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Endogenous Market Structures and Macroeconomic Theory

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ABSTRACT

This article applies the emerging theory of endogenous market structures to macroeconomic issues through a few simple models. First, we study a model of Schumpeterian growth where strategic interactions and endogenous entry determine the equilibrium behaviour of the firms investing in R&D. Second, we provide a new framework to study business cycles with imperfect competition in quantities à la Cournot and endogenous entry, and we show how a temporary shock promotes entry, reduces the mark ups and magnifies the impact on consumption. Third, we revisit the new trade theory adopting both strategic interactions and endogenous entry and revisiting some traditional results on the impact of opening to trade, the optimal tariff and the optimal export subsidy.

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I. INTRODUCTION

The neoclassical economic theory is based on the constant returns to scale/perfect competition framework. In this framework, entry of firms is endogenous in the sense that all firms expect zero profits at each point in time, but the market structure is indeterminate: whether one or infinite firms produce each good is irrelevant as long as there are constant returns to scale, and strategic interactions do not play any role.

In the last three decades, economists have emphasized the importance of increasing returns to scale and market power, and these factors have been introduced and widely used in the modern theories of international trade (Krugman, 1980), of the business cycle (Blanchard and Kiyotaki, 1987), and of endogenous growth (Romer, 1990). Nevertheless, most of the literature has adopted the monopolistic competition framework of Dixit and Stiglitz (1977) in which strategic interactions do not play any role given the high number of players, and the number of firms has been often kept exogenous (typically in the theory of business cycles). Therefore, the macroeconomic literature has systematically neglected either the strategic interactions between firms or the endogeneity of entry. We believe that the lack of consideration for the rationality of the entry decisions and of the interaction between these and the strategic decisions of the firms are a crucial limit of the modern economic literature, especially because the rest of it is largely (and sometimes excessively) relying on the rationality of all the agents and of their expectations.

Recent microeconomic investigations on market structures where entry is endogenous have provided a number of applications for the theory of industrial organization,[1] especially for the understanding of investments in R&D and in advertising, of the determinants of the financial structure, and of the behaviour of market leaders (with particular reference to predatory strategies, price discrimination, bundling and vertical restraints), of the effects of mergers and of the effectiveness of price fixing agreements (which of course have crucial consequences for antitrust policy). The endogenous entry approach, however, may be relevant also for the analysis of macroeconomic issues. In this article, we will review a number of extensions of the traditional macroeconomic analysis to take into account endogenous market structures, emphasizing the role of realistic markets with their leaders and their competitive levels in affecting the functioning of the aggregate economy.

Our main aim is to clarify a new channel through which endogenous market structures affect the economy. We may describe it in a simple way taking in consideration the effects of a productivity shock to the economy. Suppose that the marginal cost of production exhibits a temporary reduction in all the sectors. In a perfectly competitive sector, all prices equate the marginal costs of production and the shock is instantaneously transferred to the prices: since the price reduction follows the reduction in the marginal cost and is temporary, consumption has a temporary boom which in turn pushes the economy. Now consider sectors characterized by few firms competing in quantities and entering endogenously in the markets. Since firms price at a markup on the marginal cost, the shock has an initial positive impact on the individual profits, which attracts entry of new firms. Entry strengthens competition which reduces the equilibrium mark ups. This in turn implies that the prices are reduced by more than the reduction in the marginal cost, and the boom in consumer demand is therefore magnified by the competition effect (compared to a perfectly competitive economy). Of course over time the strengthening of competition reduces the individual profits and brings back entry to the initial level. This mechanism works also in an international context. For instance, a similar shock in one country may induce further entry of its firms in the local sectors for non tradable goods or in the global sectors for tradable goods, reducing the respective mark ups and magnifying the impact of the shock in the domestic market or in the global market as well. Finally, entry driven by profitable opportunities is what drives investments in R&D and therefore technological progress, and is at the basis of the theory of Schumpeterian growth. We will provide an analysis of the strategic interactions of the firms investing in R&D and of the role of technological leaders with the aim of clarifying further the determinants of the endogenous growth process.

The article is organized as follows. In Section II we will deal with innovation and growth on the basis of Etro (2004, 2007b), in Section III with business cycles on the basis of Colciago and Etro (2007), and in Section IV with open economy issues, with particular reference to trade policy (see Etro, 2006b). Section V will conclude.

II. ENTRY, TECHNOLOGICAL LEADERS AND GROWTH

One of the first macroeconomic applications of the theory of endogenous market structures concerned Schumpeterian models of technological progress. The modern theory of growth (Romer, 1990; Aghion and Howitt, 1992) has disregarded non-convexities and strategic interactions in the competition for the market, modelling the latter as characterized by constant returns to scale and atomistic firms, neglecting the persistence of technological leadership, and deriving the investment in R&D from no-arbitrage conditions.

Endogenizing the structure of the competition for the market allows to open the black box of the engine of growth and clarify its mechanism, the incentives of market leaders and followers to invest in R&D, the aggregate consequences of the strategic interaction and entry and the role of policy. Etro (2004, 2007b) shows that under realistic conditions, market leaders have a crucial role in innovating, a result in contradiction with the recent literature, but in line with the original Schumpeterian ideas. Empirical evidence confirms that incumbents do a lot of research and their leadership persists through a number of innovations.[2] Moreover, it emerges that the market for innovation is characterized by excessively small firms leading to dynamic inefficiency and to the general optimality of positive R&D subsidy, a result in contrast with the ambiguous outcome of the standard endogenous growth literature.

