. After a while, however, prices may have compensated for the initial wage rise and workers will voluntarily return to not working.

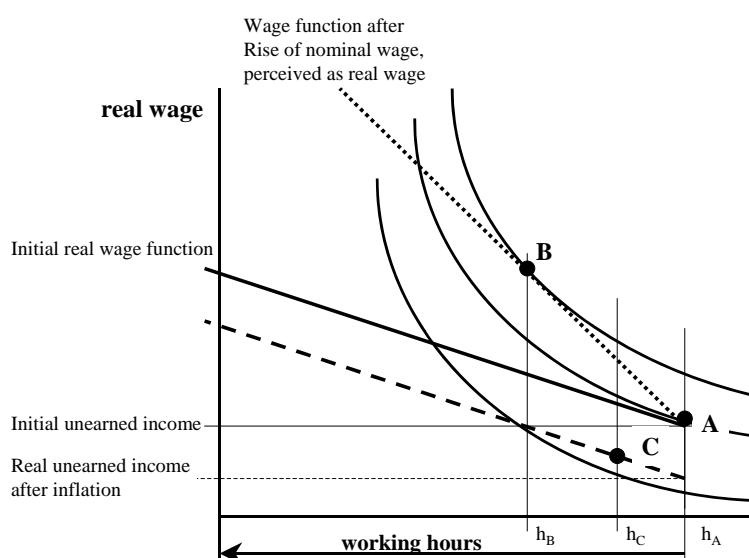
Not only wages are subject to inflation, but also unearned income will suffer from higher prices. Unless unearned income is indexed, its real value will be lower after the expansionary macroeconomic policy shock. Lower v will unambiguously increase the labor supply of former incumbent workers and of those workers pulled into employment by the expansionary macroeconomic policy shock.¹¹ Thus even if higher prices fully compensate for the initial nominal wage rise, a reduced value of v will cause a positive labor supply effect (illustrated in Figure 1 by the downward shift of the wage function -- dotted line).

Additional workers pulled into employment will produce additional output until they withdraw. However, the addition of workers might reduce productivity. Capital utilization is always somewhat flexible although additional workers may not work with the marginal productivity as the already employed workers. (We discuss this issue in the next section.) The

¹¹ Whether it needs a rise in wages to pull people into employment is questionable, but it is the underlying assumption in Lucas/Sargeant (1978).

labor supply of the incumbent workers, those who had worked before the expansionary policy shock, may return to their initial position in the labor supply. But if they also see a decline in real unearned income, they would expand their labor supply.

Figure 1: Labor Supply effect of lower real unearned income



3.2 Second inconsistency: Why do employers hire in the short-run?

If workers are pulled from unemployment into employment, someone must hire them. But who hires additional workers at higher wages if the capital-labor ratio is at the optimum, when it is cost minimizing? When firms hire, they obviously want to serve increased demand and want to produce more.¹² But assuming that the economy is in unit-cost minimizing equilibrium firms produce at the optimal (cost minimizing) capital-labor ratio, several situations may occur:¹³

¹² Under certain conditions, agents will tend temporarily to mistake a general increase in all absolute prices as an increase in the relative price of the good that they are selling, leading them to increase their supply of that good over what they had previously planned. Since everyone is, on average, making the same mistake, aggregate output will rise above what it would have been. This increase of output will rise above what it would have been.

¹³ Deviating from the full employment assumption one may assume idle capital and an expansionary macroeconomic impulse could result in hiring additional workers.

Capital stock flexible

Given a production technology with constant returns to scale, firms with unchanged relative factor prices would expand labor and capital at the same proportions to meet increased demand. The latter, of course, creates even more demand in the economy. However, given the labor supply assumptions (see above) additional workers can only be hired at higher wages. Unless capital costs are indexed to wages, relative input factor costs change in favor of capital thus leading to a substitution of labor by capital requiring an additional rise in the capital stock.

Capital stock constant (in the short-run?)

If the capital stock cannot be adjusted (probably a short-run friction) firms can expand output along the production function moving away from the optimal capital-labor ratio. Marginal productivity of labor will decline. Additional workers' productivity thus is lower although wages are rising. If input factors are compensated according to their marginal productivity, wages should fall rather than rise. Cost minimizing factor combinations would require some labor to be substituted by capital, which again requires investment, lifting demand.

Inelastic product supply

If firms perceive the demand expansion to be short-lived and if attracting additional workers requires higher wages, they may not expand production, so the product-supply function would be totally price-inelastic. Then, however, an expansionary impulse will result in rising prices immediately canceling out the expansionary effect. There will be no additional jobs and no hiring of unemployed workers. The latter may misperceive a possible rise in nominal wages¹⁴ but additional labor supply may increase but firms will not hire additional workers if relative factor prices remain unchanged. With investment, the neoclassical model requires lower (real) wages rather than higher –if only intermediately real-- wages.

