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Underemployment, Irreversibilities and Growth under Trade Unionism*

David de la Croix

National Fund For Scientific Research and University of Louvain, Belgium

Omar Licandro

FEDEA and University Carlos III, Madrid, Spain

Abstract

The effects of irreversibility and uncertainty are analyzed in a unionized economy with overlapping generations. Irreversible decisions about technology and physical and human capital are made under uncertainty and generate underutilization of labor and equipment not only over the convergence path, but also at steady state. The related inefficiency negatively affects the accumulation process by reducing the per-capita capital stock at steady state. The effect of union power on capital is ambiguous and depends crucially on the presence of irreversible decisions.

I. Introduction

The aim of this paper is to analyze the effects of irreversible decisions and uncertainty on the accumulation process in a standard overlapping generations economy. The fact that economic agents have to take irrevocable decisions under uncertainty about their future environment is an important feature that may affect the growth path of actual economies. We consider three types of irreversibilities: technological (a putty-clay technology), physical capital (the capital stock is firm specific and cannot be marketed elsewhere) and human capital (firm-specific labor markets). The effect of these irreversibilities on growth are studied through two channels.

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First, irreversibilities may account for the fact that both labor and capital can remain underutilized over very long periods of time, which is one of the most striking puzzles in macroeconomics. Standard growth theory neglects not only the idea that the labor market is characterized by persistent underemployment but also that equipment could remain underutilized at length. These two facts affect the accumulation process and therefore the long-run movements of the economy. The growth model of this paper displays persistent unemployment and underutilization of equipment, without requiring any price rigidity assumption. It is shown that long-run underutilization of productive factors can be due to a combination of the following two elements:[1] (i) irreversibility of capital, technology and skill decisions (implying firm-specific skills), (ii) firm-specific shocks on productivity. Underemployment results from the fact that the irreversible skill decisions of households and the investment decisions of firms are taken without knowing with certainty the firms' productivity in the next period. This implies that agents invest their human and physical capital in some firms that will be hit by a negative shock, generating underemployment of their resources, while other firms are hit by a positive shock, but are unable to benefit fully from it, because there is a lack of capital and skills in their particular micromarket. The reality that (i) some sectors report skill shortages even when unemployment is very high, and (ii) unemployment rates for particular skills, regions and industries seem very persistent, suggests that an important part of actual unemployment is linked with segmentation and irreversibility of past decisions.

Second, irreversibilities affect the way unions influence accumulation. Devereux and Lockwood (1991) have shown that the effects of unions on capital accumulation in a general equilibrium perspective are very different from those in partial equilibirum, as in Grout (1984). This is basically due to the fact that the interest rate is made endogenous. An important result of Devereux and Lockwood (1991) is that union power may positively affect the capital stock. This is because an increase in union power increases the wages and savings of the young generation. However, their example depends crucially on their assumption of zero depreciation of the capital stock. We assume full depreciation after one period, which is more consistent with our irreversibility assumption. In this case, it is shown

[1] The literature on quantity rationing models contains some general equilibrium examples of the existence of unemployment and underutilization of capacities at equilibrium; cf. Sneessens (1987), Licandro (1995) and Arnsperger and de la Croix (1993). In a partial equilibrium model, Malinvaud (1980) and Licandro (1992) show that, with a Leontief technology and firm-specific uncertainty, capacities are generally underemployed, even at steady state.

that a rise in union power may induce a crowding-out of physical capital by pure profits. The rise in union power is therefore less favorable to physical capital in the presence of irreversibility and its effect may even become negative.

II. The Model

The model is an overlapping generations model with perfect competition on the goods market and wage bargaining in the labor market. N_t represents the members of generation t, and n the growth rate of the population. Individuals live for three periods. They are children in the first period, young workers in the second period and old capitalists in the third period. Children do not work and do not consume but they must choose a firm-specific human capital i.[2] There is a continuum of labor markets in the interval [0, 1]. In each labor market, denoted by i, the N_t young-workers are organized into a union. We assume there is one firm in each labor market (returns to scale are assumed constant).

