Monopolistic Competition: Entry, Firm Selection and Efficiency

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Abstract

We study monopolistic competition among heterogeneous firms under quasi-linear preferences with an indirectly additive aggregator. Market equilibrium selection of firms and their sizes turn out to be optimal for a family of surplus functions that generate linear, exponential and iso-elastic demands, and the overall allocation is actually efficient for a generalization of the LogSumExp specification. Insufficient entry generally arises in allocations constrained by equilibrium pricing.

1 Introduction

In a celebrated work, Spence (1976) analyzed monopolistic competition for a class of quasi-linear preferences with inverse demands based on an aggregator of quantities. His approach was paralleled by Dixit and Stiglitz (1977), who formalized the canonical model of monopolistic competition based on directly additive preferences. In these models, equilibrium entry can be either socially excessive or insufficient, and with heterogeneous firms also their selection by the market and the associated allocation of production are generally inefficient

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(Dhingra and Morrow, 2019). In fact, in imperfectly competitive market structures there is a bias toward excess entry when at the equilibrium the latter exerts a negative effect on industry profits that more than compensates the positive impact on consumer welfare (Mankiw and Whinston, 1986). Here we argue that, for a setting with product differentiation and monopolistic competition, the opposite holds, and entry is (weakly) insufficient. Moreover, the equilibrium allocation turns out to be optimal under some special cases which generalize the so-called LogSumExp (LSE) specification.

In particular, we consider a class of quasi-linear preferences represented by an indirect utility function which aggregates the individual surpluses created by differentiated goods. These preferences generate a demand system with a price aggregator which is additive with respect to the surpluses, and we explore their implications for monopolistic competition under heterogeneous firms. A version of these preferences has been used in partial equilibrium models of product differentiation, for instance by Nocke and Schutz (2018) to study multiproduct pricing, and by Etro (2023a,b) to analyze pricing by sellers on a platform setting commissions on their revenues. Here, in the spirit of earlier work (Bertoletti and Etro, 2017 and 2021), we aim to establish the properties of the equilibrium market structure and compare it to the constrained and unconstrained optimal allocations. The equilibrium and its welfare properties depend on the substitutability among differentiated products and with respect to the *numéraire* determined by the specification of preferences. We show that market selection of firms and their sizes turn out to be optimal for a particular family of surplus functions, and that entry is generally insufficient in comparison to the optimal allocation constrained by equilibrium pricing.

The note is organized as follows. Next section describes our setting and analyzes the equilibrium. The following section discusses optimality. The last concludes. Some details and the case of homogeneous firms are presented in the Appendix.

2 The Model

Consider L consumers with the following indirect utility:

$$V = H\left(\int_{\Omega} v(p(\omega))d\omega\right) + E, \tag{1}$$

where E is expenditure allocated between an outside *numéraire* and differentiated goods with price $p(\omega)$ and "incremental surplus" $v(p(\omega))$ for variety $\omega \in \Omega$. The price aggregator $A = \int_{\Omega} v(p(\omega))d\omega$ is additive across individual surpluses, with the function $v(p(\omega))$ positive, strictly decreasing and convex in the price (as in Bertoletti and Etro, 2017). The $H(A)$ transformation is assumed increasing and concave, and to satisfy the regularity conditions of an indirect utility function we assume that it is a convex function of prices, i.e., that A is H-convex.

The value of the price aggregator A is a sufficient statistic for the effects of prices on consumer welfare. Assuming the suitable differentiability, the Roy's identity provides the demand of variety ω as:

$$q(\omega) = |v'(p(\omega))| \, H'(A),$$

which decreases in its own price and in the price aggregator. Therefore a market providing more and/or cheaper varieties implies a lower demand for each individual variety. We will often refer to the example of transformation $H = \log A$, which requires that v is log-convex and provides the demand function $q(\omega) = |v'(p(\omega))| \, /A$.

2.1 Properties of the demand system

The substitutability among the differentiated goods depends on the shape of the incremental surplus function. However, their substitutability with the outside commodity is also affected by the transformation of the price aggregator.

We define two key elasticities:

$$\zeta\left(p(\omega)\right) \equiv \frac{|v'(p(\omega))| \, p(\omega)}{v(p(\omega))} \quad \text{and} \quad \varepsilon\left(p(\omega)\right) \equiv \frac{v''(p(\omega))p(\omega)}{|v'(p(\omega))|}$$

as the first-order and second-order price elasticities of the surplus generated by variety ω. The own price elasticity of demand for a variety ω is given by:

$$\left|\frac{\partial \ln q(\omega)}{\partial \ln p(\omega)}\right| = \varepsilon\left(p(\omega)\right),$$

and coincides with the Morishima Elasticity of Substitution between variety ω and any other variety (see Bertoletti and Etro, 2016).

