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Entry Deterrence, Macroeconomic Equilibria and Pro-Competitive Policies

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Abstract

This paper presents a macroeconomic model that is microfounded on an industrial structure characterized by an oligopolistic game à la Dixit and Spence within every industry: the incumbents' investment decisions have commitment value in deterring potential rivals from entering the market. We obtain an entry deterrence macroeconomic equilibrium that has remarkable implications for pro-competitive policies, implications which differ from those usually obtained by other models based on a monopolistic competition framework: (i) the positive effects on employment and the real wage deriving from a competition policy that works to increase the elasticity of the demand curve persist in the long run; (ii) a reduction in the fixed entry cost has favourable effects on the employment and the real wage both in the short and in the long run; (iii) a mix of the two pro-competitive policies - reduction in the fixed entry cost and increase in the elasticity of demand – enhances these results, driving the macroeconomic entry deterrence equilibrium to asymptotically approach the competitive equilibrium.

Keywords: oligopoly; entry deterrence; macroeconomic equilibrium; pro-competitive policy.

JEL classification: E24, D43, L40.

1. Introduction and summary

Over the last twenty-five years, several theoretical and – with particular reference to European and OECD countries - empirical studies have investigated the effects on macroeconomic performance that we can expect from liberalization and pro-competitive policies in product and labor markets.[1] In general, the literature converges to the conclusion that these policies have favorable effects on aggregate employment and output, with the effects on real wages depending on the relative impact of product market versus labor market reforms.

The consequences of product market reforms are usually analyzed by assuming a utility function à la Dixit and Stiglitz (1977) and a macroeconomic model micro-founded according to the Blanchard and Kyiotaki (1987) approach. In this respect, the most representative model is that of Blanchard and Giavazzi (2003; hereafter "B-G"), whereby pro-competitive policies affect two product market parameters: the cost of entry for a new firm (which is assumed to be proportional to its output) and the elasticity of demand (assumed to be constant and equal for all goods). In the short run, the number of firms is given; therefore, a change in the cost of entry does not affect macroeconomic equilibrium, while an increase in the elasticity of demand - by reducing firms' markup - increases the real wage and employment. In the long run the number of firms is endogenous and the equilibrium requires a zero-profit condition for firms. Thus, an increase in the elasticity of demand due to pro-competitive measures - by reducing firms' markup - reduces the number of firms in the long run. Assuming that elasticity of demand increases in the number of products, as in the Hotelling hypothesis, the exit process - by reducing the number of goods - brings the elasticity back to its initial level. Hence the short-run favorable effect on employment and real wages vanishes and they return to their initial levels. Only a decrease in the cost of entry has durable positive effects on employment and real wages.

The key assumption underlying the results of the model is the absence of sunk costs: (1) the cost of entry is proportional to output, not fixed; (2) there is no capital, so that there can be no sunk cost due to imperfectly revocable investments. These hypotheses imply that all

[1] Examples of theoretical models include those of Nickell (1999), Gersbach (2000), Spector (2002), Blanchard and Giavazzi (2003), Ebell and Haefke (2003), Koeniger and Prat (2007). For the empirical literature, see in particular Fiori et al. (2007) who present interesting estimates of the effects of the interaction between policies and institutions on product and labor markets, Feldmann (2012) for an econometric test covering a very large sample of 80 countries, Bloch (2012) for an estimate of an inverse relationship between competition and inflation dynamics, Eklund and Lappi (2018) who present an estimate of long-run profits persistence based on an updated OECD countries data-set. Escribà-Pèrez and Murguy-Garcìa (2017) investigate the impact of barriers to entrepreneurship on investment, while Cette et al. (2016) and Anderton et al. (2020) show positive effects of pro-competitive policies on total factor productivity.

costs are treated as variable costs in the model, so that there are no real barriers to entry for firms. In this way it becomes possible to deal with the long-run equilibrium in a standard manner within a monopolistic competition framework à la Chamberlin, where the entry and exit process encounters no obstacles, market imperfection has an "exogenous" nature (i.e., it is due only to the presence of product differentiation) and there is no kind of "endogenous" barrier to entry for firms.

Therefore, such a model can be useful for highlighting some possible macroeconomic implications of pro-competitive policies, but only in a very simplified imperfect competitive framework. It does not seem suitable for analyzing the same implications when pro-competitive, and in particular antitrust, policies have to deal with more complex market structures, such as those characterized by barriers that limit market contestability: in this case, the presence of sunk costs cannot be removed from the analysis.

This paper presents a macroeconomic model which is micro-founded on an oligopoly hypothesis and the entry and exit choices of firms are conditioned by the presence of sunk costs. This is a hypothesis which seems to be more in line with some of the most important European antitrust cases, and today more in line with cases involving not only European firms but also companies based in third countries.

In our model, for a given number of industries, the entry process takes place within each of them, where the incumbent adopts some kind of strategic behavior (e.g., making irrevocable investment choices) designed to narrow the market space for its rivals. We will analyse the macroeconomic equilibrium when the economy is characterized by an entry deterrence game *à la* Dixit-Spence, so that the barrier to entry has an "endogenous" nature.

The implications of the model for antitrust policies are noteworthy and differ from those of Blanchard and Giavazzi: under our oligopoly market framework, a reduction in the setup cost for firms has positive effects on employment and real wage both in the short and in the long-run; moreover, there are permanent positive effects of an increase in demand elasticity too; and finally, these results can be enhanced by combining the two kinds of policies.

The key steps of the model can be summarized as follows.

We start from the Dixit-Spence approach which emphasizes the commitment value of a prior and irrevocable investment decision by an established firm;[2] "a firm that buys equipment today signals", to the potential entrant, "that it will be around tomorrow if it cannot resell the equipment".[3] In other words, purchasing equipment may have strategic

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[2] See Spence (1977) and Dixit (1979, 1980).