In the textbook version (e.g., Mishkin 2010) of the REH or the deduced macroeconomic ineffectiveness hypothesis, the economy expands output (and employment) in the short run but not in the long run, because the supply function is assumed to shift up. Why is product supply in the long-run totally price inelastic but not in the short-run? With the assumptions of the neoclassical production function –constant returns to scale, decreasing marginal productivity of input factors-- it is implausible that the short-run reaction is an expansion of

¹⁴ why should wages rise if no additional workers are hired?

real production and that the long-run reaction is a pure price effect. Why would employers hire workers with lower marginal productivity but leave the capital stock unchanged? Why would they return to the initial factor proportions by reducing their workforce instead of raising the capital stock? If the capital stock is assumed to be constant (and inflexible) in the short-run, rising prices should occur in the short-run. But with totally price inelastic product supply, no hiring and no mistakes of workers should occur. In this case, the cause of the claimed rise in nominal wages remains unclear. Prices may rise, depressing the real wage and which should lead, according to the labor supply function, dominated by the substitution effect (see above) to decline in labor supply.

Unemployed workers may be pulled into employment by a nominal wage rise that has been misperceived as a real wage rise, but why would employers expand production and hire additional workers in the short-run and correct their mistake only in the long-run?

4. Conclusion

The REH states that in response to a first-time expansionary macroeconomic impulse, workers are pulled into employment by rising wages. Therefore, firms must offer higher wages. After some time, these recently hired workers realize that the wage rise was nominal rather than real and they thus quit and return to their utility maximizing position: unemployment. Workers learn from that experience and do not make the same mistake again. Accepting the neoclassical assumptions of labor supply and production, we analyze the learning process and find the following flaws in the REH. First, the impact of inflation on unearned income will unambiguously raise labor supply of the formerly unemployed and of the incumbent workers. Labor supply increases even if the assumption that real wages return to their initial value holds, unless unearned income is indexed.

We can find another inconsistency of the REH in firms' behavior: Assuming a neoclassical production function with constant returns to scale technology and decreasing marginal productivity of input factors, the capital stock should rise if firms perceive the expansionary macroeconomic impulse as real.¹⁵ Firms may move along a given production function and use more labor -- a declining marginal productivity of labor but rising wages -- claimed to be necessary to pull unemployed workers out of their initial utility-maximizing position into employment-- but they should try to correct the sub-optimal capital-labor ratio either through investments or by the dismissal of parts of their workforce. Since firms are assumed to hire, they obviously expect --probably incorrectly-- the demand expansion to be real and therefore it seems to be more likely that they expand capital and thus capacity.

When workers take up employment and employers hire and probably invest, output increases. Why then should inflation occur, or more precisely, why should one assume that inflation exactly cancels out the initial (nominal) expansionary impulse? But if employers assume that demand will be higher-- as they obviously expected when hiring additional workers -- they may invest and raise the capital stock, probably bringing marginal productivities back to their

¹⁵ If firms cannot expand production at all, i.e. if the product-supply function is totally inelastic, a rise in prices will immediately compensate the expansionary effect. Then, however, no firm hire additional worker. Even if labor supply would rise, it would be reflected in higher unemployment only.

initial levels.¹⁶ Marginal productivity of labor may be back at its initial level but wages may still be above productivity causing a substitution of labor through capital.¹⁷

To summarize, even within the neoclassical model -- the model claimed to be essential for micro-foundations -- the experience of workers may not be what the REH claims. Rigor and micro-foundations may actually lead to the conclusion that workers see a rise in real production probably with some but most likely not fully compensating price rises in response to a macro-economic impulse. Even if the initial nominal wage rise -- whether higher demand in the economy leads to higher wages is questionable -- is fully compensated by inflation, non-work income -- i.e. transfers-- will decline in real terms. If employers hire, they obviously expect higher demand to be real, so they may invest in capacity expansion rather than raise prices. Thus taking learning and neoclassical micro-foundations serious workers and employers will find expansionary macroeconomic policy to be effective. The REH seems to be inconsistent on its own neoclassical micro-foundations.

¹⁶ Investment may induce technological progress as seminally emphasized in Arrow (1962) and Kaldor (1957).

¹⁷ Empirically productivity growth is pro-cyclical because in recessions some capital and labor seems to be idle allowing labor productivity to behave pro-cyclical [as Keynes --initially assuming that higher employment requires lower real wages- had to admit when confronted with the analysis of Dunlop (1938) and Tarshis (1939)].

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