Let us define the "average" values of the two surplus elasticities across all varieties as:

$$\overline{\zeta} \equiv \int_{\Omega} \zeta(p(\iota)) \frac{v(p(\iota))}{\int_{\Omega} v(p(\omega))d\omega} d\iota > 0, \;\; \overline{\varepsilon} \equiv \int_{\Omega} \varepsilon\left(p(\iota)\right) \frac{p(\iota)q(\iota)}{\int_{\Omega} p(\omega)q(\omega)d\omega} d\iota > 0,$$

and the elasticity of demand with respect to the aggregator as:

$$\rho\left(A\right) \equiv \frac{-H''\left(A\right)A}{H'\left(A\right)} > 0.$$

A natural measure of the aggregate "outside substitutability" of the differentiated products with respect to the *numéraire* is provided by how much the overall expenditure, $\int_{\Omega} p(\omega)q(\omega)d\omega$, reacts to a proportional increase of all prices for a given set Ω of consumed varieties (Bertoletti, 2018). One can show that this measure is given by:

$$\begin{aligned}
\Psi \;\; &\equiv \;\; 1 - \left.\frac{d\ln\left\{\int_{\Omega} \lambda p\left(\omega\right)\left|v'\left(\lambda p\left(\omega\right)\right)\right| H'\left(\int_{\Omega} v\left(\lambda p\left(\iota\right)\right)d\iota\right)d\omega\right\}}{d\ln\lambda}\right|_{\lambda=1} \\
&= \;\; \overline{\varepsilon} - \rho\left(A\right)\overline{\zeta}.
\end{aligned}$$

The average direct impact of an hypothetical proportional price increase on spending in differentiated goods is captured by the average demand elasticity $\overline{\varepsilon}$. This is countered by an indirect effect due to the reduction of the price aggregator, whose average impact is given by $\rho(A)\overline{\zeta}$. The net effect is null only if the differentiated products cannot be substituted by the *numéraire*, namely if $\overline{\varepsilon} = \rho(A)\overline{\zeta}$ and the overall expenditure increases in the same proportion as the prices. A violation of $\Psi \geq 0$, or:

$$\rho(A) \leqslant \overline{\varepsilon}/\overline{\zeta}, \tag{2}$$

would imply an increase of the aggregate demand of differentiated products and is inconsistent with preference convexity.

To illustrate, consider the LSE specification, which combine the logarithmic transformation $H = \ln A$ with the exponential surplus function $v(p(\omega)) = e^{-\alpha p(\omega)}$, where $\alpha > 0$ and $\zeta(p) = \varepsilon(p) = \alpha p$ and $\rho = 1$, to obtain the utility :

$$V = \log\left(\int_\Omega e^{-\alpha p(\omega)} d\omega\right) + E.$$

The LSE model provides the demand

$$q(\omega) = \frac{\alpha e^{-\alpha p(\omega)}}{\int_\Omega e^{-\alpha p(\iota)} d\iota},$$

which corresponds to the multinomial logit demand under discrete choices (see Anderson *et al.*, 1992: chapter 2) and implies a constant “aggregate” quantity, namely $\int_\Omega q(\omega) d\omega = \alpha$.

For another example, consider the specifications in which an iso-elastic transformation $H(A) = \frac{A^{1-\rho}}{1-\rho}$ (the logarithmic transformation arises for $\rho \to 1$) is coupled with a isoelastic surplus function $v(p(\omega)) = p(\omega)^{1-\varepsilon}$ with $\varepsilon > 1$, $\frac{\varepsilon}{\varepsilon - 1} \geq \rho > 0$: accordingly,

$$V = \frac{\left(\int_\Omega p(\omega)^{1-\varepsilon} d\omega\right)^{1-\rho}}{1-\rho} + E, \;\; q(\omega) = \frac{(\varepsilon - 1) p(\omega)^{-\varepsilon}}{\left(\int_\Omega p(\iota)^{1-\varepsilon} d\iota\right)^\rho},$$

which provides an instance of the classic iso-elastic demand.[2]

2.2 Pricing

Each variety is provided by a single firm with an idiosyncratic marginal cost c and a common fixed cost F. Each marginal cost is independently drawn from a continuous distribution $G(c)$ with support $[0, \overline{c}]$ upon the payment of an entry cost F_e, *à la* Melitz (2003). The profits of an active firm setting price p are:

$$\pi = (p - c) |v'(p)| H'(A) L - F, \tag{3}$$

[2] More generally, $q(\omega) = (\varepsilon - 1) p(\omega)^{-\varepsilon} H'(A)$ whenever $v(p) = p^{1-\varepsilon}$, $\varepsilon > 1$.

where the impact of a price choice on the aggregator is null, as usual under monopolistic competition.

Monopolistic competition delivers the price rule $p = p(c)$ such that:

$$p(c) \equiv \frac{\varepsilon(p(c))c}{\varepsilon(p(c)) - 1}, \tag{4}$$

where to satisfy the first- and second-order condition for profit maximization it is assumed that $\varepsilon(p) > 1$ and $2\varepsilon(p) \geq \phi(p)$, where $\phi(p) \equiv \frac{-v'''(p)p}{v''(p)}$. The price increases in the marginal cost and with undershifting (overshifting) whenever demand elasticity $\varepsilon(p)$ is increasing (decreasing): see Bertoletti and Etro (2017).

2.3 Entry and firm selection

The equilibrium profits of an active firm with marginal cost c are then given by:

$$\pi(c) = (p(c) - c) \left| v'(p(c)) \right| H'(A)L - F, \tag{5}$$

and are decreasing in the marginal cost by the Envelope theorem ($\pi'(c) = v'(p(c))\, H'(A)L = -q(c)\, L < 0$). Accordingly, there is a cut-off firm with marginal cost $\hat{c}$ such that:

$$\pi(\hat{c}) = 0,$$

and we assume that $\hat{c} < \bar{c}$. Given this, the equilibrium value of the aggregator can be written as:

$$A = N \int_0^{\hat{c}} v(p(c)) dG(c), \tag{6}$$

where N is the mass of created firms and we define with $n = G(\hat{c})N$ the measure of active firms.