[3] Tirole (1988, p. 314).

effects by making credible the established firm's threat that its postentry output will equal its preentry capacity;[4] such investment has commitment value to the extent that it is sunk.[5]

We divide time into a succession of discrete periods and assume that, in every period, each of the *m* industries in the economy is characterized by a two-stage oligopolistic game à la Dixit and Spence, between a firm (the "incumbent", which is the same in all periods) that has the first-mover advantage and another firm (the "potential entrant") that enters the market in the second stage. In the first stage, the incumbent *i* chooses its capacity level via an investment that is irrevocable (sunk) in the second stage and that completely depreciates by the end of the period; in the second stage, the prospective entrant *e* decides whether or not to enter and then the incumbent chooses its optimal output accordingly. Assuming that there is a fixed setup cost (a cost which is sunk in the second stage) that both the incumbent and the entrant incur in each period, we will define the deterrence condition – that is, the condition whose satisfaction ensures that, within the period, the Dixit-Spence deterrence strategy dominates the Stackelberg accommodating strategy. Under a hypothesis of symmetry among the industries, we will obtain the price-setting (*PS*) curve between aggregate employment and real wage in both cases: when the Dixit-Spence strategy dominates the Stackelberg strategy and vice versa.

In order to focus our analysis on the macroeconomic effects of the firms' entry deterrence behavior on the product market, we simplify the labor market analysis by assuming perfect competition and deriving the wage-setting (*WS*) curve as the inverse labor supply function.

Finally, in each case (i.e., dominance by Dixit-Spence and Stackelberg strategies) we will study properties of the macroeconomic equilibrium in terms of employment and real wages. For the sake of simplicity, we assume that demand functions and production technologies remain constant in all periods. Macroeconomic equilibrium reached in each period – whether of the entry deterrence or accommodating type – turns out to be also a stationary state, i.e. a long-run equilibrium: the number of firms and the level of industry and aggregate output remain constant over time.

Our model's implications for pro-competitive and antitrust policies that address the product market are as follows. Starting with a macroeconomic equilibrium in which Dixit-Spence deterrence strategies dominate:

- a reduction in the fixed setup cost shifts the price-setting curve upward, so that its point of intersection with the wage-setting curve moves toward higher employment

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[4] Thus, the Dixit-Spence approach overcomes the main weakness of the Bain-Sylos-Modigliani limit pricing model.

[5] For a discussion of the key role of sunk costs in entry deterrence models, see Tirole (1988, ch. 8).

and a higher real wage. The best macroeconomic equilibrium attainable under this policy is the one corresponding to the dominance of Stackelberg accommodating strategies by incumbents;

- an increase in the elasticity of demand also shifts the price-setting curve upward and thus likewise increases employment and the real wage. In this case, the macroeconomic equilibrium approaches competitive equilibrium as the elasticity of demand increases - but only up to the point where the firm's gross profit is just sufficient to cover its fixed setup cost ("nonnegative-profit" condition);
- a mix of these two pro-competitive policies – reducing the fixed entry cost and increasing the demand elasticity - enhances these predicted results. In theory, such a mix could asymptotically approach a competitive macroeconomic equilibrium, provided the entry cost and the demand elasticity tend toward zero and infinity, respectively.

Thus, this paper contributes to the analysis of the antitrust policies effects in terms of changes in both the single market and macroeconomic equilibrium, when the economy is characterized by an oligopolistic industrial structure where the incumbents adopt a strategic behavior aimed to deter rivals' entry.

The paper is organized as follows. Section 2 presents the model and its equilibrium outcomes: starting from a simplified microeconomic model of entry deterrence behavior, I build the corresponding macroeconomic model of the product market under the usual symmetry hypothesis and then, combining the price-setting curve with a competitive wage-setting curve, I analyze the possible macroeconomic equilibria and their properties. Section 3 discusses the model's implications for pro-competitive policies and Section 4 concludes the paper.

2. From micro entry deterrence strategies to macroeconomic equilibrium

2.1. A simplified microeconomic model of entry deterrence behavior

As a starting point, let us use the Dixit (1980) two-stage oligopolistic game. In the first stage, the incumbent *i* chooses its capacity level $\bar{k}_i$, which may subsequently be increased but not reduced (irrevocable investment). In the second stage, the prospective entrant *e* decides either to enter (and to produce quantity y_e), or not to enter, and the incumbent then chooses its optimal output accordingly.

Among the possible outcomes of the model,[6] we will consider the case where the postentry profit of the entrant π_e is positive if the incumbent behaves as a monopolist and becomes zero - along the entrant's reaction function - only for a greater incumbent output y_i. In this case,[7] "the established firm can only bar entry by maintaining capacity (and output) at a level greater than it would want to as a monopolist; thus it is faced with a calculation of the costs and benefits of entry-prevention. [...] The alternative is to allow entry and settle for the best duopoly point"[8] (i.e., the Stackelberg equilibrium point). Therefore, the incumbent will compare its profit π_i^S in the Stackelberg postentry equilibrium *S* to its profit π_i^D in the entry deterrence equilibrium *D*, which is guaranteed by a preentry capacity that is just greater than $\bar{k}_i = y_i^D$ - a capacity just greater than the incumbent's output that results in zero postentry profit for the entrant.[9] The entry deterrence equilibrium will be chosen by the incumbent when $\pi_i^D > \pi_i^S$. A sufficient condition for this is that, along the entrant's reaction function, y_i^D is not higher than the incumbent's output y_i^S corresponding to the Stackelberg equilibrium (both these quantities are greater than monopoly output, so for $y_i^D \le y_i^S$ we must have $\pi_i^D > \pi_i^S$). Note that this is not a necessary condition: we could have $\pi_i^D > \pi_i^S$ also when $y_i^D > y_i^S$ because, in the Stackelberg equilibrium, firm *e* enters and so reduces the market price and the incumbent's profit. A condition that is both necessary and sufficient will be calculated in what follows.

Before doing so, however, we must specify the model's equations. In accordance with Dixit (1980), we first assume that the cost function is characterized by a constant average variable cost *w*, a constant unit cost of capacity expansion *s*, and a fixed setup cost *f*. We will further simplify the analysis by assuming: (a) that the cost function is the same for the two firms;[10] and (b) that the only variable input is labor (with productivity equal to 1), so that the average variable cost *w* also denotes the wage rate. Under these assumptions, the cost function of the entrant in the second stage of the game will be

[1] $$C(y_e) = f + (w+s)y_e$$

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[6] See Dixit (1980, pp. 100-101).

