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PRICE-INCREASING MONOPOLISTIC COMPETITION?

THE CASE OF IES PREFERENCES[1]

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ABSTRACT

We introduce a new class of "increasing elasticity of substitution" (IES) preferences to model product differentiation. In a monopolistic competition setting *à la* Dixit – Stiglitz (1977) we find that, even under constant returns to scale and complete information, a rise in the number of firms can be price-increasing. This result extends to Cournotian competition. Despite the price increase, consumers benefit from a rise in the number of monopolistic competitors because of higher product diversity. Higher prices are therefore associated with higher consumer welfare. Our results suggest a possible explanation to the empirical puzzle posed by the countercyclical movements of price-cost margins following globalisation and market reforms. In addition, they should be of interest for real business cycle literature which investigates the impact of an endogenous market structure.

Keywords: monopolistic competition, endogenous mark up, elasticity of substitution

JEL Classification: D43, D11, L11, L16.

1 Thanks are due to Alberto Bucci for his comments on a previous version of this work, and to Alessandra Catozzella who pointed out that a condition was expressed erroneously. We are deeply indebted to Paolo Epifani who generously discussed many aspects of the paper, suggested relevant extensions and provided essential references. We are also grateful to Federico Etro, who suggested the Cournotian extension. The usual caveat applies.

1 Introduction

An economic commonplace is that, in the absence of increasing returns to scale, an "increase in competition"[2] delivers an equilibrium with lower prices, larger quantities and (possibly) higher product variety. This wisdom is deeply rooted and it has not been challenged either by some contrary casual empirical evidence from various industries, or by theoretical counterexamples.[3] The intuition is straightforward and comes from the standard results of Cournotian models with *homogenous products* where an increase in the number of firms lessens market power and reduces the distortions associated with imperfect competition (see e.g. Tirole, 1988: chapter 5).

The aim of this paper is to investigate the relationship between market prices and competition under *product differentiation*. In particular, we define a new class of well-behaved consumer preferences, called *Increasing Elasticity of Substitution* (IES) preferences, and use it in the standard framework introduced by Dixit & Stiglitz (1977) to model the Chamberlinian "monopolistic competition". As a matter of fact, the possibility that consumers might pay more for a richer set of products should not come as a complete surprise. Indeed, we show that an increase in the number of firms/varieties in our monopolistic competition setting results in an increase in the equilibrium price. However, the higher price does not harm consumers in that they are more than compensated by the rise of product variety available for consumption: with IES preferences, higher prices are therefore associated with higher consumer welfare. As proved in Appendix 2, price-increasing competition can also arise in an oligopoly *à la* Cournot version of our setting.

The intuition for our results is the following. A rise in the number of firms shifts downwards the residual demand curve and, given the representative consumer's disposable income, reduces the equilibrium consumption of each variety. The overall effect on prices is contingent on how demand elasticity changes according to the scale of consumption. It turns out that demand elasticity only depends on the functional form chosen to model consumers' preferences. In particular, in a symmetric equilibrium, the elasticity of demand (in absolute value) coincides with the elasticity of substitution between any two varieties. The main issue is then how the scale of consumption affects commodity substitutability. For example, the widely adopted hypothesis of a representative consumer with CES preferences (see e.g. Dixit & Stiglitz, 1977: section 1, and Krugman, 1980) gives rise to isoelastic residual demand. Under these preferences, competition does not affect demand elasticity, the equilibrium price does not depend on the number of firms (with constant marginal costs) and consumers benefit from an increase in the number of firms through higher

[2] On the difficulty of measuring competition see e.g. Boone (2000).
[3] See, for example, the references given in Chen & Riordan (2006: Introduction).

product diversity. In the somewhat less known case of varieties with a decreasing (with respect to the scale of consumption) elasticity of substitution (see e.g. Krugman, 1979, and Bertoletti, 2006), more competition also lowers the equilibrium price.