In addition, the free entry condition requires that the expected profit is equal to the entry cost, namely:

$$\int_0^{\hat{c}} \pi(c) dG(c) = F_e.$$

The equilibrium conditions can then be expressed as follows:

$$(p(\hat{c}) - \hat{c}) \left| v'(p(\hat{c})) \right| H'(A)L = F, \tag{7}$$

$$H'(A)L \int_0^{\hat{c}} (p(c) - c) \left| v'(p(c)) \right| dG(c) = G(\hat{c})F + F_e : \tag{8}$$

they determine $(\hat{c}, N)$ or more simply $(\hat{c}, A)$, and therefore consumer welfare.

To derive the relevant comparative statics, note that (7) and (8) can be combined as:

$$\int_0^{\hat{c}} \frac{(p(c) - c)v'(p(c))}{(p(\hat{c}) - \hat{c})v'(p(\hat{c}))} dG(c) = \frac{F_e}{F} + G(\hat{c}). \tag{9}$$

Formally, the LHS of (9) is a marginal rate of exchange between N and $\hat{c}$ in terms of gross profitability, while the RHS is the corresponding rate in terms of fixed costs. Intuitively, the equilibrium value of $\hat{c}$ depends on the ratio between the average profitability and the profitability of the cut-off firm. In fact, (9) defines the cut-off $\hat{c}$ independently from the market size L and the transformation H, and as an increasing function of F_e/F. As a consequence, the equilibrium values of the mass of firms N and of the aggregator A are increasing functions of the market size and decreasing functions of the entry cost F_e. Their values depend also on the transformation adopted, which affects the substitutability of the differentiated products with the *numéraire*. Finally, since from (7) the equilibrium value of $H'(A)L$ only depends on $\hat{c}$ and F, it follows that the equilibrium firm size $q(c)L$ does not really depend on market size L.

Our main findings are summarized in the following proposition.

Proposition 1. *In a monopolistic competition equilibrium of our setting: a) the marginal cost threshold $\hat{c}$, which is an increasing function of F_e/F, depends neither on market size L nor on the transformation H; b) firm size $q(c)L$ depends neither on market size L nor on the transformation H; c) the measure of created firms N and consumer surplus A depend upon the transformation H, increase with respect to L and decrease with respect to F_e.*

The only (possibly) surprising result in Proposition 1 is the "dichotomy" according to which L and H do affect neither $\hat{c}$ (firm selection) nor $q(c)L$ (firm size): this is due to the fact that the former have an impact on gross profitability which does not depend on c. To see more, let us define:

$$\eta(p) = \frac{\varepsilon(p)}{\zeta(p)} > 0.$$

It is easy to see that η is a measure of curvature of the incremental surplus v such that v is (locally) log-convex if and only if $\eta \geq 1$. Since convexity of preferences requires that condition (2) holds everywhere, namely, for any pricing function $p(c)$, distribution G, cutoff $\hat{c}$ and measure N, it also implies that everywhere $\eta(p) \geq \rho(A)$.

$\eta(p)$ plays a key role in characterizing the monopolistic competition equilibrium and its welfare properties. In fact, it is an inverse measure of profitability, since the equilibrium profit (5) can be written as

$$\pi(c) = \frac{v(p(c))}{\eta(p(c))} H'(A)L - F.$$

Then, (7), (8) can then be restated as:

$$A = H'^{-1}\left(\frac{\eta(p(\hat{c}))F}{v(p(\hat{c}))L}\right), \tag{10}$$

$$H'(A)L \int_0^{\hat{c}} \frac{v(p(c))}{\eta(p(c))} dG(c) = F_e + G(\hat{c})F, \tag{11}$$

and the expression (9) as:

$$\int_0^{\hat{c}} \frac{v\left(p(c)\right)}{\eta\left(p(c)\right)} \frac{\eta\left(p(\hat{c})\right)}{v(p(\hat{c}))} dG(c) = \frac{F_e}{F} + G(\hat{c}). \tag{12}$$

Notice from (10) that, for a given value of $\hat{c}$, the equilibrium value of A increases with respect to $\frac{v(p(\hat{c}))}{\eta(p(\hat{c}))}$. Moreover, the equilibrium consumption of a variety produced with marginal cost c is given by:

$$q(c) = \left|v'\left(p(c)\right)\right| \frac{\eta\left(p(\hat{c})\right) F}{v(p(\hat{c}))L}. \tag{13}$$

To illustrate, let us consider the logarithmic transformation $H = \ln A$. Then we obtain:

$$A = \frac{v(p(\hat{c}))L}{\eta\left(p(\hat{c})\right) F}, \; N = \frac{L}{\overline{\eta}(\hat{c})[F_e + G(\hat{c})F]}, \tag{14}$$

where

$$\overline{\eta}(\hat{c}) = \left[\int_0^{\hat{c}} \frac{1}{\eta(p(c))} \frac{v(p(c))}{\int_0^{\hat{c}} v(p(c))dG(c)} dG(c)\right]^{-1}$$

is the weighted harmonic mean value of $\eta(p(c))$ across active firms, which captures the average profitability.