In our framework, irreversibility is based on the following three assumptions: (a) Human capital and physical capital are decided one period in advance. Associated with the capital stock there is a given technology implying that the capital-labor ratio is chosen at the same time that the equipment is bought.[3] (b) The factors of production are firm specific, i.e. the labor market is segmented and human and physical capital cannot be valuable in other firms. (c) Human and physical capital have depreciated after one period. Full depreciation is a means to avoid the possibility of firm-specific physical capital becoming an homogeneous good again at the end of the period.[4]

The timing, even if it is relatively standard, is relevant in generating underemployment of productive factors. Technological and accumulation choices are made one period in advance under uncertainty concerning the productivity of capital. This uncertainty is only firm specific so that there is no aggregate uncertainty. At the same time, children choose a firm-specific human capital. Since expected labor incomes are the same for all types of human capital, children are uniformly distributed over the different segments of the labor market (the number of workers in each segment of

[2] The introduction of children into the model is a simple way to rationalize skill decisions. This does not modify the formal structure of the model, so that it is comparable to the standard two-period Diamond (1965) model.

[3] This putty-clay technology, as in Malinvaud (1980), is the simplest way to account for the fact that *ex-post* capital/labor substitutability is limited.

[4] Alternatively a positivity constraint can be imposed on investment; see Dixit and Pindyck (1994).

the market at period t is equal to N_t), and they select their qualifications randomly and costlessly. The other decisions are made after the realization of the technological shock. The union and the firm bargain over wages as in a standard "right-to-manage" model. The young worker consumes, saves for future consumption and offers inelastically one unit of labor. The old capitalist sells his shares and debts issued by firms and consumes. Firms live infinitely, hire labor, buy capital and produce. They borrow from individuals to finance their investments. Any pure profits at equilibrium are distributed to the shareholders.

Consumption and Savings

Individuals have preferences over consumption when young c_{1t} and consumption when old c_{2t+1}. These preferences can be represented by a Cobb–Douglas utility function, which is the same for all individuals from all generations. However, individuals from the same generation have a different labor endowment, since labor is firm specific. An individual of generation t, with specific labor endowment i, solves the following problem

$$\max_{c_{1it},\, c_{2it+1}} c_{1it}^{\theta} c_{2it+1}^{1-\theta} \quad \text{subject to} \quad c_{1it} + \frac{c_{2it+1}}{1+r_{t+1}} = w_{it} l_{it}$$

with $0 < \theta < 1$ and $l_{it} \in \{0, 1\}$. The real wage w_{it} and the interest rate r_{t+1} are given, and employment l_{it} can be 1 if employed or 0 if unemployed. The first-order conditions for this problem are $c_{1it} = \theta w_{it} l_{it}$ and $c_{2it+1} = (1-\theta)(1+r_{t+1}) w_{it} l_{it}$. The corresponding individual savings s_{it} are

$$s_{it} = (1-\theta) w_{it} l_{it}. \quad (1)$$

The indirect utility function of a young worker of generation t is proportional to

$$w_{it}(1 + r_{t+1})^{1-\theta}, \quad (2)$$

if he works and equal to zero if he is unemployed.[5]

Output and Employment

The firm's technology is putty-clay. Defining the *ex-ante* capital-labor ratio as x_{it}, the *ex-post* average labor productivity is $x_{it}^{1-\alpha}$, and the corresponding *ex-post* average capital productivity is $x_{it}^{-\alpha} \mu_{it}$. The parameter α

[5] Since utility is linear in labor income, workers are risk neutral concerning employment and they are not interested in an unemployment insurance system (strictly speaking, they are indifferent). In any case, the existence of such a system does not affect the equilibrium.

satisfies $0 < \alpha < 1$. The averge productivity of capital is assumed stochastic, where μ_{it} is an idiosyncratic productivity shock coming from a known distribution $F(\mu; \xi)$, the same for all i and t. ξ is a vector of known parameters. We assume for simplicity that the productivity of labor is not stochastic. The *ex-post* production function is Leontief. Given that in each segment of the labor market employment should be lower or equal to labor supply N_t, production must satisfy:

$$Y_{it} \leq \min\{x_{it}^{1-\alpha} N_t, x_{it}^{-\alpha} K_{it} \mu_{it}\}. \tag{3}$$

where K represents capital. This says that the firm faces two constraints in production: (i) the *full-employment constraint* which is equal to the number of labor suppliers in this segment of the labor market N_t multiplied by their average productivity, and (ii) the *capacity constraint* which is equal to the capital stock K_{it} times its average productivity. All components of both constraints were decided in the previous period. As long as wages are lower than the productivity of labor, optimal output and employment are given by

$$Y_{it} = x_{it}^{1-\alpha} L_{it} \tag{4}$$

$$L_{it} = \min\left\{N_t, \frac{K_{it}}{x_{it}} \mu_{\iota\tau}\right\}. \tag{5}$$