In contrast, the class of (symmetric) preferences that we introduce in this paper is characterized by an increasing elasticity of substitution with respect to the level of (symmetric) consumption. Therefore, the lower the scale of consumption of each variety, the lower (in absolute value) the residual demand elasticity that each firm faces. Even if IES preferences are deeply related to CES preferences[4], one could wonder how realistic they are as a description of consumer attitudes towards product variety. Here we offer the following example. Consider a child who owns many pencils of different colours/varieties. With IES preferences she would regard any two pencils of different colours to be closer substitutes when she has many of them (the same number for each colour) than when she has a few. On the contrary, with CES preferences the substitutability would not change with the number of pencils of each colour.

We regard the contribution of this paper as being threefold: firstly, it proposes an unexplored variation of the monopolistic-competition model of Dixit and Stiglitz (1977), stressing the relevance of consumer preferences for equilibrium price behaviour. Secondly, it adds to the recent literature on price-increasing competition under product differentiation. The possibility that competition could raise prices has in fact been considered in a couple of papers by Chen & Riordan (2006) and Cowan & Yin (2006). These papers show that, in discrete choice models of product differentiation, the symmetric duopoly price can be higher than the monopoly price.[5] The latter paper also shows that, in a Hotelling model with a monopolistic firm, consumers can actually be worse off following the entry of a new competitor if two-part tariffs are adopted.

Finally, providing an endogenous (preference-based) countercyclical mark up, our work also contributes to the literature that looks for explanations of the price-cost margin behaviour. The monopolistic competition setting we consider has indeed been widely adopted both in macroeconomic and international trade models. In particular, our paper directly relates to the many contributions that followed Krugman (1979) and (1980) in discussing the possibly pro-competitive effects of international trade: see Boulhol (2006) for a recent example. Moreover, our results might be of some interest for the vast literature on the cyclical behaviour of prices (see the review in Rotemberg & Woodford, 1999), and in particular for the recent stream concerned with the so-called "endogenous market structure": see, for example, Colciago & Etro (2007).

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[4] CES utility function arises under a special parametric choice of the IES utility function: see next section.
[5] This result appears to have been somehow anticipated in a passage by Wicksell (1901: pp. 87-8).

The paper is organized as follows: section 2 introduces the model and section 3 studies its welfare implications. Section 4 summarizes the results. Appendix 1 illustrates the cases of monopolistic competition with the alternative CES and CARA preferences. Appendix 2 deals with the case of Cournotian competition under IES preferences.

2 The model

Following Dixit & Stiglitz (1977) and Krugman (1979), we consider a market with n identical firms, each producing a different variety of a particular commodity. Let x_i be the quantity of variety i, produced by firm i with a (positive) marginal cost c. If variety i is actually sold, its market price is p_i. Assume that the representative consumer has the utility function $U(\boldsymbol{x}) = \Sigma_i u(x_i)$ (that is, her preferences are symmetric and *additive*[6]), defined over a large number $N > n$ of potential varieties ($i = 1, ..., N$). It is also assumed that $u(\cdot)$ is a well-behaved (sub-utility) function with $u(0) = 0$ and $u''(\cdot) < 0 < u'(\cdot)$.[7] Let Y denote the disposable income of the representative agent. Then her budget constraint in any *symmetric* equilibrium (i.e., in any equilibrium in which the price of varieties, p, is the same and hence also the quantity, x, is the same) can be written as:

$$p = \frac{Y}{nx}. \tag{1}$$

The other equilibrium condition is given by firms' profit maximization. In order to compute that, we first have to consider the FOCs for the maximization of the representative consumer's utility:

$$p_i = \frac{u'(x_i)}{\lambda}, \tag{2}$$

for $i = 1, ..., n$, where $\lambda > 0$ is her marginal utility of income.

One can prove that, if prices are not disproportionate, the elasticity of λ with respect to each price is of the same order of magnitude as $1/n$ (see e.g. Deaton & Muellbauer, 1980: section 5.3). Thus, under the assumption of many varieties (i.e., if n is large enough), one can assume that each firm ignores the price interaction with the others, that is, each firm considers λ as a constant (this is the *monopolistic competition hypothesis* popularised by Dixit & Stiglitz, 1977). Accordingly, the

[6] See e.g. Deaton & Muellbauer, 1980: section 5.3.