In this section we will review a simple model of competition for the market that emphasizes the role of strategic interactions and endogenous entry. Building on this, we will then draw some macroeconomic and policy implications.

A. *A simple model of innovation*

Competition for the market works as a sort of contest. Firms invest to innovate and to win the contest. It may be that the innovator obtains a patent on the invention and exploits monopolistic profits for a while on its innovation. It may be that the same innovator just keeps it secret and exploits its leadership on the market until an imitator replaces it. In both ways the expected gain from an innovation is what drives firms to invest in R&D. In this section we want to study in the simplest way competition for the market in the case in which investment decisions are taken strategically and entry is endogenous.

Consider a simple contest between N firms to obtain a drastic innovation which has an exogenous expected value $V \in (0,1)$ for the winner and generates no gains for the losers. Each contestant i invests resources $z_i \in [0,1)$ to win the contest. This investment has a cost and, for simplicity, we will assume that the cost is quadratic, that is $z_i^2/2$.

The investment provides the contestant with the probability z_i to innovate. The innovator wins the contest if no other contestant innovates, for instance because in the case of multiple winners competition between them would drive profits away. Therefore, the probability to win the contest is $\Pr(i\ wins) = z_i \prod_{j=1, j\neq i}^{N} [1 - z_j]$, that is its probability to innovate multiplied by the probability that no one else innovates. In conclusion, the profit function of a generic contestant is:

$$\pi_i = \beta z_i \prod_{j\neq i} (1 - z_j) V - \frac{z_t^2}{2} - F \qquad (1)$$

where $\beta = 1/(1+r)$ is the discount factor (with r interest rate).

In a preliminary period the incumbent monopolist can exploit its technology to obtain profits $K \in (0,V]$. If no one innovates, the incumbent retains its profits K. Therefore, the expected profits of the incumbent monopolist, that we now label with the index M, are:

$$\pi_M = K - \frac{z_M^2}{2} - F + \beta\left[z_M \prod_{j\neq M} (1 - z_j) V + (1 - z_M) \prod_{j\neq M} (1 - z_j) K\right] \qquad (2)$$

in case of positive investment in the contest.

Consider a Nash equilibrium with a general number of firms. If the monopolist is investing, the first order conditions for the monopolist and for the other firms in Nash equilibrium would be $z = \beta(1-z)^{N-2}(1-z_M)V$ and $z_M = \beta(1-z)^{N-1}(V-K)|$, which always imply a lower investment of the monopolist. When entry of firms is endogenous, investors enter as long as expected profits are positive, that is until the following zero profit condition holds $\beta z(1-z_M)(1-z)^{N-2}V = z^2/2 + F$. This implies that each one of the other firms invests $z = \sqrt{2F}$, while the monopolist should invest less than this, and it is easy to verify that it is actually in the interest of the monopolist not to invest at all. The endogenous market structure requires:

$$z = \sqrt{2F}, \quad N(V,F) = 1 + \frac{\log\left(\beta V / \sqrt{2F}\right)}{\log\left[1 / \left(1 - \sqrt{2F}\right)\right]}$$

In this simple example of endogenous market structure, the lack of incentives to invest for the monopolist emerges quite clearly.

Often times, however, competition for the market is between an incumbent monopolist that is leader in the competition with the outsiders. In such a case the incentives to invest in innovation may be different. Following Etro (2004), we will now study the same market as before where the monopolist can act as a leader and commit to an investment level before the other firms. It is easy to verify that, as long as the investment of the leader is small enough to allow entry of at least one outsider, the endogenous entry condition delivers again the same investment $z = \sqrt{2F}$ for each outsider, and the number of firms $N(z_M) = 2 + \log\left[(1 - z_M)V / \sqrt{2F}\right] / \log\left[1/\left(1 - \sqrt{2F}\right)\right]$. Putting together the two equilibrium conditions in the profit function of the leader, we would have:

$$\Pi_M(z_M, V) = K - \frac{z_M^2}{2} - F + \frac{z_M}{1 - z_M}\sqrt{2F}\left(1 - \sqrt{2F}\right) + \frac{K}{V}\sqrt{2F}\left(1 - \sqrt{2F}\right)$$

whose last element, the one associated with the current profits obtained in case no one innovates, is independent from the choice of the leader. Profit maximization generates a corner solution such that no outsider enters. Since $N(z_M) = 2$ requires $\log\left[(1 - z_M)V / \sqrt{2F}\right] = 0$, we can conclude that the leader will invest:

$$\bar{z}_M = 1 - \frac{\sqrt{2F}}{V} \tag{3}$$

The leadership in the competition for the market radically changes the behaviour of a monopolist: from zero investment to maximum investment.[3] Summing up, *there are two sufficient conditions under which monopolists have in-centives to invest in R&D and to invest more than other firms: 1) leadership for the monopolist and 2) endogenous entry for the outsiders in the race to innovate.*

B. *Macroeconomic implications*

The macroeconomic implications of the endogeneity of the market structure characterized above have been studied in Etro (2004, 2007b), in a dynamic general equilibrium model where the innovations increase total factor productivity and therefore translate into output growth.