[7] Where, in Bain's terminology, entry cannot be "blockaded" but only deterred or accommodated.

[8] Dixit (1980, p.101).

[9] Following Dixit (1980), in the second stage of the game any capacity held to deter entry is used by the incumbent, while in Spence (1977) the incumbent partially maintains idle capacity. If the demand function is concave, then Spence's result is not a perfect equilibrium; only when the demand function is so convex that the reaction curves are upward sloping, Spence's excess capacity may reappear (see Bulow et al., 1985).

[10] This simplifying hypothesis is consistent with the usual goal of entry cost reduction policies – namely, to favour the entry of firms that are no less efficient than the established firms.

while that of the incumbent will be

[2] $$C(y_i)=\begin{cases} f+wy_i+s\bar{k}_i & for \quad y_i \le \bar{k}_i \\ f+(w+s)y_i & for \quad y_i > \bar{k}_i \end{cases}$$

Consequently, the marginal cost of the entrant will be

[1'] $$MC_e = w+s$$

and that of the incumbent

[2'] $$MC_i = \begin{cases} w & for \quad y_i \le \bar{k}_i \\ w+s & for \quad y_i > \bar{k}_i \end{cases}$$

Let us assume the following linear (inverse) demand function:

[3] $$p = a - by$$

where *p* and *y* denote (respectively) the market price and the industry total output (i.e., $y = y_i + y_e$).

The entrant's reaction function is then:

[4] $$y_e = \frac{a-(w+s)}{2b} - \frac{1}{2}y_i$$

Stackelberg leader behavior by the incumbent implies that it allows entry by installing a capacity level equal to its output in the Stackelberg solution obtained on the basis of its marginal cost $MC_i = w+s$.[11] Therefore, the Stackelberg equilibrium *S* is:

[5] $$\begin{aligned} y_i^S &= \frac{1}{2}\cdot\frac{a-(w+s)}{b} \\ y_e^S &= \frac{1}{4}\cdot\frac{a-(w+s)}{b} \\ y^S &= \frac{3}{4}\cdot\frac{a-(w+s)}{b} \\ p^S &= \frac{1}{4}\cdot[a+3(w+s)] \end{aligned}$$

Dixit entry deterrence behavior implies, in turn, that the incumbent installs a preentry capacity level such that the entrant's profit is zero along its reaction function [4]. Therefore, the Dixit equilibrium *D* is characterized by $y_e^D = 0$ (firm *e* does not enter) and:[12]

[11] In this case, the strategic behavior of the incumbent is that of using the capacity commitment value as a barrier to mobility – that is, as a tool for limiting firm *e*'s scale of entry (see Caves and Porter 1977). For a model of barriers to mobility in an infinite-horizon framework, where the equilibrium depends on a firm's advantage in terms of investment speed or initial conditions, see Spence (1979) and Fudenberg and Tirole (1983, 1986).

[6] $$y^D = y_i^D = \bar{k}_i = \frac{a-(w+s)}{b} - 2\sqrt{\frac{f}{b}}$$
$$p^D = w + s + 2\sqrt{bf}$$

As we stated previously, a sufficient condition for the entry deterrence choice by the incumbent is $y_i^D \leq y_i^S$. This is the case when

[7] $$f \geq \Omega$$

where $\Omega \equiv \frac{[a-(w+s)]^2}{16b}$. More generally, the necessary and sufficient condition for the entry deterrence equilibrium is $\pi_i^D \geq \pi_i^S$, which is satisfied when

[8] $$f \geq \left(\frac{3}{2} - \sqrt{2}\right)\Omega$$ *necessary and sufficient deterrence condition*[13]

Of course, when the sufficient condition [7] is satisfied, price p^D (which is set by the incumbent) is higher than the price p^S (which corresponds to the Stackelberg solution) because $y^D = y_i^D \leq y_i^S < y_i^S + y_e^S = y^S$. But this is true also for a fixed setup cost *f* that is lower than Ω as long as $y_i^S < y_i^D \leq y_i^S + y_e^S = y^S$. By comparing solutions [6] and [5] for p^D and p^S, we can immediately derive the condition for $p^D \geq p^S$:

[9] $$f \geq \frac{1}{4}\Omega$$

In other words, if we start from $f = \Omega$ and $y_i^D = y_i^S$, then, as the fixed setup cost *f* decreases, the entry deterrence strategy requires an increase in preentry capacity level $\bar{k}_i$ and a reduction in price p^D, which remains higher than p^S until condition [9] is satisfied. When $f < (1/4)\Omega$, the Stackelberg price becomes higher than the Dixit price (because $y_i^S + y_e^S = y^S < y_i^D = y^D$); however, the incumbent continues to choose the entry

[12] The Dixit solution can be derived by substituting the entrant's reaction function [4] into its profit function, which is assumed to be equal to zero, that is $\pi_e = (a - by_i - by_e)y_e - (w+s)y_e - f = 0$. This yields a second-degree equation; of its two solutions, only $y_i = \frac{a-(w+s)}{b} - 2\sqrt{\frac{f}{b}}$ guarantees a positive profit for the incumbent.

[13] This is one of the two solutions of the equation $\pi_i^D = 8\sqrt{\Omega f} - 5f = 2\Omega - f = \pi_i^S$. The condition $f \leq \left(\frac{3}{2} + \sqrt{2}\right)\Omega$, which corresponds to the alternative solution of the equation, must be satisfied because otherwise the incumbent's profit would be negative in both the Dixit and the Stackelberg solution. (More precisely, *f* must be strictly lower than this threshold value because the profits are already negative when $f = \left(\frac{3}{2} + \sqrt{2}\right)\Omega$.)

deterrence strategy until condition [8] is satisfied. Finally, for a fixed setup cost that violates condition [8], the incumbent abandons the deterrence strategy, allows entry, and behaves as a Stackelberg leader; in this case, the industry output goes down to $y^S < y^D$ and the price jumps to $p^S > p^D$.

