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Monopolistic competition, endogenous markups, and growth

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Abstract

Markup variations brought about by changing demand conditions can have a significant impact on the growth dynamics of imperfectly competitive economies: they can generate multiple steady states, as well as multiple equilibrium paths for given initial conditions. We illustrate that result in the context of two alternative models. In the first model equilibrium markups depend on the aggregate savings rate. In the second model the markup level varies with the range of intermediate goods available. We discuss some of the empirical implications of the class of models introduced in the paper.

Key words: Monopolistic competition; Endogenous mark-ups; Multiple equilibria; Growth models

JEL classification: L13; O41

1. Introduction

The present paper describes some recent research on the implications of market power and markup variations for the dynamics of growth. The central result of that research can be summarized as follows: economies in which the nature of competition implies some systematic variation of markups along a growth path may exhibit equilibrium dynamics substantially different from those found in the neoclassical model of Cass (1965) and Koopmans (1965). In particular, they may exhibit multiple steady states, as well as multiple equilibrium paths for given initial conditions. This is true even in economies in which the presence of markup power is the only departure from standard neoclassical assumptions.

In order to understand the role of markups in dynamic models of capital accumulation it is useful to look at the following first-order condition of a monopolistic competitor's problem:

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$$(P_j/P)(1-1/\xi_j)f'(k_j)=r+\delta, \tag{1}$$

where j indexes variables that are specific to our firm, P_j is the price per unit of output (set by the firm), P is an aggregate price index, k_j is the capital stock, $f'(k_j)$ is the marginal product of capital (MPK), ξ_j is the price-elasticity of demand, δ is the depreciation rate, and r is the interest rate. The left-hand side of (1) corresponds to the firm's marginal revenue product of capital (MRPK), i.e., the product of the marginal revenue $(P_j/P)(1-1/\xi_j)$ and the marginal product of capital f'. The right-hand side corresponds to the rental price of capital. The firm's optimal markup is given by $\mu_j \equiv (1-1/\xi_j)^{-1}$. Here is the key point: the presence of market power introduces a wedge between the firm's MPK and its MRPK. That wedge results from the firm's recognition that a price reduction would be needed if its customers had to absorb the additional output resulting from a (marginal) increase in the capital stock. The lower is the price elasticity (i.e., the higher the markup), the larger the price reduction required and, given the MPK, the lower the return to investment. Thus, the dynamics of capital accumulation are affected by demand conditons.

Consider now a symmetric, stationary equilibrium of a Chamberlinian economy with many such firms. Symmetry implies $P_j=P$, $k_j=k$, $\xi_j=\xi$, and $\mu_j=\mu$, for all j. Under the simplifying assumption of no underlying growth, stationarity requires that r coincides with the consumer's discount rate ρ. Thus, a steady state capital stock k^* is implicitly given by any solution to

$$R(k^*)\equiv\frac{f'(k^*)}{\mu}-\delta=\rho. \tag{2}$$

Under the neoclassical assumption of a diminishing MPK and the usual Inada conditions, a constant markup μ implies the existence of a unique steady state k^*. Furthermore, one can easily show that, in that case, the presence of market power will be equivalent in its general equilibrium effects to the introduction of a constant tax rate $(1/\xi)$ on capital income (with full rebate): the resulting equilibrium dynamics are suboptimal, but qualitatively identical to those found in the model without distortions.

In contrast, if the nature of competition is such that, in equilibrium, the elasticity ξ increases with the aggregate capital stock, the MRPK could be increasing for some range of capital values: the positive effect on marginal revenue implied by the higher demand elasticity associated with higher capital could more than offset the negative effect resulting from the diminishing MPK, and thus lead to a return function R consistent with multiple steady states, as illustrated in Fig. 1. Notice that such a result does not hinge at all on the presence of increasing returns, multiple sectors, overlapping finite-lived agents or any other departure from the Cass–

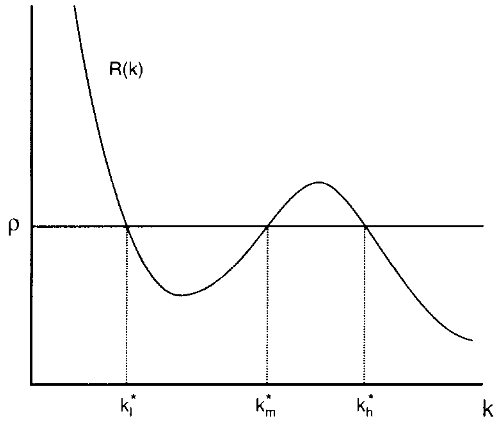

Fig. 1

Koopmans framework that other researchers have shown to be a possible source of multiple steady states.