If the productivity shock is *bad* (i.e. if $\mu_{it} \leq N_t x_{it}/K_{it}$), capacities are smaller than full-employment output, the capacity constraint determines employment and there is *ex-post* involuntary unemployment (in the sense that unemployed persons are willing to work at the equilibrium wage). If the productivity shock is *good* (i.e., if $\mu_{it} \geq N_t x_{it}/K_{it}$), full employment occurs in this segment of the labor market.

Wages

As stated before, the negotiation process is decentralized. In each segment of the labor market, the firm and union bargain once the capital stock has been installed by the firm. The bargaining process is modeled using the generalized Nash bargaining solution. The utility of the union is the sum of the indirect utility (2) of its members. The fallback utility is zero. Since the installed capital cannot be sold to other firms, even in case of breakdown in the negotiation, the expected fallback profits are $-(1+r_t)K_{it}$. Therefore, net profits are $Y_{it} - w_{it}L_{it}$. Each union-firm couple maximizes

$$\max_{w_{it}} (L_{it} w_{it}(1+r_{t+1})^{1-\theta})^{\beta} (Y_{it} - L_{it} w_{it})^{1-\beta}, \qquad 0 < \beta < 1$$

subject to equations (4) and (5). The parameter β represents the relative power of the union in the negotiation. Given that the interest rate is exogeneous at the firm level, the first-order condition for this problem is

$$w_{it} = \beta x_{it}^{1-\alpha}. \tag{6}$$

The wage is a share β of average labor productivity. It does not depend on the realization of the shock.[6] Note that pure profits are on average positive because the firm has a positive power in the labor market.

Uncertainty

We assume that the productivity shock μ_{it} is lognormally distributed with unit mean, i.e., $\log \mu_{it} = -\sigma/2 + \varepsilon_{it}$, $\varepsilon_{it} \sim N(0, \sigma^2)$. From Lambert (1988), expected production can be approximated by a CES function of the two expected constraints:

$$E(Y_{it}) = ((x_{it}^{1-\alpha} N_t)^{-\rho} + (x_{it}^{-\alpha} K_{it})^{-\rho})^{-1/\rho}, \tag{7}$$

where ρ is a function of the variance of the shock:

$$\rho = -1 + \frac{2}{\sigma} \frac{f(-\sigma/2)}{F(-\sigma/2)}.$$

F is the standard normal distribution and f the corresponding density function. The interpretation of equation (7) is made clearer by considering Figure 1. The upward sloping curve describes the known full-employment output as a function of the *ex-ante* capital/labor ratio. This ratio affects the constraints positively through the *ex-post* productivity of labor. The downward sloping curve describes the *expected* capacity constraint. If the location of this constraint was known with certainty, output and expected output would coincide and would simply be equal to the minimum of the two constraints. However, this is not the case since the capacity constraint is affected by a random term. Lambert's result says that expected output can be approximated by a CES function of the two constraints. The distance between the CES and the lines is positively affected by the variance of the shock. An increase in σ (i.e., in $1/\rho$) moves the CES to the west.

[6] Note that if the labor market was characterized by perfect competition, wages would differ across firms. If the productivity shock was bad (capacities are smaller than full-employment output), the real wage would then be equal to the reservation wage (here 0) and there would be voluntary unemployment ($L_{it} < N_t$). If the productivity shock was good, the wage would be equal to marginal productivity and employment would be equal to N_t.