2.2. Macroeconomics of the product market with entry deterrence behavior

As outlined in the Introduction, we divide the time into a succession of discrete periods and consider an economy with *m* single-product symmetric industries. Every industry *j* is characterized, in each of the periods, by a Dixit deterrence game between an incumbent *i* (which is the same in all periods) and a potential entrant *e*. In order to simplify the model's analytical structure, we assume that productive capacity *k* is produced by an industry that is outside the economy under consideration: for instance, capacity is produced by a foreign country which exports it to our economy. In this case, the unit cost of capacity expansion *s* is the quantity of domestic output that is necessary to buy one unit of *k* from abroad; the current account flows are in equilibrium by hypothesis, and the economy exports an amount of its output that is exactly equal to *s* times the overall imported capacity. Finally, to further simplify matters, we will adopt some restrictive assumptions in order to obtain a sufficiently manageable macroeconomic framework: demand functions and production technologies remain constant in all periods and there is symmetry among the industries.

For the demand side of every industry $j = 1,\dots,m$, we assume a linear (inverse) demand curve that is obtained by linearizing the usual demand curve à la Blanchard and Kyiotaki (1987) – which in turn is derived from the Dixit-Stiglitz (1977) utility function - around the general symmetric equilibrium real price $p_j = P_j / P = 1$ (see the Appendix):

[10] $$p = \frac{1+\theta}{\theta} - \left[\frac{Y(1-s)}{m}\right]^{-1} \frac{1}{\theta} y$$

where the subscript *j* is omitted to simplify notation; here *Y* denotes aggregate output and $Y(1-s)$ denotes total consumption (equal to consumers' disposable income - i.e., aggregate output net of the portion used by firms to purchase capacity from abroad). Finally, $\theta > 1$ is a parameter corresponding to the (constant) elasticity of substitution in the Dixit-Stiglitz utility function (see the Appendix). Of course, this linearized form plays a simplifying role in our model. Observe that, around the general symmetric equilibrium point, equation [10] is equivalent to the constant elasticity demand curve (so that the elasticity of [10] is θ) and that an increase in the parameter θ has a positive effect on the elasticity of demand in all points of [10].

The term $(1+\theta)/\theta$ is equivalent to the term *α* in equation [3], and $[Y(1-s)/m]^{-1}(1/\theta)$ is equivalent to *b*. Therefore, Stackelberg and Dixit solutions that correspond to the demand function [10] are (respectively):

[11]
$$
\begin{aligned}
y_i^S &= \frac{1}{2}\cdot\frac{Y(1-s)}{m}\{1+\theta[1-(w+s)]\}\\
y_e^S &= \frac{1}{4}\cdot\frac{Y(1-s)}{m}\{1+\theta[1-(w+s)]\}\\
y^S &= \frac{3}{4}\cdot\frac{Y(1-s)}{m}\{1+\theta[1-(w+s)]\}\\
p^S &= \frac{1}{4}\cdot\left[\frac{1+\theta}{\theta}+3(w+s)\right]
\end{aligned}
$$

and

[12]
$$
\begin{aligned}
y^D &= y_i^D = \bar{k}_i = \frac{Y(1-s)}{m}\{1+\theta[1-(w+s)]\}-2\sqrt{f\theta\frac{Y(1-s)}{m}}\\
p^D &= w+s+2\sqrt{\frac{f}{\theta}\cdot\frac{m}{Y(1-s)}}
\end{aligned}
$$

The necessary and sufficient deterrence condition [8] becomes:

[13]
$$
f \geq \left(\frac{3}{2}-\sqrt{2}\right)\Omega \qquad \text{with} \qquad \Omega \equiv \frac{\{1+\theta[1-(w+s)]\}^2}{16\theta}\cdot\frac{Y(1-s)}{m}
$$

Now, we can immediately verify the effects on the deterrence condition of changes in aggregate output *Y* and in the parameter θ (i.e., in the elasticity of demand). Because $\partial\Omega/\partial Y > 0$, the deterrence condition [13] becomes more binding when total output increases. The explanation is straightforward: an increase in total output implies an increase in industry *j*'s demand; therefore, the fixed setup cost *f* can be distributed over a greater output, the profit of the entrant in the Stackelberg equilibrium increases, and the entry deterrence strategy becomes more difficult. In contrast, the derivative $\partial\Omega/\partial\theta$ is negative:[14] an increase in θ makes the deterrence condition less binding because it reduces the incumbent's profit more in the Stackelberg than in the Dixit equilibrium.

[14] Indeed, we have

$$
\frac{\partial\Omega}{\partial\theta} = \frac{\{1+\theta[1-(w+s)]\}\cdot\{\theta[1-(w+s)]-1\}}{16\theta^2}\cdot\frac{Y(1-s)}{m}
$$

which is negative for $\theta[1-(w+s)]<1$. This condition is certainly satisfied in our model because the industry output is higher (in both the Stackelberg and Dixit equilibria) than the monopolistic level, so that $d\pi/dp > 0$. As a result, for the symmetric general equilibrium price $p=1$ we have $d\pi/dp = y\{1-\theta[1-(w+s)]\} > 0$; that is, $\theta[1-(w+s)]<1$.

Finally, from the second of equations [12] we can immediately see that the entry deterrence price p^D is a decreasing function both of the parameter θ and of total output *Y*. The first result is standard, since an increase in θ implies an increase in the elasticity of demand. The second result has a simple explanation that is analogous to the one just given for the effect of *Y* on the deterrence condition: an increase in total output implies an increase in industry *j*'s demand and so the fixed setup cost *f* can be distributed over a greater output; hence, in order to keep the expected profit of the entrant at zero, the incumbent must increase its own preentry capacity level $\bar{k}_i$ and reduce its price p^D. Of course, an analogous effect derives from a decrease in the fixed setup cost *f*.

We can now derive the price-setting curve in the labor market that corresponds to this oligopolistic game in the product market. By introducing the symmetric equilibrium real price $p^D = 1$ in the second of equations [12], we obtain the real wage w^D that is consistent with the Dixit deterrence equilibrium in the product market:

[14] $$w^D = 1 - s - 2\sqrt{\frac{f}{\theta} \cdot \frac{m}{\ell(1-s)}}$$ *PS curve*

where, given the assumption that labor productivity equals 1, we can write the aggregate employment ℓ in place of *Y*. Let us normalize the labor force to 1 so that ℓ denotes the employment share (which of course is equal to $1-u$ for *u* the unemployment rate).