As illustrated below, the existence of multiple steady states is often associated with the presence, for given initial conditions, of multiple equilibrium paths approaching different steady states. Clearly, such a characterization of the economy's equilibrium outcome is in sharp contrast with the predictions of the original Cass–Koopmans framework.

In the next two sections I sketch two models which generate, in equilibrium, the negative relationship between markups and the capital stock which underlies the multiple equilibrium results discussed above, and describe some of the resulting dynamics.

2. A model in which markups depend on the savings rate

The model described in this section is a version of the one developed in Galí (1993a). Assume a market structure characterized by a fixed number (say, M) of monopolistically competitive firms. Each firm produces a differentiated product with a constant returns technology that uses labor and capital. It sells its product to two types of customers: consumers, who derive utility from its consumption, and other firms, which use it to increase their capital stock. We assume that firms cannot price-discriminate across those two markets. Let $\sigma > 1$ and $\eta > 1$ be the (constant) elasticities of substitution across goods in consumption and production activities, respectively. The effective demand elasticity faced by a typical firm (say, firm j) at any point in time is given by

$$\xi(\lambda_j)=\lambda_j\eta+(1-\lambda_j)\sigma, \tag{3}$$

where λ_j is the share of firms' purchases in total demand for good j. In a symmetric equilibrium $\lambda_j=\lambda$, $j=1,2,\ldots,M$, where λ corresponds to the aggregate savings rate. Accordingly, the equilibrium markup μ will be a function of that savings rate.

As in the neoclassical model,[1] the economy's equilibrium can be defined as a trajectory of a system of differential equations in capital (k) and consumption (c) satisfying the appropriate initial and transversality conditions. The dynamical system for the model sketched above is

$$(\dot{c}/c)\gtreqless\theta(r(k,c)-\rho), \tag{4}$$

$$\dot{k}=f(k)-\delta k-c, \tag{5}$$

where

$$r(k,c)\equiv\frac{f'(k)}{\mu(1-c/f(k))}-\delta$$

is the equilibrium interest rate and θ is the consumer's (constant) elasticity of intertemporal substitution. Let

$$R(k)\equiv r(k,f(k)-\delta k)=\frac{f'(k)}{\mu(\delta k/f(k))}-\delta$$

determine the interest rate as a function of k, *conditional on* $\dot{k}=0$. A steady state capital stock k^* associated with (4)–(5) is given by any solution to $R(k^*)=\rho$, as in (2).

Under the neoclassical assumptions of diminishing average and marginal products of capital, the possibility of multiple steady states (i.e., multiple solutions to $R(k^*)=\rho$) arises whenever η is sufficiently greater than σ, i.e., whenever markups are (sufficiently) inversely related to the savings rate, for in that case R may be nonmonotonic.

Suppose that three such steady states exist (as in Fig. 1). One can show that the 'low' and 'high' steady states (hereafter, **L** and **H**) are always *saddles*, whereas the 'middle' steady state (**M**) is, generically, either a *sink* (for high values of θ) or a *source* (for low values of θ).

Figs. 2 and 3 illustrate the kind of global equilibrium dynamics that arise in the presence of multiple steady states. Both figures correspond to a calibrated version of the model discussed above. The three steady states correspond to the three intersections of the $\dot{k}=0$ and $\dot{c}=0$ loci.

[1] See, e.g., Barro and Sala-i-Martin (1992, Ch. 1).