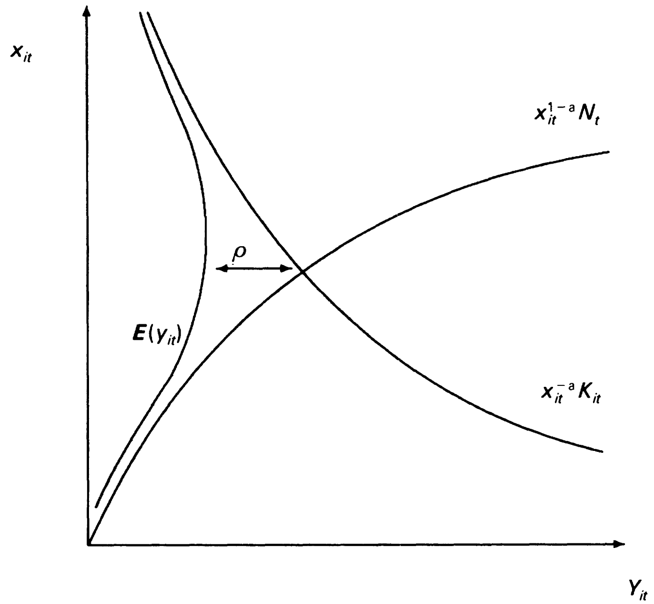

Fig. 1. Expected production.

Technology

At period $t-1$ there is uncertainty concerning the average productivity of capital for coming periods. The firm chooses the capital stock and the capital/labor ratio for time t by maximizing the expected flow of profits, subject to the outcome of the future negotiation given by equation (6).[7] Given that there are no adjustment costs, the problem of the firm is a one-period problem. Using (7), (6) and (4), the optimal capital stock and the optimal capital/labor ratio are given by:

$$\max_{K_{it},\, x_{it}} \quad (1-\beta)((x_{it}^{1-\alpha}N_t)^{-\rho}+(x_{it}^{-\alpha}K_{it})^{-\rho})^{-1/\rho}-(1+r_t)K_{it}.$$

The first-order condition for the capital/labor ratio is:

$$x_{it}=\left(\frac{1-\alpha}{\alpha}\right)^{1/\rho}\frac{K_{it}}{N_t}, \tag{8}$$

[7] The firm takes into account the effect of the capital stock and technological decisions on the wage level in the next period.

Equation (8) says that the optimal capital/labor ratio is proportional to the capital stock per capita, where the constant depends on the ratio of marginal productivities. With a more general technology, x is a nonlinear function of the capital stock per capita.

The first-order condition for the capital stock merged with (8) gives:

$$1+r_t=(1-\beta)(1-\alpha)x_{it}^{-\alpha}(1-\alpha)^{1/\rho}. \tag{9}$$

The marginal cost of capital is equal to the firm's share $(1-\beta)$ of the expected marginal productivity of capital $((1-\alpha)x_{it}^{-\alpha})$, weighted by $(1-\alpha)^{1/\rho}$. This last term measures the extent to which capacities are expected to be used.[8]

III. The Aggregate Equilibrium

Since all firms are *ex-ante* identical (uncertainty is i specific and there is no aggregate uncertainty), they will all choose the same capital stock and the same capital/labor ratio. Conditions (8) and (9) verify at the aggregate, i.e.,

$$1+r_t=(1-\beta)(1-\alpha)^{1+(1/\rho)}x_t^{-\alpha} \tag{10}$$

$$x_t=\left(\frac{1-\alpha}{\alpha}\right)^{1/\rho}k_t, \tag{11}$$

where $k_t=K_t/N_t$ is the capital stock per capita. Moreover, since x_t is the same for all firms, all union-firm couples set the same real wage (equation (6)):

$$w_t=\beta x_t^{1-\alpha}. \tag{12}$$

Finally, aggregate output and aggregate employment are equal to the firm's expected output and employment, implying that (from equations (4) and (7)):

$$l_t=\left(1+\left(\frac{k_t}{x_t}\right)^{-\rho}\right)^{-1/\rho} \tag{13}$$

[8] From Lambert, the weighted probability of being capacity constrained is given by

$$P_w[Y_{it}=x_{it}^{-\alpha}K_{it}\mu_{it}]=\left(\frac{E_{t-1}(Y_{it})}{x_{it}^{-\alpha}K_{it}}\right)^{\rho}.$$

Computing the value of this probability with equations (7) and (8), it can be shown that the optimally chosen weighted probability of being capacity constrained is $1-\alpha$. In the same way, it can be shown that the weighted probability of being constrained by labor supply is α.

$$y_t = x_t^{1-\alpha} l_t, \quad (14)$$

where $l_t = L_t/N_t$ is the employment rate and $y_t = Y_t/N_t$ is per-capita production.