The *PS* curve is increasing and concave in ℓ (see Figure 1).[15] The economic interpretation of this result is based on the behavior of the deterrence price p^D, which – as emphasized before – is reduced when the aggregate output increases. The intercept of the curve on the vertical axis for $\ell = 1$ is $w^D = 1 - s - 2\sqrt{\frac{f}{\theta} \cdot \frac{m}{1-s}}$ and that on the horizontal axis is $\ell = \frac{4}{(1-s)^3} \cdot \frac{fm}{\theta}$.

[15] Because $\partial w^D / \partial \ell = \ell^{-3/2}\sqrt{fm/\theta(1-s)} > 0$ and $\partial^2 w^D / \partial \ell^2 = -(3/2)\ell^{-5/2}\sqrt{fm/\theta(1-s)} < 0$.

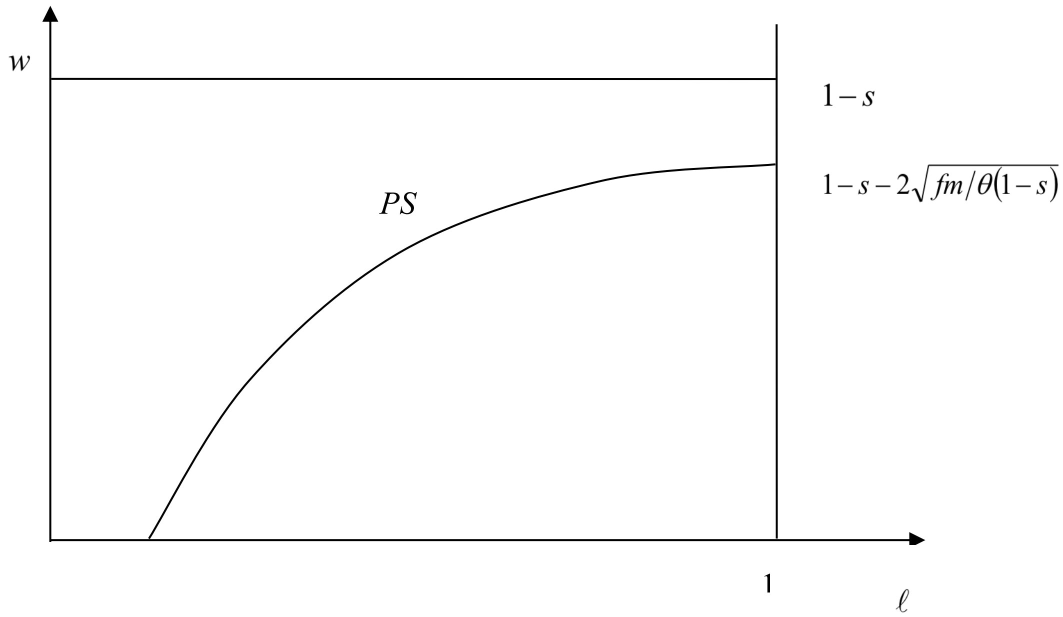

Figure 1

Moreover, the response of p^D to changes in demand elasticity and in the fixed setup cost causes the *PS* curve to shift upward when θ increases and/or *f* decreases.[16] Finally, $\lim_{\theta \to \infty} w^D = 1 - s$ and $\lim_{f \to 0} w^D = 1 - s$; in both cases, the wage entirely absorbs labor productivity net of the unit cost of capacity expansion.

The price-setting curve that corresponds to the Stackelberg solution can easily be derived by introducing the symmetric equilibrium real price $p^S = 1$ in the fourth of equations [11]:

[15] $$w^S = 1 - s - \frac{1}{3\theta}$$

In the figure, this would be plotted as a horizontal straight line. For a low enough level of the fixed setup cost, the price-setting curve [15] crosses the price-setting curve [14] when $\ell < 1$; in this case, condition [9] is violated and the Stackelberg price is higher than the Dixit one. Moreover, for a still lower level of *f*, the deterrence condition [13] is violated; here the Stackelberg strategy dominates the Dixit strategy for employment levels higher than a threshold value that is lower than 1.

[16] Because $\partial w^D / \partial \theta = \theta^{-3/2} \sqrt{fm/\ell(1-s)} > 0$ and $\partial w^D / \partial f = -f^{-1/2} \sqrt{m/\theta\ell(1-s)} < 0$.

2.3. The (inverse) labor supply curve

In order to focus our analysis on the macroeconomic effects of firms' entry deterrence behavior on the product market, we simplify the labor market analysis by assuming perfect competition. We also assume separability and additivity of the disutility of labor in the consumer's utility function, so we obtain the following labor supply curve (see the Appendix):

$$\ell = \left(\frac{w}{\mu[(\varepsilon+1)/\varepsilon]} \right)^{\varepsilon}$$

where μ is a constant and ε denotes the (constant) elasticity of labor supply. Let us assume for simplicity that $\varepsilon = 1$ and $\mu = (1-s)/2$; then the inverse labor supply curve is:

[16] $$w = (1-s)\ell \qquad \textit{WS curve}$$

This curve is actually a straight line that starts at the origin and increases by the coefficient $(1-s)$. Its intercept on the vertical axis for $\ell = 1$ is also $w = 1-s$. We will call equation [16] the "wage-setting" curve for the sake of symmetry with respect to the price-setting curves [14] and [15].

2.4. The general macroeconomic equilibrium

We now combine price-setting and wage-setting curves to obtain the macroeconomic equilibrium. In general, the equilibrium employment share is characterized as:

[17] $$\ell_E = \frac{w^H}{1-s}$$

where $H = \{D, S\}$ indicates that the equilibrium depends on the dominance of strategies (Dixit versus Stackelberg) in the product market.