In the LSE specification we have $p\left(c\right) = c + \frac{1}{\alpha}$ and $\eta(p) = 1$ for any p, and therefore:

$$A = \frac{L}{Fe^{1+\alpha\hat{c}}} \quad \text{and} \quad N = \frac{L}{F_e + G(\hat{c})F},$$

where the cut-off $\hat{c}$ satisfies $F_e + G(\hat{c})F = F\int_0^{\hat{c}} e^{\hat{c}-c}dG(c)$. In the specification with isoelastic surplus functions, instead, we have $p\left(c\right) = \varepsilon c/\left(\varepsilon - 1\right)$ and $\eta = \varepsilon/\left(\varepsilon - 1\right) > 1$, and therefore:

$$A = \left(\frac{\varepsilon - 1}{\varepsilon}\right)^{\varepsilon} \frac{L}{F\hat{c}^{\varepsilon-1}} \quad \text{and} \quad N = \frac{(\varepsilon - 1)L}{\varepsilon[F_e + G(\hat{c})F]},$$

with $F_e + G(\hat{c})F = F\hat{c}^{\varepsilon-1}\int_0^{\hat{c}} c^{1-\varepsilon}dG(c)$.

3 Optimality

We now consider the allocation selected by a social planner. We start with the unconstrained problem where the social planner selects prices, cut-off and measure of firms, which provides the first-best allocation. We then consider constrained optima where pricing is the equilibrium pricing obtained under monopolistic competition in the spirit of Mankiw and Whinston (1986). In a second-best analysis the social planner selects both the cut-off and the measure of firms. In a third-best analysis the social planner selects only the measure of firms. In each case we compare the solution with the equilibrium allocations.

3.1 The first best

A social planner that maximizes the Marshallian welfare chooses the measure N^* of created firms, the threshold for active firms $\hat{c}^*$ and the price schedule $p^*(c)$ under the resource constraint,[3] determining the price aggregator:

$$A^* = N^* \int_0^{\hat{c}^*} v(p^*(c))dG(c). \tag{15}$$

Assuming that income is large enough to allow us to ignore the resource constraint (so that the consumption of the *numéraire* is positive, as implicitly assumed in the previous section), the planner's problem can be stated as:

$$\max_{p^*(c),\ \hat{c}^*,\ N^*} W = H\left(A^*\right)L + EL + N^* \begin{bmatrix} H'(A^*)L \int_0^{\hat{c}^*} \left(p^*(c) - c\right) \left|v'(p^*(c))\right| dG(c) \\ -G(\hat{c}^*)F - F_e \end{bmatrix}.$$

Point-wise maximization of W shows that it must be the case that $p^*(c) = c$, $c \in [0, \hat{c}^*]$. Accordingly, the previous program can be rewritten as:

$$\max_{N^*,\hat{c}^*} W = \left\{ H\left(N^* \int_0^{\hat{c}^*} v(c)dG(c)\right) L + EL - N^*\left[G(\hat{c}^*)F + F_e\right] \right\}.$$

The FOCs then give (assuming $\hat{c}^* < \overline{c}$):

$$v(\hat{c}^*)H'(A^*)L = F, \tag{16}$$

$$H'(A^*)L \int_0^{\hat{c}^*} v(c)dG(c) = G(\hat{c}^*)F + F_e. \tag{17}$$

Condition (16) says that the contribution to consumer surplus of the optimal cut-off firm is equal to its fixed cost of activation, while condition (17) shows that the expected contribution of the marginal entry is equal to its expected fixed costs. Together they imply:

$$\int_0^{\hat{c}^*} \frac{v(c)}{v(\hat{c}^*)} dG(c) = G(\hat{c}^*) + \frac{F_e}{F}. \tag{18}$$

Formally, the LHS of (18) is the marginal rate of substitution between N^* and $\hat{c}^*$ in terms of consumer surplus, while the RHS is the corresponding marginal rate of transformation in terms of fixed costs (Bertoletti *et al.*, 2018). Intuitively, the optimal value of $\hat{c}$ depends on the ratio between the average incremental surplus and the incremental surplus provided by the cut-off firm. In fact, (18) determines $\hat{c}^*$ as independent from market size and from the transformation

[3] The resource constraint is:

$$N^* \left[\int_0^{\hat{c}^*} c\left|v'(p^*(c))\right| H'(A^*)LdG(c) + F_e + G(\hat{c}^*)F\right] \leq EL,$$

and it is satisfied if E is large enough.

adopted, and an increasing function of F_e/F. As an implication, the optimal mass of firms $N^*$and the optimal individual consumer surplus A^* increase with respect to L and decreases with respect to F_e. Notice that from (16) the optimal consumption is:

$$q^*(c) = \frac{v'(c)\,F}{v'(\hat{c}^*)L}, \tag{19}$$

so that the optimal production of each variety does not really depend on market size.

These results parallel those of Proposition 1 (in particular, a similar dichotomy arises), and for the sake of brevity we do not summarize them into a formal proposition. It is more interesting to compare the equilibrium values to the optimal ones but, not surprisingly, this comparison is made difficult by the rather different pricing. We can illustrate this difficulty by referring to the simple case of the logarithmic transformation $H(A) = \log A$, for which we get:

$$A^* = v(\hat{c}^*)\frac{L}{F}, \;\; N^* = \frac{L}{F_e + G(\hat{c}^*)F}.$$

Since in this case preference convexity requires $\eta(p) \geq 1$, a comparison to (14) suggests that the equilibrium should deliver a smaller consumer surplus and an insufficient measure of created firms, as it does in the case of homogeneous firms (see Appendix C). However, to ensure that these results always (whatever L, F, F_e and G) hold we also need that $\hat{c}^* \leq \hat{c}$, namely, that optimal firm selection is not looser than the equilibrium one. Unfortunately, the latter need not to be the case, and accordingly in general anything goes: namely, the equilibrium and optimal cut-offs are different and either one could be larger.