[7] Note that, being strictly concave with respect to $\boldsymbol{x}$ and increasing with respect to n, $U(\cdot)$ embodies a Chamberlinian "taste for variety". Moreover, it is well defined over the positive orthant of the relevant Euclidean space: according to standard results, this implies regular and well-behaved demand functions for (strictly) positive prices and income.

inverse demand function for variety i is given by $p_i(x_i) = u'(x_i)/\lambda$. Therefore, demand elasticity can be written as:

$$\varepsilon_i(x_i) = \frac{p_i(x_i)}{p_i'(x_i)x_i} = \frac{u'(x_i)}{u''(x_i)x_i} . \tag{3}$$

Note that $\varepsilon_i(\cdot)$ does not depend on λ.[8] It can be shown that, in any symmetric equilibrium (thanks to the properties of symmetric additive preferences), $\varepsilon_{ji} = -u'(x)/(nxu''(x)) = -\varepsilon_{ii}/(n-1)$, where ε_{ii} and ε_{ji} are respectively the direct and cross elasticities of the "compensated" (Hicksian) demand for variety i. It follows that, for a symmetric consumption, demand elasticity (hereafter, we omit the suffix i), $\varepsilon(\cdot)$, equals in absolute terms the (partial) elasticity of substitution between any two varieties, i.e., $\varepsilon(x) = -\sigma(x)$.[9]

The profit-maximizing first and second order conditions for each firm under monopolistic competition can be written as follows:

$$p = \frac{\varepsilon(x)}{1+\varepsilon(x)} c = m(x)c , \tag{4}$$

$$u'''(x)x + 2u''(x) < 0 . \tag{5}$$

The symmetric equilibrium is then given by a couple (p, x), such that equations (1), (4) and (5) are simultaneously met. Equation (1) – the budget constraint – is an equilateral hyperbola in the space (p, x), whose distance from the origin depends on the *disposable income per variety* Y/n. Equation (4) – the profit maximising FOC – depends only on $\varepsilon(\cdot)$ (it requires $|\varepsilon(x)| > 1$, i.e. $u''(x)x + u'(x) > 0$), that is on the elasticity of the marginal utility $u'(\cdot)$. Equation (5) – the profit maximising SOC – is just a decreasing marginal revenue condition which must be satisfied in our setting.

In order to study the effect of an increase in competition, we consider an exogenous decrease in the disposable income per variety, Y/n. This affects only equation (1): from a graphical point of view, the equilateral hyperbola simply shifts towards the origin. In economic terms, this implies that the revenues of each active firm, px, must decrease. Since (5) implies that $m(x)x = [u'(x)x]/[u''(x)x + u'(x)]$ is an increasing function, in this setting also x must get smaller. However, p might increase or

[8] $\varepsilon_i(\cdot)$ equals the reciprocal of the elasticity of the marginal utility $u'(\cdot)$, i.e. minus the so-called "coefficient of relative risk aversion" of $u(\cdot)$.

[9] More precisely, it can be showed that the so-called "Morishima" elasticity of substitution between varieties i and j, $\sigma_{ij} = \varepsilon_{ji} - \varepsilon_{ii}$, is equal to $-u'(x_i)/(u''(x_i)x_i)$ whenever $p_i = p_j$ and then $x_i = x_j$ (on the different partial elasticity of substitution measures see Blackorby and Russell, 1989).

decrease depending on the properties of $\varepsilon(\cdot)$. Figure 1 provides a graphical representation of how the effects of a rise in competition might differ according to the slope of $m(x)$, which in turn depends on the characteristics of $\varepsilon(\cdot)$.