Assuming the Dixit strategy, the price-setting curve [14] can be plotted on the same graph as the wage-setting curve [16]; see Figure 2. Since for $\theta < \infty$ and $f > 0$ we see that the intercept of the *PS* curve on the vertical axis for $\ell = 1$ is lower than $1-s$ and since the *PS* curve crosses the horizontal axis for $\ell > 0$, it follows that there are three possible cases as determined by the parameter values. The first case is illustrated in Figure 2: the economy exhibits two equilibria, *E* and E'. Before analyzing their properties, we must note that the existence of a general macroeconomic equilibrium in the Dixit strategies may not be assured. Indeed, recall that the *PS* curve shifts downwards when θ decreases and/or *f* increases. This makes possible the second and third cases: a tangential point between the *PS* and *WS* curves (i.e., only one point of equilibrium) and no equilibrium at all. The latter case may occur with sufficiently low values of θ and/or sufficiently high values of *f*; in such circumstances, the real wage levels that are consistent with the Dixit deterrence equilibrium in the product market are too low (with respect to the corresponding real wage levels on the labor supply function) for every level of employment.

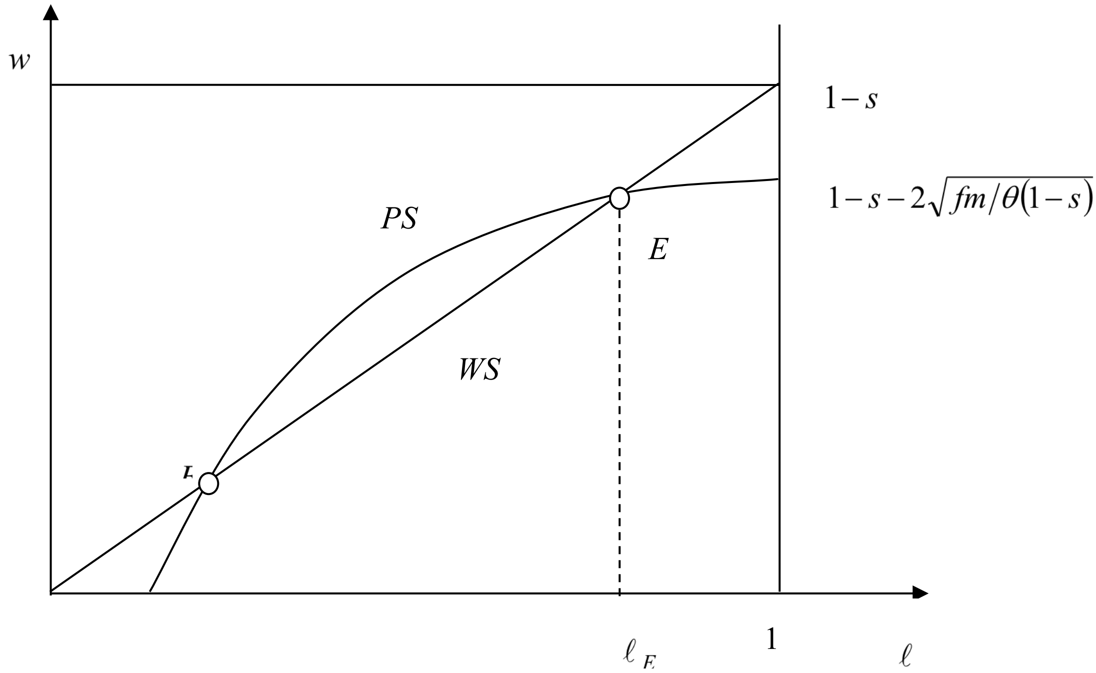

Figure 2

Let us now consider the two equilibria case illustrated in Figure 2. The equilibrium *E* has macroeconomic stability properties whereas the equilibrium E' is unstable. For an employment share lower than ℓ_E, at the real wage (as determined by the *PS* curve) there is an excess of labor supply: as long as wages decrease in every sector of the economy, the industry output increases and the aggregate output increases, too. We know that an increase in aggregate output induces incumbents to deter entry by further increasing their preentry capacity levels and further reducing their prices; hence, for equation [14], we see increases not only in the employment share but also in the price-determined real wage w^D. Because the *PS* curve around point *E* exhibits a smaller slope than does the *WS* curve, the distance between the two curves reduces as employment increases and so the economy moves, over time, toward the equilibrium point. An analogous adjustment in the opposite direction takes place if the economy initially lies to the right of point *E*. The respective directions of movement involved in these adjustment processes imply that the equilibrium point E' is unstable.[17]

[17] Observe that, in the case of a tangential point between the *PS* and *WS* curves, the equilibrium will be stable (resp. unstable) if the economy lies to its right (resp. left).

The reader can easily draw the diagram that corresponds to the hypothesis of Stackelberg dominance by combining the wage-setting curve [16] with the price-setting curve [15]. In this case there is a unique and stable equilibrium because equation [15] describes a horizontal straight line whose intercept is lower than $1-s$ for $\theta<\infty$.

The macroeconomic equilibrium – whether characterized by dominance of Dixit or Stackelberg strategy - is a long-run equilibrium in this sense: the choice of entry (or not) is endogenous and the equilibrium persists over time once the economy reaches it.

3. Pro-competitive policy implications

In the model presented here, two key parameters are natural candidates to be affected by pro-competitive policies: the fixed setup cost f and the parameter θ, which in turn affects the elasticity of the industry demand curve. The latter is formally introduced as a "taste" parameter in the Dixit-Stiglitz utility function, but we can adopt the B-G suggestion and view θ as the degree of substitutability among products which may change for whatever reason.[18]

Liberalization and antitrust policies can reduce f in several ways, for instance: by eliminating legal barriers to entry in some industries, taking a nondiscriminatory approach to licencing, cutting red-tape costs for the creation of new firms. An increase in θ may be affected by, for example, eliminating tariff barriers (so as to increase substitutability between domestic and imported goods), enforcing antitrust prohibitions against collusive behaviors that aim to segment markets, assessing antitrust penalties for tying strategies (so as to increase substitutability of each of the goods produced by a firm with respect to the products of other firms), and promoting a more informed consumer behavior.

For sake of simplicity, and consistently with the adopted symmetry hypothesis among the industries, we will assume that pro-competitive policies affect the cost of entry f and the elasticity parameter θ in the same measure for all industries.[19]

The effects of such pro-competitive policies can easily be analyzed by means of Figure 3, where the superscripts D and S mark the price-setting curves that are consistent with Dixit and Stackelberg strategies, respectively. We assume that the Dixit strategy dominates the

[18] See Blanchard and Giavazzi (2003, p. 885).