To simplify, consider a stationary environment where there is a sequence of innovations obtained through contests as the one studied in the previous section. Each innovation provides constant profits K to the innovator and induces growth. Imagine that the long run growth rate g is an increasing function of the aggregate of innovation Z in a representative sector as the one described in the previous section $g = g(Z)$-this relation can be microfounded in general equilibrium from equality between savings and investment.

Under Nash competition with endogenous entry we have seen that $Z = \left|N(V,F)\sqrt{2F}\right.$ therefore the growth rate is:

$$g = g\left[N(V,F)\sqrt{2F}\right]$$

while under Stackelberg competition with endogenous entry we had $Z = 1 - \sqrt{2F}/V$ and the growth rate is:

$$g = g\left(1 - \sqrt{2F}/V\right)$$

In both cases, growth is increasing in the expected value of the innovation. However, the value of innovation is different in the two cases: it corresponds to the exploitation of a single innovation in the first case, and it corresponds to the exploitation of all the future innovations in the second case. One can show that the latter is always larger than the former:[4] in general, *a persistent leadership due to the pressure of potential innovators leads to higher innovation rates and growth rates than continuous leapfrogging due to the lack of a technological leadership*.

Etro (2007b) studies a more realistic form of competition for the market where the leader does not deter entry but invests more than the followers nevertheless, and analyzes the macroeconomic consequences. The decentralized equilibrium is always characterized by dynamic inefficiency because of a bias in the R&D sector toward firms investing too little – essentially because, for a given total investment in R&D, too many firms do research since they do not consider the negative externality induced by their entry on the expected profits of the other firms. The presence of incumbent monopolists doing a lot of research limits this inefficiency, but does not eliminate it. In macroeconomic jargon, dynamic inefficiency means that a reallocation of resources in the innovation sector (inducing larger research units) could increase both current and future consumption, and a consequence of this is that the optimal innovation policy requires always R&D subsidies. This result differs from the typical ambiguity emerging in the traditional literature where the innovation technology is characterized by constant returns to scale and the market structure is indeterminate.[5]

III. COURNOT COMPETITION, ENTRY AND THE BUSINESS CYCLE

Most of the modern theory of the business cycle, starting with Kydland and Prescott (1982), is based on the constant returns to scale/perfect competition/flexible price framework of the RBC literature. In this framework, entry is endogenous in the sense that all firms expect zero profits at each point in time, but the market structure is indeterminate: whether one or infinite firms produce each good is irrelevant as long as there are constant returns to scale.

Since a wide macroeconomic evidence, at least starting with the work of Hall (1986, 1990), suggests the relevance of departures from the perfectly competitive model, economists have introduced increasing returns to scale and monopolistic competition à la Dixit and Stiglitz (1977) and have widely used them in the modern general equilibrium newkeynesian literature (together with price rigidities for monetary analysis). Nevertheless, most of this literature has neglected both the strategic interactions between firms and the endogeneity of entry (starting with the early work of Blanchard and Kiyotaki, 1987). Strategic interactions have been neglected because they are absent in the standard monopolistic competition model, and because competition in quantities has never been taken in consideration in a literature that was mainly interested in introducing price rigidities to study the real effects of monetary shocks (and therefore always focused on price choices). Entry has been almost always considered exogenous because the crucial consequences of price rigidities (due to small menu costs or imperfect price adjustments) depended on the existence of market power and positive profits of the firms. As a consequence, macroeconomics has been virtually silent on the fluctuations of the number of firms, on the degree of competition in the markets, on the endogenous markups, and on the interaction between these fluctuations and those of the aggregate variables as output, consumption and employment.

We believe that the lack of consideration for the rationality of the entry decisions, and of the interaction between these and strategic decisions in the markets, is a crucial limit of the modern macroeconomic literature, especially because the rest of it is largely (and sometimes excessively) relying on the rationality of all the agents and of their expectations. In this section we will show that the endogenity of the market structures can play a crucial role in propagating the business cycle, beyond what happens in standard neoclassical models.

A. *A simple two-periods example*

Consider a two period model with logarithmic subutilities:

$$U = \log C_1 + \beta \log C_2 \tag{4}$$

where $\beta \in (0,1)$ is the discount factor. The consumption good is homogenous and it is produced by multiple firms in each period. Firms compete in quantities.

Given the price level in the two periods p_1 and p_2 and the interest rate r, and given the exogenous income Y, the budget constraints of the two periods are:

$$C_1 = \frac{Y - S}{p_1} \quad C_2 = \frac{S(1+r)}{p_2}$$

Utility maximization requires the demand of consumption $C_1 = Y/(1+\beta)p_1$ in the first period and $C_2 = \beta(1+r)Y/(1+\beta)p_2$ in the second one, which imply the inverse demand functions:

$$p_1 = \frac{Y}{(1+\beta)C_1} \qquad p_2 = \frac{\beta(1+r)Y}{(1+\beta)C_2}$$

In each period, N_t firms compete in quantities producing at marginal cost c_t. For simplicity, assume $(1+r)\beta = 1$ in what follows. Defining x_{it} as the production of firm i in period t, we have the gross profit functions:

$$\pi_{it} = \frac{Yx_{it}}{(1+\beta)\sum_{j=1}^{N_t} x_{jt}} - c_t x_{it}$$

In Cournot equilibrium, each firm produces $x_{it} = Y(N_t - 1)/(1+\beta)N_t^2 c_t$, and the equilibrium price is $p_t = \mu_t(N_t)c_t$ where the mark up function is:

$$\mu_t(N_t) = \frac{N_t}{N_t - 1} \tag{5}$$

which is decreasing in the number of competitors. It follows that:

$$\frac{C_2}{C_1} = \frac{c_1 \mu_1(N_1)}{c_2 \mu_2(N_2)} \tag{6}$$

The traditional outcome of perfect competition emerges in case of constant returns to scale, here equivalent to the absence of fixed costs of production. In such a case, endogenous entry implies an infinite number of firms, price equals the marginal cost in both periods and relative consumption is uniquely linked to the ratio of marginal costs: $C_2/C_1 = c_1/c_2|$. The neoclassical theory of the business cycle is largely based on this mechanism: a permanent increase in productivity does not affect the relative marginal cost and consumption, but a temporary increase in productivity today (a reduction in c_1/c_2) induces an increase in relative consumption today (a raise in C_1/C_2). Finally, notice that an exogenous change of income does not affect prices and relative consumption in the two periods.

When the markets are characterized by positive fixed costs of production, however, only few firms can be active and entry strongly affects relative prices and consumption. As a preliminary example, imagine that the fixed cost of production in period t is F_t, and entry is endogenous. Then we have:

$$N_t = \sqrt{\frac{Y}{(1+\beta)F_t}}, \quad \mu_t(N_t) = \left[1 - \sqrt{\frac{(1+\beta)F_t}{Y}}\right]^{-1} \tag{7}$$

which shows that an increase in income or a reduction in the fixed cost of production increase the number of firms and reduce the mark ups. Relative consumption can be calculated as:

$$\frac{C_2}{C_1} = \left(\frac{c_1}{c_2}\right)\left[\frac{\sqrt{Y} - \sqrt{(1+\beta)F_2}}{\sqrt{Y} - \sqrt{(1+\beta)F_1}}\right]$$

This shows two mechanisms due to the endogeneity of the market structures. The first is rather straightforward: an increase in the fixed cost of production in one period increases the relative consumption in the other period. The second mechanism is less intuitive: an exogenous increase in output increases the relative consumption of the good produced by a lower number of firms (suppose $F_1 < F_2$: this implies that more firms are active in the first period, and $p_1/c_1 < p_2/c_2$; under these circumstances, an increase in output increases C_2/C_1).

Assume now that the fixed cost of production is related to the marginal cost $F_t = \eta c_t$, as it typically happens when both fixed and variable costs require the same combination of inputs (for instance just labour). In such a case, we obtain a magnification effect of technology shocks. Rewriting the optimality condition as:

$$\frac{C_2}{C_1} = \left(\frac{c_1}{c_2}\right)\left[\frac{\sqrt{Y} - \sqrt{(1+\beta)\eta c_2}}{\sqrt{Y} - \sqrt{(1+\beta)\eta c_1}}\right] \tag{8}$$

one can notice that a reduction in the marginal cost of the first period is going to increase relative consumption in the first period more than proportionally. This new propagation mechanism works through endogenous entry. A temporary shock reduces the marginal cost which makes current consumption more attractive. Moreover, the reduction in the entry costs induces more firms to enter in the market, temporarily increasing competition. This induces a temporary reduction in the equilibrium mark up, which exhibits countercyclicality.[6] Accordingly, the shock makes current consumption even more attractive. In conclusion: *in the presence of endogenous market structures characterized by competition in quantities and endogenous entry, the impact of a temporary productivity shock on consumption is magnified through the impact of entry on the markup.*[7]

The result is dependent on two differences from the standard neoclassical setup. The first is the departure from the standard constant returns to scale assumption: fixed costs of entry imply increasing returns to scale in the production function. The second difference relies on the form of competition: here we adopted standard competition in quantities, but more general models of strategic interaction would deliver similar results.

B. *An endogenous market structure theory of the business cycle*

The simple example of the previous section shows that the introduction of endogenous market structures in the standard RBC framework can enlight a new and strong propagation mechanism of the business cycle. An important work by Bilbiie, Ghironi and Melitz (2007a, b) has explored the consequences of endogenous entry in a simple dynamic stochastic general equilibrium model where monopolistic competition without strategic interactions is assumed.[8]

Here, we present the results of a related model, developed by Colciago and Etro (2007) in a more general formulation, where the competition in quantities as characterized above takes place. Contrary to the usual assumption of imperfect substitutability between goods produced monopolistically, we assume that there are many sectors characterized by homogenous goods produced by firms competing in quantities. The existence of fixed costs of production justifies the presence of a limited number of firms in each sector, and free entry endogenizes the degree of market power in each sector as a function of the number of competitors. As a consequence, both the strategic interactions and the entry choices of the firms are endogenized.