In fact, comparing the integrand in the LHS of (12) to the integrand in the LHS of (18) shows that the market chooses $\hat{c}$ by considering $\widetilde{v}(c)/\widetilde{v}(\widehat{c})$, where $\widetilde{v}(c) = \frac{v(p(c))}{\eta(p(c))}$ is a sort of "virtual social surplus". Thus the market equilibrium distorts the surplus $v(p)$ by evaluating it at $p(c) > c$ and dividing it by $\eta(p(c))$. The relative pattern of $\widetilde{v}(c)/\widetilde{v}(\widehat{c})$ versus $v(c)/v(\widehat{c})$ is not obvious, since it depends on the curvature features of $v(p)$. However, by defining $\Phi(c) = \frac{f(c)}{\eta(p(c))}$, where $f(c) = \frac{v(p(c))}{v(c)} < 1$: one can prove the following proposition.

Proposition 2. *A sufficient condition for $\hat{c}^* < (>)\ \hat{c}$ is that $\Phi(c)$ is monotonic increasing (decreasing). Accordingly, with a decreasing (increasing) $\eta(p)$ a sufficient condition for $\hat{c}^* < (>)\ \hat{c}$ is that $f(c)$ is increasing (decreasing).*

The conditions of Proposition 2 are rather involved: while in general $\varepsilon'(p)$ and $\zeta'(p)$ need not agree in sign, they do agree when $\varepsilon(p)$ is monotonic,[4] and in such a case *a fortiori* we cannot predict the sign of $\eta'(p)$.[5] Moreover, $f'(c) >$

[4] One can prove that when $|v'(p)|$ is so-called (see Mrázová and Neary, 2019) $super(sub)$-convex, meaning $\frac{d^2 \ln|v'(p)|}{d(\ln p)^2} = \frac{d\{-\varepsilon(p)\}}{d\ln p} > (<)\, 0$, then under some technical conditions also $v(p)$ is $super(sub)$-convex, meaning $\frac{d^2 \ln v(p)}{d(\ln p)^2} = \frac{d\{-\zeta(p)\}}{d\ln p} > (<)\, 0$.

[5] But notice that $\eta'(p) \geq 0$ is equivalent to $\phi(p) + \zeta(p) \leq 2\varepsilon(p)$, which would be satisfied under log-convexity of v if demand were locally concave (i.e., if $\phi(p) \leq 0$).

$(<)\, 0$ is equivalent to $\zeta\left(p\left(c\right)\right)\frac{d\ln p(c)}{d\ln c} < (>)\,\zeta\left(c\right)$, and we have $d\ln p\left(c\right)/d\ln c \lesseqgtr 1$ if $\varepsilon'\left(p\right) \gtreqless 0$. In general the equilibrium and optimal cut-offs are different and either one could be larger. Notice in particular that it might well be the case that $\hat{c}^* > \hat{c}$, implying that a planner would like to activate firms which cannot survive at the market equilibrium: for instance, this happens if $v\left(p\right) = \frac{p+1}{p}$, since then $\Phi\left(c\right) = \frac{1}{4(c+1)}$.

However, a simple case arises if the surplus function exhibits a constant η, a property which holds only for the "translated power" family of surplus functions discussed in Appendix A (which includes the exponential and the isoelastic surplus specification). In such a case we have that also f is constant and thus Φ is constant too and smaller than 1,[6] and as a result the equilibrium cut-off is equal to the optimal one. Moreover, a comparison of (13) and (19) reveals that the equilibrium consumption $q\left(c\right)$ is at its optimal level $q^*\left(c\right)$.[7]

Finally, (16) can be rewritten as

$$A^* = H'^{-1}\left(\frac{F}{v(\hat{c}^*)L}\right),$$

so that a comparison with (10) shows that $A^* > A$ is equivalent to $\frac{v(p(\widehat{c}))}{\eta(p(\widehat{c}))} < v\left(\hat{c}^*\right)$, which is certainly satisfied if $\hat{c}^* \leq \widehat{c}$ and v is log-convex. Notice that $A^* > A$ is equivalent to $\Phi < 1$ for the class of surpluses for which η is constant, and thus it is always satisfied in those cases.

To illustrate these results, consider the well-known case of a power function. This provides $\Phi = \left[\frac{\varepsilon}{\varepsilon-1}\right]^{-\varepsilon}$ and then $\hat{c} = \hat{c}^*$, $q^*\left(c\right) = q\left(c\right)$ and $A^* > A$. In our setting, the constant equilibrium markup makes both the market selection and the equilibrium size of active firms optimal. However, under the logarithmic transformation, the equilibrium mass of created firms would be too small, i.e., too large the equilibrium consumption of the outside commodity (very much as in the case of homogeneous firms: see Appendix C).

For the negative exponential surplus function, we get $\Phi = \frac{1}{e}$, thus again $\hat{c} = \hat{c}^*$, $q^*\left(c\right) = q\left(c\right)$ and $A^* > A$. Moreover, in the LSE case $(\eta = 1 = \rho)$ $N = N^*$ and then the overall equilibrium allocation must be optimal: in fact the reduction of consumer surplus is fully compensated in terms of welfare by the increase of profits.

These interesting findings can be generalized as it follows: suppose that a surplus function with a constant $\eta \neq 1$ is coupled with the iso-elastic transformation $H\left(A\right) = \frac{A^{1-\rho}}{1-\rho}$, with (to satisfy convexity of preferences) $\eta \geq \rho > 0$.