Underemployment of Production Factors

Before closing the model by writing down the capital market equilibrium conditions, we are already able to show that capital and labor are under-utilized. Combining (11) and (13) we derive the equilibrium value for aggregate employment, which gives $L_t = \alpha^{1/\rho} N_t \leq N_t$. For each period t, aggregate employment is smaller than the labor supply. This result comes from the aggregation of heterogeneous situations. In the economy, firms facing a bad (good) productivity shock are unable (able) to hire all the workers in the corresponding segment of the labor market.[9]

The corresponding unemployment rate is independent of time and it is given by

$$u_t = \bar{u} = 1 - \alpha^{1/\rho} \geq 0 \qquad \forall t. \quad (15)$$

It is zero only when $\rho \to \infty$, in which case both uncertainty and heterogeneity vanish. Underemployment results from the fact that the irreversible skill decisions of the households and the investment decisions of the firms are taken without knowing with certainty the firms' productivity in the next period.

The degree of capacity utilization d_t is defined as the ratio of aggregate production to aggregate capacities, i.e., $d_t = Y_t x_t^{\alpha}/K_t$. Using (11), (13) and (14) it can be shown that d_t is independent of time and is equal to

$$d_t = \bar{d} = (1-\alpha)^{1/\rho} \leq 1 \qquad \forall t. \quad (16)$$

In this economy, heterogeneity is related to uncertainty and is at the basis of the existence of unemployment and underutilization of capacities at equilibrium. When uncertainty and heterogeneity disappear (if $\rho \to \infty$), capacities become fully employed and the unemployment rate goes to zero.

In this simple version of the model, d and u take the same values for all periods. This is due only to the Cobb–Douglas specification that has been

[9] At the aggregate level, the weighed proportion of firms constrained by labor supply is equal to α. Note that this weighted proportion is equal to $(L/N)^{\rho}$ for all t and is equal to the weighted probability of the full-employment constraint defined in Section II.

chosen for the production function. With a more general technology, the equilibrium paths of d_t and u_t are time dependent.[10]

The Capital Market Equilibrium

As stated in Section I, individuals can put their savings in two different assets, debts and shares in pure profits, both issued by firms. *Intra*generational borrowing and lending is zero at equilibrium, because all individuals are identical. Since there is no aggregate uncertainty and since firms are *ex-ante* identical, expected profits are the same for all firms and the return of the market portfolio is equal to the expected return of firms.[11]

In each period, each share pays a dividend of that period's profit. The aggregate flow of profits is known and individuals can correctly forecast the share price q_t for all future periods. The *arbitrage condition* must hold for both shares and debts to be held at equilibrium: $(q_{t+1}+\pi_{t+1})/q_t = 1+r_{t+1}$. Computing $\pi_{t+1} = Y_{t+1} - w_{t+1}L_{t+1} - (1+r_{t+1})K_{t+1}$ with the aggregate equilibrium conditions (10) to (14) and using the equilibrium value for $\bar{u}$, the arbitrage condition becomes

$$z_{t+1} = z_t \frac{(1-\beta)\,\bar{d}^{1+\rho}}{1+n}\, x_{t+1}^{-\alpha} - (1-\beta)x_{t+1}^{1-\alpha}(1-\bar{u})^{1+\rho}, \tag{17}$$

where z_t is equal to the value of shares per person q_t/N_t.

The equality between savings and investment can be written as $(1-\theta)w_t l_t = k_{t+1}(1+n) + z_t$. Using the conditions (10) to (14), it becomes

$$x_{t+1} = \frac{(1-\theta)\beta}{1+n}\,\bar{d}x_t^{1-\alpha} - \frac{\bar{d}}{(1+n)(1-\bar{u})}\, z_t. \tag{18}$$

The optimal capital/labor ratio follows a process (18) which is very similar to the one obtained in the standard Diamond model. There are, however,

[10] Note also that at the micro level, capacities and employment move in opposite directions. In a market with a good shock, the firm can hire all workers but still underuses its capacities. Surprisingly, underemployment of capacities is associated with good shocks and is negatively related to unemployment at the firm level. In this version of the model, the firm's production is sold on a competitive market with perfect information. In an imperfectly competitive economy with idiosyncratic demand shocks, underemployment of both productive factors can coexist within the same firm.