The model is a standard representative agent model with alogarithmicutility and a production function:

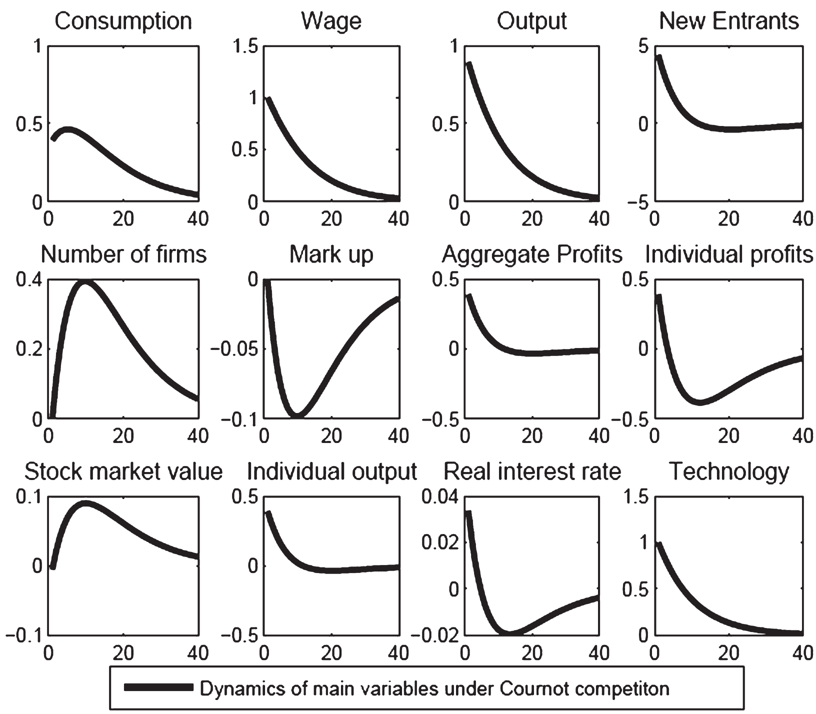
$$y_{it} = A_t L_{it} \tag{9}$$

for every firm active in each period. The marginal cost of production is therefore $c_t = w_t / A_t$ where w_t is the wage. In every period, a fraction $\delta \in (0,1)$ of the firms exits for exogenous reasons, and the number of entrants in the representative sector, N_t^I, is determined by an endogenous entry condition equating the value of a firm (i.e. the discounted value of its expected profits), to the fixed labour cost of entry $F_t = \eta c_t$. Labour supply is exogenous and normalized to one, while the number of firms follows the standard equation of motion $N_{t+1} = (1-\delta)(N_t + N_{t+1}^I)$.

Below we report a simulation drawn from the Colciago and Etro (2007) model with $\delta = 2.5\%$, $\beta = 99\%$, $\eta = 1$ and A calibrated to obtain a realistic mark up in steady state (25% in this example). As usual in the RBC literature, the temporary productivity shock has a autocorrelation coefficient of 0.9.

FIGURE 1

Impulse Response Function to a 1% temporary technology shock. Steady state mark up: 25%. Perfect substitutability. Source: Colciago and Etro (2007).



The impact of a temporary shock to the productivity parameter is somewhat similar to the typical impact in a standard RBC model with capital accumulation. However, in this case, the initial increase in the aggregate gross profits induces new firms to enter in the market, which in turn strengthens competition and reduces the mark ups. This new competition effect creates a large impact on current consumption, which is propagated through the gradual investment in creation of new firms financed by the savings of the representative agent. As discussed in Colciago and Etro (2007), the model is able to reproduce the procyclical variability of output and consumption in a similar fashion to the standard RBC model, it matches the procyclicality of entry and profits as in Bilbiie, Ghironi and Melitz (2007a, b), and it also matches the countercyclicality of mark ups due to a novel endogenous competition effect.

Colciago and Etro (2007) have extended the model to imperfect substitutability between goods. Assuming that the consumption index takes form:

$$C_t = \left[\sum_{j=1}^{N_t} C_{jt}^{\theta} \right]^{\frac{1}{\theta}} \tag{10}$$

the model nests the case of homogenous goods when $\theta = 1$, and perfectly independent goods for $\theta \to 0$, but it allows to parametrize the degree of substitutability with intermediate values of θ. In this case, the mark up function under competition in quantities generalizes to:

$$\mu_t(N_t) = \frac{N_t}{\theta(N_t - 1)} \tag{11}$$

while under competition in prices it becomes:[9]

$$\mu_t(N_t) = \frac{N_t - \theta}{\theta(N_t - 1)} \tag{12}$$

Both expressions are decreasing in the degree of substitutability. While the qualitative properties of the model are similar to the case of homogenous goods, Colciago and Etro (2007) compare the performance of the alternative models in matching business cycle data moments.

IV. TRADE LEADERS, ENTRY AND EXPORT PROMOTION

The introduction of imperfect competition in models of trade started with the pathbreaking model of Krugman (1980), that adopted the Dixit and Stiglitz (1977) framework of monopolistic competition for a positive analysis of intraindustry trade, and was later applied to normative analysis of trade policy (see Helpman and Krugman, 1989). As it happened in other fields, the characterization of the endogenous market structures was incomplete, because the Dixit-Stiglitz framework was taking in consideration the endogenous entry mechanisms, but not the strategic interactions between a limited number of firms, a rather crucial element for the understanding of concentrated markets.

The theory of endogenous market structures can be applied to open economy contexts to develop a unified and consistent general equilibrium framework and to exploit it for macroeconomic analysis. In this section we will discuss some basic elements of such a framework. Nevertheless, the more relevant applications of the endogenous entry approach to open economy contexts come from the policy front, especially the theory of strategic trade policy, which will be discussed in a later section.