[19] Otherwise the analysis would become hugely more complex because it would be necessary to remove the symmetry hypothesis that helps to simplify our macroeconomic model.

Stackelberg one: the PS^D curve lies below the PS^S curve for all levels of employment and so it follows that, in every industry, $p^D > p^S$ and the entry deterrence condition [13] is certainly satisfied (cf. the arguments at the end of Section 2.1).

The economy is at the equilibrium *E*, and the employment share is ℓ_E. We begin by considering an increase in θ, given the fixed setup cost *f*: the PS^D curve shifts upward, so that both employment and real wages increase. Also the PS^S curve shifts upward with the increase in θ (see equation [15]), so the Dixit strategy continues to dominate the Stackelberg one (cf. the discussion in Section 2.2 regarding the entry deterrence condition [13]). The new macroeconomic equilibrium persists over time and, in contrast with the B-G result, the favorable effect on employment and real wages does not vanish in the long-run.

As the elasticity of demand increases, the macroeconomic equilibrium gradually approaches the competitive equilibrium characterized by a real wage of $1-s$ (i.e., the zero-profit condition for $f=0$) and full employment ($\ell=1$). However, this process does not continue indefinitely: sooner or later, the firm's gross profit $[p-(w+s)]y$ will be just sufficient to cover the fixed setup cost.[20] Thereafter, any further increase in the elasticity of demand would violate the nonnegative-profit condition and prevent firms from continuing to produce in the following periods.

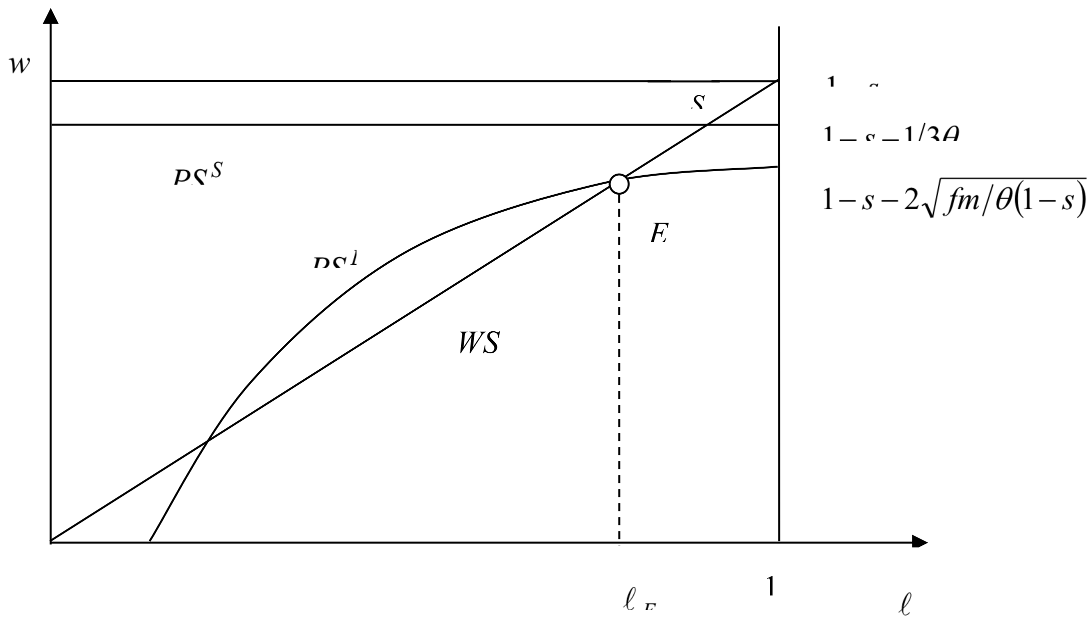

Figure 3

[20] In our macroeconomic model this result is obtained in a general equilibrium framework based on the assumption of symmetry among the industries. It seems to be reasonable that an analogous result should characterize also an equilibrium with sectoral specific demand functions: the main difference should be that when the nonnegative-profit condition is reached for the first industry, the others still make supernormal profits.

Let us now consider the effects of a reduction in the fixed setup cost *f*, given the parameter θ, starting from the equilibrium point *E* in the figure. The PS^D curve shifts upward, so that both employment and real wages increase. Of course, also in this case, the new macroeconomic equilibrium – by persisting over time - has the characteristics of a long-run equilibrium.

This process naturally continues as the setup cost decreases, but the change in *f* does not affect the PS^S curve. Therefore, for a sufficiently low value of *f*, the PS^D curve will intersect the PS^S curve: from now onward, $p^D < p^S$ even if the Dixit strategy still dominates the Stackelberg one. As *f* continues to decrease, the Stackelberg strategy eventually dominates the Dixit one; at this point, the equilibrium suddenly changes and the economy exhibits a jump to lower employment and lower real wages.

But the story does not end here. Given the level reached by *f*, the reduction in aggregate output due to the reduction in employment reduces, in turn, the term Ω in condition [13]; then the Dixit strategy again becomes the dominating one. In this scenario, the economy exhibits alternation between Dixit and Stackelberg macroeconomic equilibria.

Only for a still lower level of the setup cost *f* – namely, such that condition [13] is not satisfied for the aggregate output that is consistent with the intersection between the PS^S and *WS* curves - will the Stackelberg equilibrium definitively dominate the Dixit equilibrium and the economy stabilize at point *S* in Figure 3. Note that point *S* is the macroeconomic equilibrium also for $f = 0$: in the absence of a fixed setup cost, the incumbent has no option but to allow entry and settle for the best duopoly point. That is, in the context of the assumed industry structure, a zero setup cost is not sufficient for reaching the competitive equilibrium $\ell = 1$ and $w = 1 - s$.