[11] Although expected profits are equal between firms, actual profits differ across firms, depending on the realization of the idiosyncratic shock. To avoid uncertainty in the individual's optimization problem, we assume that individuals buy a share of the market portfolio which includes shares in all firms. Note that the utility function is concave in c_2, implying that individuals are risk averse and the diversification of investments is optimal. The asset market equilibrium predicts that individuals buy the market portfolio.

three main differences from Diamond. One difference comes from the wage bargaining process (represented by the parameter β). Considering (18) at given z_t, union power has a positive effect on the capital-labor ratio as in Devereux and Lockwood (1991). This is because an increase in union power increases the wages of the young workers, thereby increasing their savings and reducing the rate of return. The second difference is due to the presence of uncertainty and heterogeneity (represented by ρ, $\bar{d}$ and $\bar{u}$). An increase in the variance of the productivity shock reduces the value of ρ. This increase in uncertainty leads to an increase in the probability of nonutilization of equipment, i.e., a decrease in the marginal productivity of capital. Third, the fact that firms obtain pure profits under bargaining makes them valuable. This requires the existence of a market for shares whose arbitrage condition introduces a second dimension into the dynamic system.

IV. Steady State and Dynamics

Equations (17) and (18) form a dynamic system in z and x which characterizes the equilibrium path of the economy. x_t is a predetermined variable and z_t is a forward-looking variable. The phase diagram for the system is represented in Figure 2. The concave phaseline $\Delta x_{t+1} = 0$ resulting from the first equation describes the equilibrium locus where saving is equal to investments in shares and physical capital. The convex phaseline

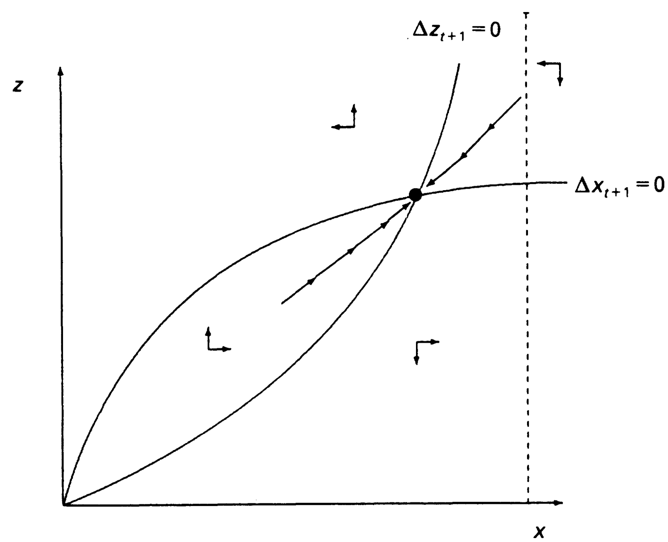

Fig. 2. The phase diagram.

$\Delta x_{t+1}=0$ resulting from the second equation describes the locus where the arbitrage condition holds. The arrows indicate the directions of motion. As is shown in an Appendix available on request, the above dynamic system has only one steady state with a positive x and z. When the economy has reached the steady state, production and capital grow at the same rate as population. As in standard growth models, the loglinearization of the dynamic system around the steady state confirms that there is a unique saddle path converging (locally) to the steady state (also in the Appendix). Under perfect foresight the economy is always located on the saddle path. Let us now consider the dynamic effects of permanent changes in uncertainty and union power.

Rise in uncertainty: A rise in the variance of the productivity shock increases uncertainty and heterogeneity. This moves the economy to a less efficient equilibrium: unemployment rises and the degree of capacity utilization drops. In Figure 3, the phase-line Δx_{t+1} moves down and the phaseline Δz_{t+1} moves up. The economy moves from A to C, with a drop in the capital-labor ratio and in the stock market value of firms. Output per-capita is reduced.

Rise in union power: An increase in β has two opposing effects on the stock of capital because both savings and the price of shares rise.

- Considering first the concave phaseline $\Delta x_{t+1}=0$, it is clear that this will move to the northwest. This first effect is the one present in Devereux and Lockwood (1991). With a zero depreciation rate, the second phaseline is not affected by union power and the equilibrium moves from point A to point B (Figure 4, case 1). The increase in union power increases wages, therefore raising the savings of the young workers and the capital stock.
- The convex phaseline $\Delta z_{t+1}=0$ also moves to the northwest because a rise in union power erodes pure profits less than the interest rate (as long as the depreciation rate is nonzero), and this requires a rise in the value of the firm to maintain the arbitrage condition.