A. *A theory of endogenous international market structures*

To start our exploration in a open economy context where market structures are truly endogenous, we examine the classic Krugman (1980) model and extend it to take into account different forms of strategic interaction between the firms. Consider a market with L agents consuming multiple goods to maximize utility from a consumption index as (10) under the budget constraint $\sum_{j=1}^{N} p_j C_j = w$, where w is the wage and labor supply is exogenous and normalized to unity. Each good i is produced according to the production function (9), but entry requires a fixed laborcost F. Under competition in quantities and in prices the equilibrium mark up is given respectively by (11) or (12).

Krugman (1980) and all the subsequent literature ignored the strategic interactions between firms obtaining the constant mark up $\mu = 1/\theta$. He adopted the endogenous entry condition $(\mu - 1)(w/A)C_j = wF$. The number of firms was derived from the market clearing condition for the labor market, $\sum l_j = L = \sum(F + C_j/A)$. Consequenctly, the number of firms is $N = L(1-\theta)/F$, which is linearly increasing in the number of agents. The conclusion of Krugman (1980) is that opening to trade increases the labour force and proportionally increases the number of varieties produced in the economy: since the equilibrium price is unaffected, utility goes up.

The approximation used by Krugman corresponds to the exact equilibrium when the number of firms tends to infinity, and it is meaningful if we interpret the economy as characterized by a single market with an extremely large number of differentiated goods. Nevertheless, if we look at the economy as characterized by many sectors with a limited number of firms producing relatively similar goods, this becomes an extremely misleading approximation. Here we will take this second approach and study a generalized version of the Krugman model with quantity competition and endogenous entry. For simplicity we will assume $w = A = 1$, so that $p = \mu$, and we will start our analysis with the case of homogenous goods ($\theta = 1$).

Consider first the equilibrium of a closed economy with endogenous market structure. The equilibrium is characterized by the mark up condition $\mu(N) = N/(N-1)$ and the endogneous entry and market clearing conditions, and it leads to the following price for each variety:

$$\mu = \frac{\sqrt{L}}{\sqrt{L} - \sqrt{F}} \tag{13}$$

Contrary to what happens in the Krugman model, where the price is independent from the domestic labour force, now the price is decreasing in the labour force. This result is due to a competition effect associated with the positive impact of the size of the market on the equilibrium number of firms,

$$N = \sqrt{\frac{L}{F}} \tag{14}$$

In a larger economy there are more firms and the strengthening of competition between them reduces the mark ups.

Consider now the opening of trade to other countries with identical agents and total population L^*. It is immediate to derive that the new equilibrium is characterized by the price $\mu = \sqrt{L + L^*} \Big/ \left(\sqrt{L - L^*} - \sqrt{F} \right)$. The total number of varieties becomes $N + N^* = \sqrt{(L - L^*)/F}$, and its increase leads to the lower international price level. Nevertheless, notice that trade has reduced the total number of firms, inducing an increase in world market concentration: in our case of homogenous goods, this represents an example of beneficial concentration, because the price level has decreased and production has become more efficient thanks to the reduction of the fixed costs. Trade clearly increases utility. Of course, in case of imperfect substitutability between goods, product variety is beneficial and the impact of trade is more complex, but the competition effects if trade on the prices and the reduction in the equilibrium number of varieties after the opening of trade persist.

Let us consider now the case of price competition. The closed economy with endogenous market structure is characterized by the following price:

$$\mu = \frac{L}{\theta(L-F)}$$

with a number of firms $N = (1-\theta)\mathrm{L}/\mathrm{F} + \theta$. In a larger economy there are more firms and the strengthening of competition between them reduces the mark ups. Consider now the opening of trade. The new equilibrium is characterized by the following price $\mu = (L+L^*)/\theta(L+L^*-F)$, and the total number of varieties becomes $N+N^* = (1-\theta)(L+L^*)/F+\theta$: its increase leads to the lower international price level without reducing the number of varieties (or reducing it of at most one unit if we take in consideration the integer constraint on the number of firms). Once again, the beneficial impact of trade emerges quite clearly, because world prices diminish and the number of varieties produced does not decrease.

The above model and similar ones can be used for further macroeconomic analysis or to study policy issues. Extending the dynamic general equilibrium model sketched in the previous section to a multicountry world, one can study the impact of shocks in the open economy. For instance, a temporary technology shock in one country may induce further entry of its firms in the local sectors for non tradable goods or in the global sectors for tradable goods, reducing the respective mark ups and magnifying the impact of the shock in the domestic market or in the global market as well.

We now turn to the trade policy issues, discussing the role of trade policy for domestic and foreign markets in static and partial equilibrium models.

B. *Optimal import tariffs with endogenous entry*

Endogenous entry in the domestic market has been already considered in the literature to study particular cases of optimal trade policy, and in particular the case of monopolistic competition with two countries (see Helpman and Krugman, 1989). In general, a system of tariffs on imports and subsidies to domestic production has to balance the effects on consumer surplus, on the profits of the domestic firm and on the net tariff revenue. Clearly, when entry in the domestic market is endogenous, one must also take in consideration the impact of these tools on the endogenous number of foreign firms. A general characterization of optimal import tariffs is beyond our scope, and it is quite complex within the framework used until now. Therefore we will approach the issue with a simpler example.