In sum: for an entry deterrence game on the product market, pro-competitive policies are able to improve the macroeconomic equilibrium, with long-run favorable effects on both employment and real wages, as follows:

- A reduction in the fixed setup cost shifts upward the price-setting curve that corresponds to the Dixit strategy, so that the point of intersection with the wage-setting curve moves toward higher employment and a higher real wage. The best macroeconomic point achievable under this policy is the one corresponding to the Stackelberg macroeconomic equilibrium.
- An increase in the elasticity of demand also shifts the price-setting curve that corresponds to the Dixit strategy upward, with an analogous effect of increasing employment and the real wage. The macroeconomic equilibrium approaches the competitive equilibrium as the elasticity of demand increases, but only up to the point where the firm's gross profit is just sufficient to cover the fixed setup cost.

- Finally, a mix of these two pro-competitive policies enhances the results and could, in theory, asymptotically approach the competitive macroeconomic equilibrium as $f \to 0$ and $\theta \to \infty$.

4. Conclusion

This paper presents a macroeconomic model in which every industry that produces a good (that is differentiated à la Dixit and Stiglitz from those produced by other industries) is characterized by a Dixit-Spence entry deterrence game: the incumbents' investment decisions have commitment value in deterring potential rivals from entering the market. This industrial structure yields an increasing and concave price-setting curve between aggregate employment and the real wage when the entry deterrence strategy dominates the accommodating Stackelberg strategy.

The entry deterrence macroeconomic equilibrium has notable implications for pro-competitive policies. A reduction in the fixed entry cost has favorable effects in the short and the long run on both employment and the real wage. The best macroeconomic equilibrium that this policy can attain is the one corresponding to dominance of the Stackelberg accommodating strategy by incumbents. An increase in the elasticity of demand increases both employment and the real wage, with a positive effect in the short run that does not vanish in the long run. As the elasticity of demand increases, the macroeconomic equilibrium approaches competitive equilibrium - but only up to the point where the firm's gross profit is just sufficient to cover the fixed setup cost. Finally, a mix of the two pro-competitive policies enhances these results and could, in theory, asymptotically approach competitive macroeconomic equilibrium as the elasticity of demand increases and the fixed setup cost decreases.

Thus, the paper contributes to the analysis of the antitrust policies effects in terms of changes in both the single market and macroeconomic equilibrium, when the economy is characterized by an oligopolistic industrial structure where the incumbents adopt a strategic behavior aimed to deter rivals' entry.

Future research could develop this model along two main lines. First, the labor market could be augmented by the introduction of wage bargaining; doing so would allow us to analyze the consequences, on macroeconomic equilibrium and pro-competitive policies, of the interaction between entry deterrence strategies on the product market and the bargaining power of workers on the labor market. The second possible development concerns the nature of the macroeconomic equilibrium that results from the model - namely, a macroeconomic equilibrium that depends only on supply-side determinants. The increasing price-setting curve suggests that an investigation into the influence of aggregate demand on macroeconomic equilibrium could reveal demand management effects on aggregate output and employment.

APPENDIX

From the utility function to the demand for goods and supply of labor curves

Assuming a utility function à la Dixit and Stiglitz (1977), omitting the subscript denoting the single consumer, and normalizing the labor force (number of consumers) to 1, the representative consumer optimization problem is:

[A1]
$$\begin{aligned} &\max \quad U = m^{1/(1-\theta)}\left(\sum_j y_j^{(\theta-1)/\theta}\right)^{\theta/(\theta-1)} - \mu\ell\frac{\varepsilon+1}{\varepsilon} \\ &s.t. \quad \sum_j P_j y_j = W\ell + \sum_j \Pi_j \\ &\qquad P = \left(\frac{1}{m}\sum_j P_j^{1-\theta}\right)^{1/(1-\theta)} \end{aligned}$$

where $j = 1,\ldots,m$ are the m goods produced in the economy, P_j is the nominal price for good j, P is the general level of prices, W is the nominal wage, and Π_j is the nominal profit in industry j (which is entirely distributed to the consumer-shareholder). Given the assumption that the disutility of labor is separable and additive, we can solve this problem for the demand for goods by further assuming $W\ell + \sum_j \Pi_j = R$. Then we obtain the following first-order conditions:

[A2]
$$\begin{aligned} &\left(\frac{y_h}{y_k}\right)^{1/\theta} = \frac{P_k}{P_h} \qquad \text{for every couple of goods} \\ &\sum_j P_j y_j = R \end{aligned}$$

Taking the definition of P into account, we derive the following demand function for each of the $j = 1,\ldots,m$ goods:

$$y_j = \left(\frac{P_j}{P}\right)^{-\theta}\frac{R/P}{m}$$

Since $R/P = Y(1-s)$ in the equilibrium between production and aggregate demand, where sY is the quantity of domestic output that buys productive capacity k from abroad, it follows that the demand curve for good j is:

[A3]
$$y_j = \left(\frac{P_j}{P}\right)^{-\theta}\frac{Y(1-s)}{m}$$

Denoting the real price of good j by $p_j = P_j/P$ and linearizing the demand curve [A3] around the general symmetric equilibrium real price $p_j = 1$, we obtain:

[A4] $$y_j = (1+\theta)\frac{Y(1-s)}{m} - \theta\frac{Y(1-s)}{m}p_j$$

Therefore, the inverse demand curve is:

[A5] $$p_j = \frac{1+\theta}{\theta} - \left(\frac{Y(1-s)}{m}\right)^{-1}\frac{1}{\theta}y_j$$

Returning now to the supply of labor, we define $V = m^{1/(1-\theta)}\left(\sum_j y_j^{(\theta-1)/\theta}\right)^{\theta/(\theta-1)}$.

Now substituting the quantity of goods with their demand functions [A3] and taking the definition of *P* into account, we obtain $V = Y(1-s)$. Hence, we can write the utility function as follows:

[A6] $$U = Y(1-s) - \mu\ell^{(\varepsilon+1)/\varepsilon} = \frac{W}{P}\ell + \sum_j \frac{\Pi_j}{P} - \mu\ell^{(\varepsilon+1)/\varepsilon}$$

The first-order condition for labor supply is:

[A7] $$\mu\frac{\varepsilon+1}{\varepsilon}\ell^{1/\varepsilon} = \frac{W}{P}$$

Now using $w = W/P$ to denote the real wage, we obtain the following labor supply curve:

[A8] $$\ell = \left(\frac{w}{\mu[(\varepsilon+1)/\varepsilon]}\right)^{\varepsilon}$$

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