The new steady state is in C with an ambiguous net effect on the capital/labor ratio (recall that through (11) there is a monotonic relation between the stock of capital per head and the capital/labor ratio). A negative effect is possible because the rise in savings could be insufficient to yield a greater price for shares,[12] obliging young people to decrease their lending

[12] If we compare our model to that of Chamley and Wright (1987), where land is the equivalent of our firms (there is a fixed supply of both), z is thus equivalent to the value of land and β to a tax on land. Our result is similar to theirs, i.e., a tax on land may increase the value of land.

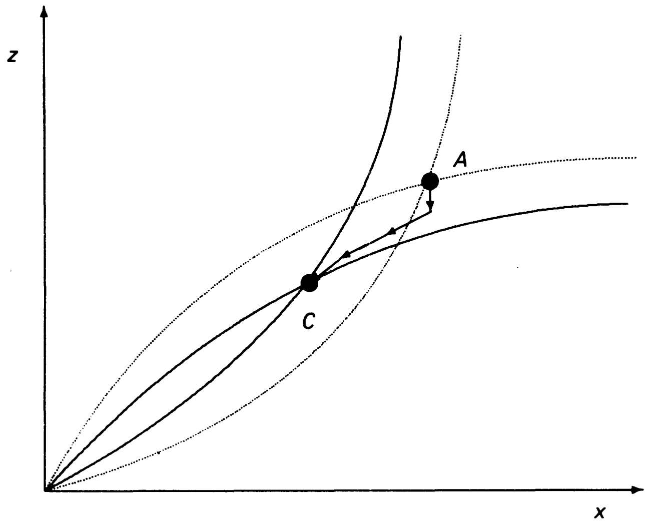

Fig. 3. Rise in uncertainty.

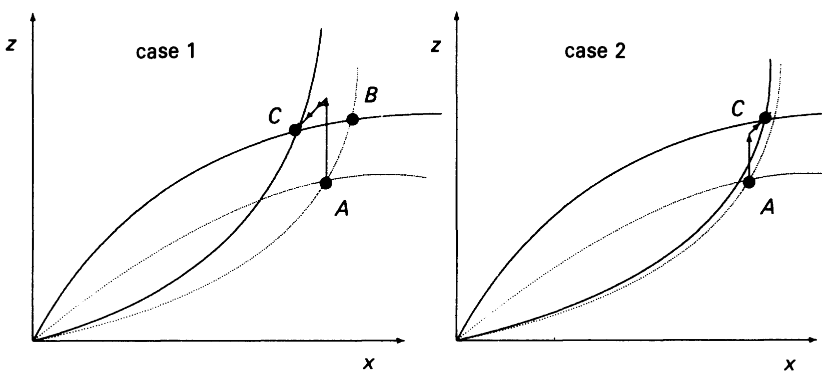

Fig. 4. Rise in union power.

(case 1): there is a kind of crowding-out of physical capital. In case 2, the net effect of the rise in union power on the capital stock at steady state is positive: there is no overshooting of the value of the firm and both variables increase monotonically to their new steady-state value.[13]

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[13] Cases 1 and 2 represent the phase diagram when the parameters take the following values: $n=1.01^{30}-1$, $\alpha=0.6$, $\rho=15$. $\theta=0.8$ in case 1 and $\theta=0.51$ in case 2. The rise in union power consists in a rise in β from 0.5 to 0.7. In both examples, the rise in union power lowers the value of the larger eigenvalue, which makes the economy converge less rapidly to the steady state. In both cases, the workers' utility function at the new steady state is increased.

V. Conclusion

In this model, which is a particular case of a more general model where the utility function is homothetic and the *ex-ante* productive function has constant returns to scale, we show that there is underemployment of production factors at equilibrium, even in the steady state. This result depends crucially on the putty-clay technology, the existence of firm-specific skills and irreversible investment, and on technological uncertainty.