[6] Computation shows that $\Phi = f = \frac{1}{e}$ when $\eta = 1$ (in the case of the exponential surplus), and that otherwise $\Phi = \frac{f}{\eta} = \eta^{\frac{\eta}{1-\eta}}$.

[7] Computation shows that the relevant condition

$$\frac{v'\left(c\right)}{v'\left(p\left(c\right)\right)} = \Phi^{-1}$$

holds.

Comparing (10) to (16) we can see that it must be the case that:

$$H'(A^*) = H'(A)\Phi,$$

and accordingly we get $A^* = A\Phi^{\frac{-1}{\rho}}$, and then

$$N^* = Nf\Phi^{\frac{-1}{\rho}} = N(\eta\Phi)\Phi^{\frac{-1}{\rho}} = N\eta\Phi^{\frac{\rho-1}{\rho}} = N\eta^{\frac{\eta-\rho}{(\eta-1)\rho}},$$

which shows that $N^* \geq N$ and thus the measure of goods is in general sub-optimal. However, the overall allocation is indeed efficient if $\eta = \rho$ and then $N^* = N$, as in the previous LogSumExp example. The intuitive reason is that in this special case the curvature of the transformation function H exactly compensates in terms of a positive impact on profits the reduction of consumer surplus in establishing the equilibrium value of N. It is worth mentioning that one can show that no efficient allocation could arise in a monopolistic competitive equilibrium with preferences *à la* Spence (1976) and heterogeneous firms.

We summarize these results in the following proposition.

Proposition 3. *In our setting equilibrium firm selection and consumption levels are optimal when the surplus function v exhibits a constant curvature η (which cannot be lower than the curvature ρ of the transformation H). In these cases the equilibrium measure of firms is generally sub-optimal, but there is overall efficiency when $\eta = \rho$.*

3.2 The second best

Following Spence (1976), Dixit and Stiglitz (1977) and Mankiw and Whinston (1986) it is interesting to characterize what happens if the planner cannot affect equilibrium pricing, given by (4), but can control the mass of firms created and also the activation of firms. In such a case the planner chooses $(\widetilde{c}, \widetilde{N})$, and therefore $\widetilde{A}$, to solve the second best problem:

$$\max_{\widehat{c},N} \widetilde{W}(\widehat{c}, N) = H(A)L + EL + N\left[\int_0^{\hat{c}} \pi(c)dG(c) - F_e\right]$$

under constraint (6). Differentiating the latter we get:

$$\frac{\partial A}{\partial \widehat{c}} = Nv(p(\widehat{c}))g(\widehat{c}) > 0 \quad \text{and} \quad \frac{\partial A}{\partial N} = \frac{A}{N} > 0, \tag{20}$$

while the welfare derivatives are given by

$$\frac{\partial \widetilde{W}}{\partial \widehat{c}} = H'(A)L\frac{\partial A}{\partial \widehat{c}} + N\pi(\widehat{c})g(\widehat{c}) + N\int_0^{\hat{c}} \frac{\partial \pi(c)}{\partial A}dG(c)\frac{\partial A}{\partial \widehat{c}}, \tag{21}$$

$$\frac{\partial \widetilde{W}}{\partial N} = H'(A)L\frac{\partial A}{\partial N} + \left[\int_0^{\hat{c}} \pi(c)dG(c) - F_e\right] \tag{22}$$

$$+N\int_0^{\hat{c}}\frac{\partial\pi(c)}{\partial A}dG(c)\frac{\partial A}{\partial N}.$$

Conditions (20)-(22) show that a rise of the cut-off and the creation of an additional firm have three similar welfare effects:

1) a positive consumer surplus effect, through a rise of the value of the price aggregator A;

2) an impact on producer surplus given respectively by the profit $\pi(\widehat{c})$ of the marginal firms (whose measure is $Ng(\widehat{c})$) and by the expected profit: this effect is null in the market equilibrium;

3) a negative business stealing effect, through the reduction of the profits of active firms due to the decrease of demand which follows a rise of the price aggregator A.

The second-best inefficiency of the equilibrium depends on the comparison of the consumer surplus effect and the business stealing effect. For a given value of A and of either $dA/d\widehat{c}$ or dA/dN, the latter is captured by:

$$N\int_0^{\hat{c}}\frac{\partial\pi(c)}{\partial A}dG(c)=-\frac{\rho(A)}{\overline{\eta}(\hat{c})}H'(A)L.$$

Accordingly, the indirect impact on profits of a greater $\widehat{c}$ or N is larger (in absolute value) the larger is $\rho(A)$ (which captures the elasticity of demand with respect to the price aggregator) and the smaller is $\overline{\eta}(\hat{c})$ (which is an inverse measure of average profitability). On the contrary, the impact on consumer welfare depends neither on $\rho(A)$ nor on the curvature of the surplus function. As a result, the net welfare impact of $\widehat{c}$ and N through A, that is the net result of consumer surplus and business stealing effects, is given by:

$$\left[1-\frac{\rho(A)}{\overline{\eta}(\hat{c})}\right]H'(A)L,$$

and therefore it is non-negative since $\overline{\eta}(\hat{c})\geq\rho(A)$.