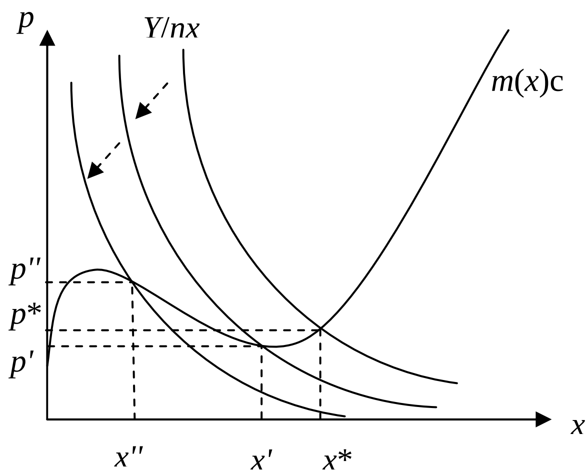

Figure 1: A non-monotonic elasticity case

In Appendix 1 we illustrate the alternative cases of CARA (Constant Absolute Risk Aversion: see Bertoletti, 2006 and Behrens & Murata, 2007) and CES preferences (see e.g. Dixit & Stiglitz, 1977: section 1), leading respectively to a result of price decrease and of no change in price after an increase in competition.

Note that the condition for demand elasticity to grow (locally) is easily derived as:

$$\frac{1}{u'(x)} - \frac{1}{u''(x)x} < \frac{u'''(x)}{u''(x)^2}, \tag{6}$$

and that this inequality requires $u'''> 0$ in the relevant interval; in other terms, a convex individual demand curve for the single firm under monopolistic competition. To satisfy (5) and (6), we assume that preferences can be described by a functional form for $u(\cdot)$ in the class:

$$u(x_i) = \frac{x_i^\rho}{\rho} + \frac{x_i^\gamma}{\gamma}, \tag{7}$$

where $0 < \rho < \gamma \leq 1$, or

$$u(x_i) = \ln x_i + \frac{x_i^\gamma}{\gamma}, \tag{8}$$

where $0 < \gamma < 1$, for $i = 1, ..., N$. We call the preferences represented by $U(\cdot)$ under (7) or (8) "Increasing Elasticity of Substitution" (IES) preferences. Note that if $\rho = \gamma$ in (7) preferences would be CES: indeed (7) and (8) are combinations of two “CES expressions”, respectively with elasticity of substitution $1/(1 - \rho)$ and $1/(1 - \gamma)$ ($\ln x$ in (8) corresponds to the “Cobb-Douglas case” with $\rho = 0$ and unit elasticity of substitution). In what follows, without loss of generality, to illustrate the case of IES preferences we use (7) and assume $\gamma = 1$: i.e.:

$$u(x_i) = \frac{x_i^{\rho}}{\rho} + x_i \,, \tag{9}$$

for $i = 1, ..., N$.

Under (9), we obtain:

$$p_i(x_i) = \frac{1 + x_i^{\rho-1}}{\lambda}, \quad \varepsilon(x) = \frac{1 + x^{1-\rho}}{\rho - 1}, \quad m(x) = \frac{1 + x^{1-\rho}}{\rho + x^{1-\rho}}. \tag{10}$$

Note that the elasticity of substitution $\sigma(x) = -\varepsilon(x)$ increases with respect to the scale of consumption, with:

$$\sigma(0) = \frac{1}{1-\rho}\,, \quad \lim_{x\to\infty} \sigma(x) = \infty. \tag{11}$$

Whenever the representative consumer has IES preferences, an increase in the number of firms/varieties, by shifting down the residual demand of each variety makes it less elastic for any given price. This, in turn, implies an increase in the equilibrium price $p(n)$. Conversely, when the number of firms (varieties) decreases, the scale of consumption increases and the market price tends to marginal cost. i.e., $p'(n) > 0$ and:[10]

$$m(0) = \frac{1}{\rho}, \quad \lim_{x\to\infty} m(x) = 1. \tag{12}$$

Are the equilibrium values unique and can they be given an explicit expression? The equilibrium value $x(n)$ is implicitly given by the condition:

$$\frac{Y}{nc} = m(x)x = \frac{x + x^{2-\rho}}{\rho + x^{1-\rho}}\,, \tag{13}$$

[10] More generally: under preferences given by (7), one finds that as x tends to infinity σ tends to $1/(1 - \gamma)$ and m tends to $1/\gamma$, while under preferences (8) $\sigma(0) = 1$ and m tends to infinity as x tends to zero.

and it is easily proved to be unique since the function in (1) is steeper than the one given by (4) at any point such that (13) is satisfied (i.e., the equilibrium *loci* (1) and (4) only cross once under IES preferences). The situation is described in Figure 2.