We will consider an example of quantity competition for the domestic market with inverse demand $p = a - Q$ and marginal cost c. The national government chooses a specific tariff t on the imports of all the foreign firms and a specific subsidy s on the sales of a single national firm. In Cournot equilibrium with N firms, the respective production levels of the foreign firms and the domestic one will be $x = (a - c - 2t - s)/(N + 1)$ and $z = [a - c + (N - 1)t + Ns]/(N + 1)$. If the number of firms is exogenous, the maximization of consumer welfare is a well known exercise. In case the government could just use the tariff ($s = 0$), its optimal level would be $t^* = 3(a - c)/(7 + N)$, and foreign firms would enter in the domestic market (as long as the fixed cost is low enough). However, if both instruments are available, welfare is maximized by $\tilde{t} = 0$ and $\tilde{s} = a - c$, that is by setting the price equal to the marginal cost and driving out of the market all foreign firms (this is true for more general demand functions).

Now imagine that entry in the domestic market is endogenous. As long as there are foreign firms in the market, the zero profit condition must be binding on them and it implies $N = \left(a - c - 2t - s\right) / \sqrt{F} - 1$, $x = \sqrt{F}$, $z = \sqrt{F} + s + t$. Welfare becomes now:

$$W(s,t) = \underbrace{\frac{\left(a - c - t - \sqrt{F}\right)^2}{2}}_{\text{Consumer surplus}} + \underbrace{\left(\sqrt{F} + s + t\right)^2 - F}_{\text{Domestic profits}} + \underbrace{-t\left(a - 2t - s - \sqrt{F}\right)}_{\text{Tariff revenue}} - \underbrace{s\left(\sqrt{F} + s + t\right)}_{\text{Subsidy cost}}$$

For any given subsidy the optimal tariff is

$$t^* = \sqrt{F} \tag{16}$$

However, welfare turns out to be a linearly increasing function of the subsidy, which implies that, when possible, it is always optimal to subsidize home production all the way until entry of foreign firms is avoided with $\tilde{t} = \sqrt{F}$ and $\tilde{s} = a - c - 4\sqrt{F}$. This outcome replicates the usual Stackelberg equilibrium with endogenous entry (Etro, 2008).

The result can be generalized as follows: *the optimal trade policy for a domestic endogenous market structure implies a positive subsidy to the domestic firms and a positive tariff on imports, leaving positive profits to the domestic firm. If the susbsidy is not available, it is optimal to adopt a positive tariff on imports.*

The analysis of optimal trade policy for a domestic market characterized by consumers with isoelastic preferences (10) and different forms of competition is more complex. Nevertheless, due to the benefits of variety, in this case it is optimal to choose a positive subsidy to domestic production and a non-prohibitive tariff on imports.

C. *Optimal export subsidies with endogenous entry*

Direct and indirect export subsidies are a widespread phenomenon. Nevertheless, economic theory is largely ambiguous on their desirability as a unilateral policy. In the neoclassical trade theory with perfect competition, for instance, export taxes are optimal because they improve the terms of trade; more precisely, the optimal export tax rate can be derived as $1 / \varepsilon$, where ε is the elasticity of demand (see Helpman and Krugman, 1989). In case of imperfect competition, export promotion assumes a strategic dimension, so its main aim becomes shifting profits toward the domestic firms. A large body of literature has studied oligopolistic models with a fixed number of firms competing in a third market. In this case, the optimal unilateral policy is an export tax under price competition (Eaton and Grossman, 1986). Under quantity competition, an export subsidy can be optimal (Brander and Spencer, 1985), but only under restrictive conditions. The ambiguity of these results represents a major problem to derive policy implications.

When entry in the international market is endogenous, however, things change. To fix ideas with an example, imagine Harley-Davidson, Ducati and Honda selling their motorbikes in a third unrelated market, say Australia. Consider the optimal unilateral policy of the US government toward H-D. According to the traditional view, the US government should tax exports of H-D. This would force H-D to increase its prices in Australia, which would lead Honda to increase its prices as well, and would generate higher American net profits from sales of H-D bikes in Australia, together with a tax revenue to be distributed between American citizens. The fallacy of this argument relies on neglecting that other international companies, say Yamaha, Suzuki or BMW, would be ready to enter in the Australian market for motorbikes whenever prices are high enough to promise positive profits. And when this is the case an export tax can only penalize H-D. When entry in the Australian motorbike market is endogenous, as we actually could expect, the optimal US trade policy is to subsidize Harley's exports. Always.

We can say something more than this: the optimal policy must implement nothing else than the Stackelberg equilibrium with endogenous entry (Etro, 2008) in which the domestic firm is the leader. Why this equilibrium? Simply because it is the best equilibrium that the domestic firm can aim for. With homogenous goods, increasing marginal costs and competition in quantities, the general expression for the optimal specific subsidy is (Etro, 2006b):

$$s^* = \frac{p}{\varepsilon} > 0 \tag{17}$$

where p is the equilibrium price of the domestic firm and ε the corresponding elasticity of demand. It is important to notice that this optimal subsidy rate is exactly the opposite of the optimal export tax rate in the neoclassical theory of trade policy![10]