Both heterogeneity and uncertainty play crucial roles in this economy. When uncertainty and heterogeneity disappear, capacities become fully employed and the unemployment rate goes to zero. When there is uncertainty but no heterogeneity, i.e., if uncertainty is not idiosycratic, all firms will be in the same situation at equilibrium. Under these conditions two types of equilibrium are possible, full-employment with underutilization of capacities or full-capacity with unemployment. The existence of heterogeneity is necessary in order to generate unemployment and underutilization of capacities simultaneously.

Underemployment results from the fact that the irreversible skill decisions of the households and the investment decisions of the firms are taken without knowing with certainty the firms' productivity for the next period. Once the shock has occurred, it is too late to revise plans and switch to more favorable micromarkets. This result can be interpreted as inducing some "mismatch" in the economy. Clearly, the persistent differences in unemployment across regions, skills and industries, as documented by Layard, Nickell and Jackman (1991, Chapter 6), suggest that an important part of current unemployment is linked with segmentation and mismatch.

In the face of such "structural" unemployment, policies aimed at reducing uncertainty should be accompanied by policies directed against irreversibilities in order to increase the mobility of productive factors across micromarkets. The two faces of the problem, uncertainty and irreversibility, should be tackled simultaneously.

Our framework can also be used to discuss unemployment insurance policies, if one allows for a concave utility function on labor income (see footnote 5). Indeed, since the risk borne by the children can be diversified, it should be optimal to purchase insurance against unemployment. This would not make any difference in the aggregate model, but the distribution of income would change and the equilibrium with insurance would Pareto-dominate the one without insurance. Another interesting subject for future research would be to analyze whether different equilibria can be Pareto-ranked as functions of union power (it is possible that a decrease in union power will generate a Pareto-superior equilibrium if the benefit from the increase in the interest rate dominates the resulting reduction in labor income in all future generations).

In the presence of capital irreversibility, the effect of union power on the stock of capital is ambiguous. Indeed, the rise in union power induces a rise in savings, but also increases the stock market value of the firms. This second effect appears in the presence of irreversibility and may crowd the investments in physical capital. This shows that the role of unions in growth depends crucially on the nature of technology.

The existence of uncertainty and irreversibilities does not modify *per se* the dynamic properties of this economy. This is closely related to the *ex-ante* Cobb–Douglas technology which is responisble for the constancy of unemployment and capacity underutilization. With a more general production function, the utilization rates of productive factors become endogenous and it becomes possible to generate richer dynamic behavior related to uncertainty and irreversibility. Another extension could be to refine the human capital decision in order to provide an answer to the following question: how do irreversible human capital decisions affect the equilibrium path of endogeneous growth models?

References

Arnsperger, C. & de la Croix, D.: Bargaining and equilibrium unemployment: Narrowing the gap between new Keynesian and "disequilibrium" theories. *European Journal of Political Economy 9*, 163–90, 1993.

Chamley, C. & Wright, B.: Fiscal incidence in overlapping generations models with a fixed asset. *Journal of Public Economics 32*, 3–24, 1987.

Diamond, P.: National debt in a neo-classical growth model. *American Economic Review 55*, 1126–50, 1965.

Devereux, M. & Lockwood, B.: Trade unions, non-binding wage agreements and capital accumulation. *European Economic Review 35*, 1411–26, 1991.

Dixit, A. & Pindyck, R.: *Investment under Uncertainty.* Princeton University Press, 1994.

Grout, P.: Investment and wages in the absence of binding contracts: A Nash bargaining approach. *Econometrica 52*, 449–60, 1984.

Lambert, J.P.: *Disequilibrium Macroeconomic Models.* Cambridge University Press, 1988.

Layard, R., Nickell, S. & Jackman, R.: *Unemployment — Macroeconomic Performance and the Labour Market.* Oxford University Press, 1991.

Licandro, O.: Investment dynamics and capacity utilization under monopolistic competition. *Annales d'Economie et de Statistique 27*, 91–113, 1992.

Licandro, O.: A non-Walrasian general equilibrium model with monopolistic competition and bargaining. *Annales d'Economie et de Statistique 37/38*, 237–53, 1995.

Malinvaud, E.: *Profitability and Unemployment.* Cambridge University Press, 1980.

Sneessens, H.: Investment and the inflation-unemployment tradeoff in a macroeconomic rationing model with monopolistic competition. *European Economic Review 31*, 781–815, 1987.

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