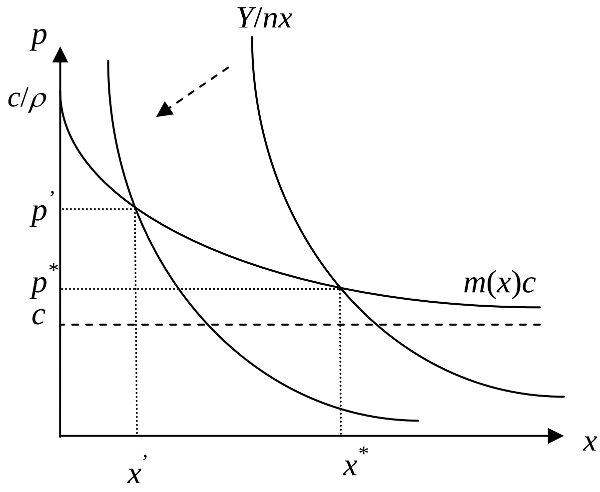

Figure 2: the IES case

Accordingly, an increase in the number of competitors does increase the equilibrium price, while it decreases each firm's revenue and profit, and the consumption of each variety. The latter fact implies a decrease in the equilibrium elasticity of substitution between any two varieties, which provides a rationale for the result. What happens to consumers' welfare is not obvious, since consumers pay higher prices but also enjoy a higher product variety, and it is investigated in next section. Interestingly, price-increasing competition under IES preferences for the representative consumer can also be extended to an oligopoly (*à la* Cournot) version of the previous setting, in which the number of competitors directly affects the mark up. The proof of this result is outlined in Appendix 2.

Finally, notice that (10) shows that, if firms had different (constant) marginal cost (i.e., with $c_j \neq c_i$), IES preferences would naturally generate monopolistic-competition Lerner indexes lower for more efficient firms and associated with larger production levels, very much as in the (asymmetric) Cournot equilibrium.

3 Welfare implications

Following Dixit & Stiglitz (1977: section 2), we can compare the (long-run) equilibrium that would arise in our setting under market free entry if the production of each potential variety also involves some fixed set-up cost $F > 0$, with a constrained (no lump-sum transfers) social optimum. The market equilibrium must satisfy the zero-profit condition:

$$p = c + \frac{F}{x}. \tag{14}$$

Together with (1) this gives the condition:

$$m(x^e) = \frac{cx^e + F}{cx^e}, \tag{15}$$

which characterizes the free entry market equilibrium. The latter has to be compared with the social optimum which maximizes $U = nu(x)$, under the constraint that $Y = ncx + nF$. The FOCs for the stated problem imply:

$$\frac{1}{\phi(x^c)} = \frac{cx^c + F}{cx^c}, \tag{16}$$

where $\phi(x) = u'(x)x/u(x)$ is the elasticity of utility $u(\cdot)$.

Given that under IES preferences $m(x) < \phi(x)^{-1}$, it can be easily proved that (15) and (16) uniquely define x^e and x^c, with $x^e > x^c$. Accordingly, by (14), under the free entry hypothesis the number of varieties (n^e) and their price (p^e) are lower than in the social optimum (n^c and p^c). Therefore, a social planner would introduce more varieties, expand less their production and price them higher with respect to the free entry market equilibrium.