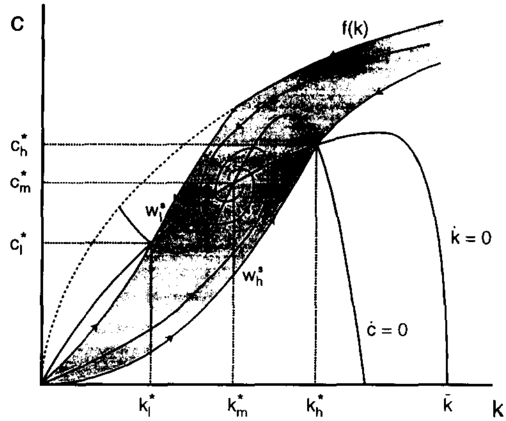

Fig. 2

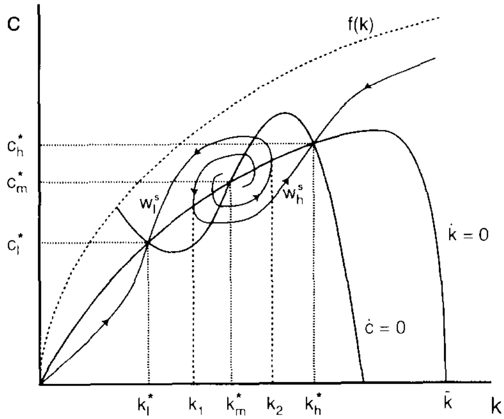

Fig. 3

In Fig. 2 the elasticity of intertemporal substitution θ has been set at a relatively high level. In the case displayed **M** is a stable focus. For any given initial capital stock $k(0)$ there are three types of trajectories consistent with a perfect foresight equilibrium. In one of them the initial level of consumption is the one that puts the economy exactly on **L**'s stable manifold (W_l^s), and convergence to **L** occurs. In a second possible equilibrium trajectory, the initial consumption level falls on W_h^s, the stable manifold converging to **H**. In addition to the previous trajectories, there exists a *continuum* of trajectories (represented as a shaded area in Fig. 2) which are also consistent with equilibrium. Each of those trajectories converges to the (stable) steady state **M**.

Fig. 3 portrays the equilibrium dynamics for a lower θ value. **M** is an unstable focus in this case, and two of the trajectories departing from it coincide with two branches of the stable manifolds of **L** and **H**. For $k(0) \in (k_1, k_2)$ there exist multiple equilibrium paths. Some of those paths lead to **L**, some lead to **H**. That multiplicity disappears when $k(0)$ is outside the overlap region (k_1, k_2). In the latter case the initial conditions fully determine the equilibrium path and whether the economy converges to **L** or **H**.

The type of global dynamics shown in Figs. 2 and 3 correspond to a range of relatively high and low values of θ. In Galí (1993a) I show that for an (admittedly small) range of intermediate values the equilibrium dynamics may also involve one or more limit cycles (some of which are stable) about **M**.

3. A model in which markups depend on product diversity

In Galí (1993b) I explore an alternative economic structure capable of generating multiple equilibria as a result of markup variations. There is a continuum of monopolistically competitive firms producing a range of intermediate goods represented by the open interval $(0, M)$. They sell their goods to a competitive firm, which uses them as inputs to produce (under constant returns) a single final good. The latter is purchased by households, who consume part of it and use the remainder to increase their capital holdings, which they rent to the intermediate firms.

The final goods technology is such that the elasticity of substitution across inputs increases with the range of inputs used (which, in equilibrium, coincides with the available range). As a result, the optimal markup charged by the intermediate firms decreases with the extent of competition, i.e., $\mu = \mu(M)$, with $\mu' < 0$. In the presence of a fixed cost (in the form of overhead capital), free entry and zero profits imply that the range of intermediate firms operating at any given point in time (and, thus, the range of inputs available) is a continuous, increasing function of the aggregate capital stock. Formally, $M = m(k)$, with $m' > 0$. The equations of motion describing an equilibrium correspond, again, to (4) and (5) with the interest rate now being given by

$$r(k, c) \equiv R(k) \equiv \frac{f'(k)}{\mu(m(k))} - \delta.$$

Again, any solution to $R(k^*) = \rho$ qualifies as a steady-state capital stock k^* of the model. As above, the existence of multiple steady states requires that R is increasing for some range of k values. That condition, in turn, requires that