We can also derive the optimal specific subsidy under price competition (Etro, 2006b), which is positive contrary to the result of Eaton and Grossman (1986) for which an export tax would be optimal under price competition. For instance, in case of a representative agent with consumption index (10) and unitary income, the optimal export subsidy can be calculated as:

$$s^* = \frac{1-\theta}{\theta\left\{(1-F)^{\frac{\theta}{1-\theta}}\left[(1-\theta)/F+\theta\right]-1\right\}} > 0 \tag{18}$$

The intuition for the general optimality of export promoting policies is the following. While firms are playing some kind of Nash competition in the foreign market, a government can give a strategic advantage to its domestic firm with an appropriate trade policy. When entry is endogenous, an incentive to be accommodating is always counterproductive, because it just promotes entry by other foreign firms and shifts profits away from the domestic firm. It is instead optimal to provide an incentive to be aggressive, to expand production or (equivalently) reduce the price, since this behaviour limits entry increasing the market share of the domestic firm. This is only possible by subsidizing exports.[11] If we interpret globalization as the opening up of new markets to international competition we can restate the main result as follows: *in a globalized word with endogenous market structures, there are strong strategic incentives to conquer market shares abroad by promoting exports.*

The general optimality of strategic export promotion in the presence of international endogenous market structures applies to other policies as well. For instance, Etro (2007b) shows that R&D subsidies for domestic firms competing for international markets are always optimal when entry in the international patent race is free.

V. CONCLUSIONS

In this article we reviewed the recent literature on the macroeconomic applications of the theory of endogenous entry. The models we presented are largely explorative and they may serve mainly as prototypes. We hope that, on the basis of this analysis, endogenous market structures will play a larger role in future macroeconomic investigations.

Further work is needed in particular at the borders between the three fields investigated in this article. The theory of Schumpeterian growth with endogenous market structures in the competition for the market could be used to investigate the impact of shocks on growth performance. The theory of business cycles with endogenous market structures could be extended to open economies, but also to monetary frameworks. Finally, the theory of trade with endogenous market structures could be used to study global endogenous growth.

NOTES

1. See for instance Etro (2004, 2006a), Erkal and Piccinin (2007), Maci and Zigic (2007) and Ino and Matsumura (2007). For a survey see Etro (2007).

2. Systematic evidence on the R&D activity by market leaders comes from patented innovations and expenditure on licenses. Czarnitzki and Kraft (2007) is the first study looking at who purchases licenses on patents: on the basis of German data this study shows that incum-bents invest more in licensing expenditures than effective and potential entrants, and that theinvestment of these incumbents is higher when the entry threats are stronger. For further empirical evidence on the persistence of leadership in Japan, see Kato and Honjo (2007).
3. See De Bondt and Vandekerckhove (2007) for further extensions of this result.
4. The value of the persistent leadership solves $V = \pi_M\left(1-\sqrt{2F}/V, V\right)$.
5. Nevertheless, notice that also in the case of endogenous market structures the equilibrium growth rate may well be below its socially optimal level (essentially because the private value of innovations can be lower than their social value), therefore the optimal innovation policy may also require subsidies to entry in the competition for the market.
6. For an alternative explanation of countercyclical mark ups see Rotemberg and Woodford (1992).
7. The result would be affected by changes in the degree of intertemporal substitution. Assuming a utility function with a higher elasticity of substitution than the logarithmic one, the impact of the temporary shock on the relative consumption in the first period would be strengthened.
8. For an early attempt in this direction see the important work of Chatterjee and Cooper (1993) summarized in Cooper (1999), and the developments in Devereux, Head and Lapham (1996).
9. Jaimovich (2007) extends the model of Devereux, Head and Lapham (1996) with fixed costs of entry in each period and capital accumulation, by adopting the mark up formula of Yang and Heijdra (1993) that depends on the number of firms, and shows that this extension helps to explain the variability of total factor productivity. However, contrary to Colciago and Etro (2007) he does not consider perfect substitutability and competition in quantities, which endogenously affect the mark ups and the entir ebusiness cycle properties of the model. Bilbiie, Ghironi and Melitz (2007a, b) study mark ups depending on N by assuming that the elasticity of substitution depends on the number of goods for reasons unrelated to competition between firms.
10. However, notice that in the case of constant marginal costs, the optimal subsidy deters entry of other firms than the domestic one. To see this, consider the case of linear demand and cost. With an exogenous number of firms we would have a production $x=(a-c-s)/(N+1)$ for the international firms and $z=(a-c+Ns)/(N+1)$ for the domestic one. The welfare function of the home country would be maximized by $s^* = (a-c)(N-1)/2N > 0$. Now, imagine that entry of international firms is endogenous. Imposing the endogenous entry condition for a given subsidy s, we obtain the equilibrium production for each international firm $x=\sqrt{F}$ and the number of firms $N=(a-c-s)/\sqrt{F}-1$. The equilibrium production of the subsidized firm is instead $z=\sqrt{F}+s$. The government maximizes the associated profits net of the tax revenue necessary to finance the subsidies $W(s)=\sqrt{F}\left(\sqrt{F}+s\right)-F$. Since this is always an increasing function of s, it is optimal to increase subsidization as long as there is entry. But entry is deterred at:

$$s^* = a-c-3\sqrt{F} > 0$$

which is the optimal subsidy.

11. Of course, we need to remind the reader that we are here referring to the optimal unilateral policy: as well known, if all countries were going to implement their optimal unilateral policies, an inefficient equilibrium would emerge. This may explain why international coordination tends to limit export subsidies.

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