Thus, when evaluated at a market equilibrium both $\partial\widetilde{W}/\partial\widehat{c}$ and $\partial\widetilde{W}/\partial N$ are non-negative. In particular, if $\overline{\eta}(\hat{c})=\rho(A)$ the equilibrium is second-best efficient. However, if $\overline{\eta}(\hat{c})>\rho(A)$ the equilibrium involves insufficient entry and excessive selection, and the planner could achieve a local welfare improvement by subsidizing both entry and activation. We state this finding as follows:[8]

Proposition 4. *In our setting, monopolistic competition pricing generates (weakly) insufficient entry and excessive selection of firms at the equilibrium.*

In summary, we find that in our setting the business-stealing effect of an additional entry and/or activation is (weakly) more than compensated by the direct positive impact on consumer surplus. These results should be compared

[8] As a corollary of Proposition 4, when the surplus functions belong to the "translated power" family considered in Appendix A, and the transformation is given by $H(A)=\frac{A^{1-\eta}}{1-\eta}$, then market allocations qualifies as a second-best.

to those of Spence (1976) and Mankiw and Whinston (1986) who use preferences represented by the direct utility function:

$$U = G\left(\int_{\Omega} u(q(\omega))d\omega\right) + Y, \tag{23}$$

where Y is consumption of the outside *numéraire*, and G and u are increasing, concave functions. In a setting with these quasi-linear, directly additive preferences and homogeneous firms they find that entry can be either insufficient or excessive. Indeed, one can show that in their setting (at the equilibrium): i) a necessary condition for excess entry is that the surplus elasticity $\varphi(q) = u'(q)q/u(q)$ is decreasing; ii) the business-stealing effect is larger the larger is $\widetilde{\rho}(B) = -G''(B)B/G'(B)$. The intuitive reason for our different results is that in their setting there is no upper-bound to the curvature of the transformation function G (namely, U is concave whatever the value of $\widetilde{\rho}$).

Finally, assuming $\overline{\eta}(\widetilde{c}) > \rho\left(\widetilde{A}\right)$, equating the derivatives (21) and (22) to zero and using (20) we get the second-best condition:

$$\int_0^{\widetilde{c}} \frac{v(p(c))dG(c)}{v(p(\widetilde{c}))} = \int_0^{\widetilde{c}} \frac{\pi(c)dG(c) - F_e}{\pi(\widetilde{c})}, \tag{24}$$

which says that expected profits and the profits of the cut-off firm should be either both negative or both positive. Notice that (24) is a generalization of (18) which takes into account the fact that variable profit are not null: with positive markups the second-best trades-off the change in consumer surplus with the impact on profits.

The second-best conditions can also be rewritten as:

$$\int_0^{\widetilde{c}} \frac{v(p(c))}{v(p(\widetilde{c}))}dG(c) - H'\left(\widetilde{A}\right)\frac{\widetilde{A}L}{\widetilde{N}F}\left[\frac{1}{\overline{\eta}(\widetilde{c})} - \frac{1}{\eta(\widetilde{c})}\right] = G(\widetilde{c}) + \frac{F_e}{F}, \tag{25}$$

$$\widetilde{N} = \frac{H'\left(\widetilde{A}\right)\widetilde{A}L}{\overline{\eta}(\widetilde{c})}\frac{\overline{\eta}(\widetilde{c}) - \rho\left(\widetilde{A}\right) + 1}{G(\widetilde{c})F + F_e}. \tag{26}$$

Notice that in general the market size L affects both $\widetilde{N}$ and $\widetilde{c}$. However, (25) implies that $\widetilde{c} = \widehat{c}^*$ for the family of surplus functions with constant η, and (26) implies that if $H(A) = \ln A$, then $\widetilde{N} < (>)\, N^*$if $\widetilde{c} > (<)\, \widehat{c}^*$.

3.3 The third best

It might also be interesting to characterize what happens if the planner, realistically, can affect neither pricing, given by (4), nor the decision of being active (determined by the non-negative profit condition (7) of the cut-off firm), but only the creation of the measure of firms N (possibly by subsidizing/taxing entry). In this case the planner's program is to choose N^c by solving

$$\max_N W(N) = H(A)L + EL + N\left[\int_0^{\hat{c}} \pi(c)dG(c) - F_e\right]$$

under constraints (6) and (7), which determine the indirect welfare impact of N through A and $\hat{c}$.

Differentiating these constraints we get $\frac{d\hat{c}}{dN} < 0$ and $\frac{dA}{dN} > 0$ (see Appendix B): while the overall impact of N on the aggregator depends on $\frac{d\hat{c}}{dN}$ and thus on transformation H (and distribution G), its sign is necessarily positive, as one would expect. Intuitively, a rise of N decreases $\hat{c}$ by reducing demand and then necessarily the profit of each active firm. The size of this effect depends on the elasticity of demand with respect to the aggregator, given by ρ: the larger this elasticity the larger the reduction of $\hat{c}$ induced by an increase of N.

The welfare derivative is thus given by:[9]

$$W'(N) = H'(A)\,L\frac{dA}{dN} + \int_0^{\hat{c}} \pi(c)dG(c) - F_e - \frac{\rho(A)}{\overline{\eta}(\hat{c})}H'(A)\,L\frac{dA}{dN},$$

which again exhibits the three welfare effects discussed in the previous section. Accordingly, the indirect impact on profits of a larger mass of firms is dominated by the positive impact on consumer surplus since $\rho(A) \leq \overline{\eta}(\hat{c})$.