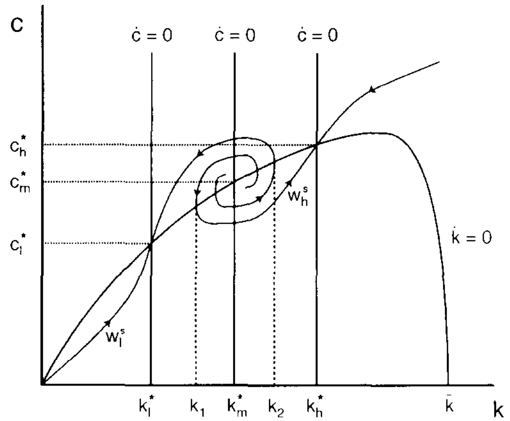

Fig. 4

(a) f' does not diminish too rapidly, (b) markups are strongly negatively related to the range of operating firms/available inputs, and (c) the latter is strongly positively related to the aggregate capital stock. Again, whenever three steady states exist (as in Fig. 1), the low and high steady states can be shown to be *saddles* whereas the middle steady state can be either a source or a sink, depending on parameter values.

Fig. 4 shows the kind of equilibrium dynamics that arise for a calibrated version of the model consistent with three steady states. In the case portrayed **M** is an unstable focus. As in Fig. 3, if $k(0)$ is sufficiently high (low) the equilibrium is unique and converges monotonically to **H** (**L**). If, on the other hand, $k(0)$ is close to k_{m}^*, multiple perfect foresight equilibrium paths coexist. Whether the economy eventually approaches **L** or **H** depends on the trajectory that is 'selected', in a way consistent with agents' initial expectations on the future path of the economy.

4. Some empirical implications

The class of variable markup models discussed above has some interesting empirical implications. First, the model yields a simple prediction on the relationship between the size of markups and income levels across economies. Suppose that all economies are characterized by identical preferences, technology and market structure. If the conditions underlying the existence of multiple equilibria hold, one would observe (at least in the long run) a negative correlation between the level of income (and capital) and the size of markups. Does that relationship hold in the data? In order to address that question we need some measure of the size of markups in different countries. In the presence of market power in goods markets, profit maximization by firms implies the following relationship between the markup (μ), the labor income share (s_L), and the elasticity of output with respect to labor input (α) (see, e.g., Hall, 1988):

$$\mu = \frac{\alpha}{s_L}.$$

Under the maintained assumption of similar α values across countries (as implied by a Cobb–Douglas technology), we can use the reciprocal of the labor income share as a proxy for the average size of markups in each country. I constructed those measures using labor income share data for 46 countries taken from the U.N. National Income Accounts publication, and corresponding to 1985. Then I tested for a significant correlation between that measure and the Summers–Heston per capita income measure (in logs, denoted by y) for the same year and countries. The estimated cross-country OLS regression is (with standard errors in brackets)

$$\underset{(0.27)}{y = 3.20} - \underset{(0.134)}{1.027}\,\mu + \varepsilon \quad (R^2 = 0.50),$$

which points to a significantly negative correlation between markups and per capita income, a result consistent with the class of models discussed above. Similar results (not reported) obtain when one controls for other variables (such as primary and secondary enrollment rates). The previous result reflects the fact that 'rich' countries tend to have a higher labor income share than 'poor' countries. Our models provide an explanation for that observation, one based on the presence of differences in markups.[2]

Some other implications should be evident from the discussion above. Given parameter values consistent with multiple steady states, the income and consumption levels of economies with identical preferences and technology may fail to converge asymptotically, even if their initial conditions (given by their initial capital stocks) are identical. That possible outcome seems consistent with what Lucas (1993) has termed 'economic miracles', i.e., episodes characterized by unpredictably fast growth that leads to a growing income gap between economies that were similar at some point in time. The interest rate is, on the other hand, asymptotically equalized across economies even in the absence of capital mobility. Such equalization of interest rates coexists with different stationary levels of capital and, thus, different asymptotic savings and investment rates. Overall, those results seem consistent with

[2] Of course, other explanations exist. Due to the nature of the technology, α could be positively related to the capital labor ratio (and income), for instance.

two empirical observations that are at odds with the Cass–Koopmans model (given identical preferences and technology for different countries): the lack of convergence in per capita income (e.g., Barro, 1991), as well as the absence of large cross-country differences in interest rates and the consequent failure of capital to flow from rich to poor countries (e.g., Lucas, 1990).

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