An intuition for these results can be grasped by looking at the sign of $\phi'(\cdot)$, as suggested by Dixit & Stiglitz (1977: pp. 303-4). As defined above, $\phi(x)$ is the ratio between $u'(x)x$ and $u(x)$. The numerator is proportional to each firm's revenue, while the denominator measures the contribution of each variety to consumer welfare: accordingly, ϕ is a sort of "appropriability ratio". Therefore, if $\phi'(\cdot) > 0$, at the margin each firm finds it profitable to produce more than the social optimum. This is indeed the case under IES preferences, since

$$\frac{\phi'(x)x}{\phi(x)} = \frac{1}{m(x)} - \phi(x). \tag{17}$$

This result is coherent with Dixit & Stiglitz's (1977) suggestion that the free market equilibrium might well involve fewer and bigger firms with respect to the (constrained) social optimum. However, Dixit & Stiglitz (1977: p. 304) based their presumption on the expectation of a positive correlation between $\phi(\cdot)$ and $|\varepsilon(\cdot)^{-1}|$. We show that under IES preferences the free entry market equilibrium has too little product diversity even if $\phi(\cdot)$ and $|\varepsilon(\cdot)^{-1}|$ are not positively related.

The previous welfare result also suggests that the entry of a new competitor (out of the long-run equilibrium) can raise consumer welfare, even if associated with a price increase. This is what actually happens under IES preferences. Indeed, by using (1) and (4) it is easily computed that:

$$\frac{x'(n)n}{x(n)} = -\frac{m(x(n))}{m'(x(n))x(n) + m(x(n))}. \tag{18}$$

It follows that an increase in the number of competitors increases consumer welfare $nu(x(n))$ if and only if:

$$\frac{1}{\phi(x(n))} > \frac{m(x(n))}{m'(x(n))x(n) + m(x(n))}. \tag{19}$$

Given that profit maximisation, even under price-increasing competition, implies that an increase in the number of competitors reduces firm’s profits, the following condition must hold:

$$m'(x(n))x(n) + m(x(n)) > 1. \tag{20}$$

Thus $\phi' > 0$ is a *sufficient* condition for more monopolistic competition to deliver an improvement of consumers’ welfare.

4 Conclusions

In this paper we have introduced IES preferences in the monopolistic competition framework of Dixit & Stiglitz (1977) and shown that in such a case: (a) more monopolistic competition results in a price increase; (b) because of higher product diversity, competition more than compensates consumers for the associated price increase; (c) the constrained Pareto optimum would have more varieties, higher prices and smaller quantities than the market long-run equilibrium of free entry. It remains an open question whether, under a different class of preferences, an increase in the number of firms leading to a price increase could actually make consumers worse-off in a monopolistic competition setting.[11] We have also shown that a case for price-increasing competition can be made also in an oligopoly setting *à la* Cournot.

[11] As Dixit & Stiglitz (1977: p. 304) argued, there is no a necessary relation between the signs of $\phi'(\cdot)$ and $m'(\cdot)$.

Our results add to the small set of recent papers (Chen & Riordan, 2006 and Cowan & Yin, 2006) which have considered the case for price-increasing competition in models with differentiated products. However, our setting differs from theirs on several grounds. Firstly, we use symmetric "non-address" product differentiation; secondly, by using the Chamberlinian model of monopolistic competition, we have firms that compete non-strategically; thirdly, we consider a market with a large number of competitors and measure the degree of competition by the ratio between consumers expenditure and the number of firms.

By proposing an explicit (and simple) micro-foundation for a countercyclical mark up based on consumer preferences, our model provides an explanation for the empirical puzzle posed by non-decreasing price-cost margins following globalisation and market reforms which is alternative to those based on cost factors: see e.g. Griffith, Harrison & Simpson (2006), Boulhol (2006) and (2008). The endogenous mark up generated by IES preferences should also be of interest to the macroeconomic literature concerned with the impact of an endogenous market structure on the standard real business cycle framework: see, for example, Colciago & Etro (2007).

One could wonder how peculiar IES preferences are. Dixit & Stiglitz (1977: p. 304) write: "… *we would normally expect that as the number of commodities produced increases, the elasticity of substitution between any pair of them should increase. In the symmetric equilibrium, this is just the inverse of the elasticity of marginal utility. Then a higher x would correspond to a lower n, and therefore a lower elasticity of substitution …*". This suggestion is taken up by Krugman (1979), who assumes a decreasing elasticity of substitution and comments this way: "... [*this assumption*] *seems to be necessary if this model is to yield reasonable results, and I make the assumption without apology*." (Krugman, 1979: p. 476). However, the previous intuition seems misplaced. As a matter of fact, due to *additive* symmetric preferences, in a symmetric equilibrium the elasticity of substitution between any two varieties does *not* depend *directly* on the number of varieties actually consumed.[12] The relevant question is rather how the elasticity of substitution might change according to the scale of consumption. We argue that IES preferences are not less likely than the popular CES ones, or than the CARA preferences, and deserve to be investigated. Indeed, this paper shows that the assumption of a non-increasing elasticity of substitution is not necessary for monopolistic competition to yield "reasonable results".

[12] This was first noticed by Pettengill (1979: p. 960), and acknowledged by Dixit & Stiglitz (1979: pp. 962-3) while pointing out that, in their setting, an increase in the number of commodities/firms does not increase the degree of crowding in the commodity space.

Appendix 1: Examples of different monopolistic competition effects on prices

In this Appendix we show two examples of utility functions leading respectively to no change and a decrease in the equilibrium price after an increase in the number of monopolistic competitors.

1. The CES case (Dixit & Stiglitz, 1977, and Krugman, 1980)

Suppose that:

$$u(x_i) = \frac{x_i^{\rho}}{\rho} \tag{A1.1}$$

for $i = 1, ..., N$, with $0 < \rho < 1$: i.e., $u(\cdot)$ is a "constant relative risk aversion" (sub-)utility function. Preferences are CES, and demand elasticity is constant and given by $\varepsilon = 1/(\rho - 1)$, with $m = 1/\rho$. Figure 1 shows the effect of an increase in the number of varieties:

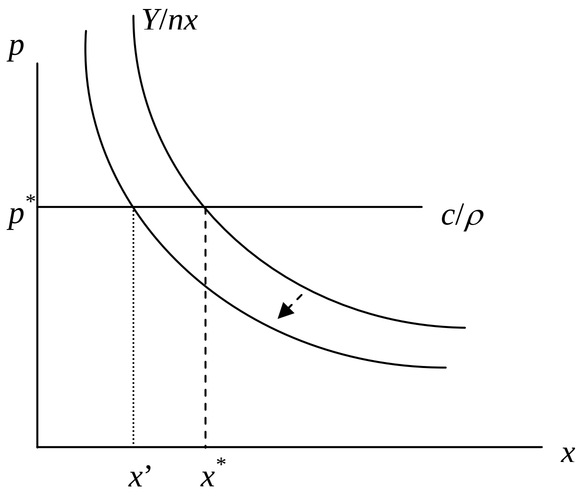

Figure A.1: the CES case

Note that in Figure A.1, an increase in the number of firms/varieties for a given level of nominal income decreases the amount of each of them, but leaves the equilibrium price unchanged. The obvious reason is that the optimal mark up does not depend, in such a case, on the amount that is to be produced. Since the equilibrium values can be easily computed, the CES case has been tremendously popular in applications (especially in international trade and macroeconomic models).

2. The CARA case (Bertoletti, 1998 and 2006 and Behrens & Murata, 2007)

Assume that

$$u(x_i) = -\frac{e^{-\alpha x_i}}{\alpha}, \qquad \text{(A1.2)}$$

for $i = 1, ..., N$, with $\alpha > 0$. Therefore, $u(\cdot)$ is a “constant absolute risk aversion” (sub-)utility function, preferences are quasi-homothetic and $\varepsilon(x) = -1/(\alpha x)$, with $m(x) = 1/(1 - \alpha x)$ (this requires that α is small enough with respect to x). Demand elasticity increases along a given individual demand curve (the elasticity of marginal utility $u'(\cdot)$ is decreasing) and a smaller consumption is associated with lower prices in a symmetric equilibrium. The situation can be graphically represented as follows:

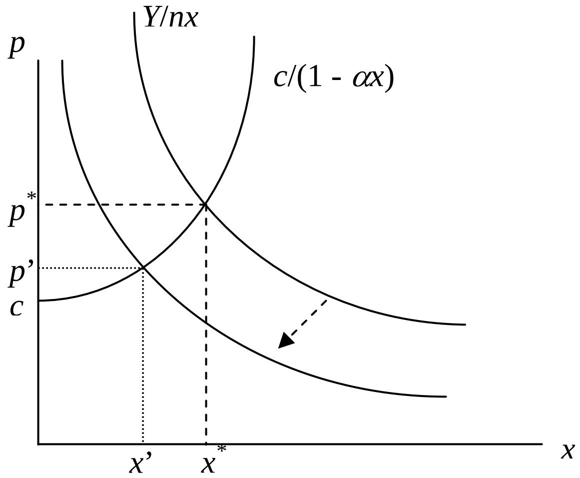

Figure A.2: the CARA case

Note that an increase in the number of varieties reduces both the consumption level of the single variety and its equilibrium price. The mark up varies “procyclically”, so that an increase in competition also benefits consumers through lower prices

Appendix 2: The case of price-increasing Cournot competition

In this Appendix we show that, under IES preferences, price-increasing competition can also arise in an oligopoly (*à la* Cournot) version of our setting. By using (1) and (2) one can easily derive the complete *inverse* demand function of the representative consumer:

$$p_i(\mathbf{x}) = \frac{u'(x_i)Y}{\sum_j u'(x_i)x_j}, \tag{A2.1}$$

which is decreasing with respect to x_i. Given (A2.1), it is straightforward to compute that the FOC for Cournot profit maximization is given by (it requires $u''(x)x + u'(x) > 0$):

$$\frac{\partial R_i(\mathbf{x})}{\partial x_i} = Y\frac{[u''(x_i)x_i + u'(x_i)](\sum_{j\neq i} u'(x_j)x_j)}{(\sum_j u'(x_j)x_j)^2} = c, \tag{A2.2}$$

and that the (global) satisfaction of (5) ensures that the "marginal revenue" $\partial R_i/\partial x_i$ is decreasing with respect to x_i.

It follows that in any *symmetric* equilibrium *à la* Cournot for which (A2.2) holds it must be that:

$$x = \frac{(n-1)[u''(x)x + u'(x)]}{n^2 u'(x)c}Y = \frac{(n-1)}{n^2 m(x)c}Y. \tag{A2.3}$$

with

$$p = \frac{n}{(n-1)}m(x)c. \tag{A2.4}$$

Thus, by using (1), the symmetric oligopoly equilibrium quantity $x_o(n)$ is defined by:

$$\frac{(n-1)Y}{n^2 c} = m(x)x. \tag{A2.5}$$

Since the left-hand-side of (A2.5) does not increase with respect to n if $n \geq 2$, and the right-hand-side is increasing with respect to x, it follows that an increase in the number of competitors/varieties decreases $x_o(n)$. Such an increase in competition also raises the equilibrium price p_o if and only if it decreases nx, i.e., if and only if the elasticity of $x_o(n)$ is less than – 1. Since:

$$\frac{x_o'(n)n}{x_o(n)} = \frac{2-n}{n-1}\frac{m(x_o(n))}{m'(x_o(n))x_o(n) + m(x_o(n))}, \tag{A2.6}$$

the condition for price-increasing oligopoly competition is equivalent to:

$$-\frac{m'(x_o(n))x_o(n)}{m(x_o(n))} > \frac{1}{n-1}. \tag{A2.7}$$

Condition (A2.7) is not obviously satisfied in any case of IES preferences (for any value of *Y*/*n*); however, consider the (limiting) case of (8). Computation shows that, under (8):

$$m(x) = \frac{1+x^{\gamma}}{\gamma x^{\gamma}}; \tag{A2.8}$$

and

$$\frac{m'(x)x}{m(x)} = -\frac{\gamma}{1+x^{\gamma}}. \tag{A2.9}$$

Accordingly, under (8), (A2.7) is equivalent to:

$$(n-1)\gamma - 1 > x_0(n)^{\gamma}, \tag{A2.10}$$

which must hold when *n* is large enough.

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