Indeed, evaluating $W'(N)$ at the market equilibrium value of N we get:

$$W'(N) = H'(A)\left[1 - \frac{\rho(A)}{\overline{\eta}(\hat{c})}\right]\frac{dA}{dN}L,$$

which is non-negative, and in fact strictly positive if $\overline{\eta}(\hat{c}) > \rho(A)$, saying that in such a case the market equilibrium is creating (with respect to its third-best value) a too small mass of firms and overall activating too much too inefficient firms (and not enough the most efficient firms). We summarize this finding as follows:

Proposition 5. *In our setting, monopolistic competition pricing and firm selection generates (weakly) insufficient entry of firms.*

Notice that the planner is here willing to accept a reduction in firm activation, while it would like to increase activation if he could incentivate it separately (as in the second-best).[10]

4 Conclusion

We have characterized the monopolistic competitive equilibrium with heterogeneous firms *à la* Melitz (2003) under an unexplored class of quasi-linear preferences, and compared it to the unconstrained and constrained social optima. In general, firm selection by the market can be either tighter or looser than the optimal one, but entry is insufficient in comparison to the optimal allocation constrained by equilibrium pricing.

[9] The impact on welfare of N through $\hat{c}$ is null by condition (7).

[10] Once again, under a transformation $H(A) = \frac{A^{1-\eta}}{1-\eta}$, the surplus functions exhibiting a constant η deliver a market equilibrium which is constrained optimal.

Further results can be achieved by making specific assumptions on the ex-ante distribution of firms' marginal costs, and/or on preferences. For instance, we have shown that market selection of firms and their sizes are indeed optimal for the family of surplus functions exhibiting a constant curvature, and that the overall allocations turns out to be efficient for a generalization of the LogSumExp specification.

Appendix A

One can prove (see Etro, 2021) that a positive, strictly decreasing and strictly convex surplus function $v(p)$ can exhibit a constant ratio $\eta = \varepsilon(p)/\zeta(p)$ only in the following cases:

1. if $\eta = 1$ then $v(p) = ae^{-\alpha p}$, where a, $\alpha > 0$, with $\varepsilon(p) = \alpha p = \zeta(p)$;
2. if $\eta < 1$ then $v(p) = [a - \alpha p]^{\frac{1}{1-\eta}}$, where $\alpha > 0$, $a > \alpha p$, with $\varepsilon(p) = \frac{\alpha\eta p}{(1-\eta)[a-\alpha p]} = \eta\zeta(p)$;
3. if $\eta > 1$ then $v(p) = [\alpha p - a]^{\frac{1}{1-\eta}}$, where $\alpha > 0$, $\alpha p > a$, with $\varepsilon(p) = \frac{\alpha\eta p}{(\eta-1)[\alpha p-a]} = \eta\zeta(p)$. Notice that for $a = 0$ we get the power surplus function $v(p) = \alpha p^{\frac{1}{1-\eta}}$, with $\varepsilon = \frac{\eta}{\eta-1} = \eta\zeta$.

Appendix B

Differentiating (6) and (7) we get:

$$\mathbf{B}\begin{bmatrix} \frac{dA}{dN} \\ \frac{d\widehat{c}}{dN} \end{bmatrix} = \begin{bmatrix} \frac{A}{N} \\ 0 \end{bmatrix}, \text{ where } \mathbf{B} = \begin{bmatrix} 1 & -Nv(p(\widehat{c}))\,g(\widehat{c}) \\ -\rho(A)\frac{F}{A} & \pi'(\widehat{c}) \end{bmatrix},$$

with

$$|\mathbf{B}| = \pi'(\widehat{c}) - \frac{\rho(A)}{A} Nv(p(\widehat{c}))\,g(\widehat{c})\,F < 0.$$

Thus, by Cramer's rule: $\frac{dA}{dN} = \frac{A}{N}\frac{\pi'(\widehat{c})}{|\mathbf{B}|} > 0$, $\frac{d\widehat{c}}{dN} = \frac{\rho(A)A}{N}\frac{F}{|\mathbf{B}|} < 0$.

Appendix C

Suppose that all firms have the same marginal cost, $c > 0$, and that the only fixed cost is the activation cost $F > 0$. It is easily established that in a monopolistic competition equilibrium with free entry:

$$p = \frac{\varepsilon(p)\,c}{\varepsilon(p) - 1},\ q = \frac{\varepsilon(p) - 1}{c}\frac{F}{L} \text{ and } \frac{F}{L} = \frac{v(p)}{\eta(p)} H'(nv(p)),$$

where n is the number of active firms. Notice that H only affect the number of firms n, which increases with respect to L/F, and that firm size qL does not depend on L.

To illustrate, suppose that $H(A) = \ln A$ and that the surplus function is the negative exponential, i.e., $v(p) = e^{-\alpha p}$:[11] then

$$p = \frac{1}{\alpha} + c,\ q = \alpha\frac{F}{L} \text{ and } n = \frac{L}{F}.$$

Suppose that, on the contrary, $H(A) = \frac{A^{1-\rho}}{1-\rho}$ and that the surplus function is the power, i.e., $v(p) = p^{1-\varepsilon}$, with $\eta = \frac{\varepsilon}{\varepsilon-1} \geq \rho > 0$ (to satisfy the convexity of preferences): then

$$p = \frac{\varepsilon c}{\varepsilon - 1},\ q = \frac{\varepsilon - 1}{c}\frac{F}{L} \text{ and } n = \left(\frac{\varepsilon}{\varepsilon-1}\right)^{-\frac{\varepsilon-\rho\varepsilon+\rho}{\rho}}\left(\frac{L}{F}\right)^{\frac{1}{\rho}} c^{\frac{(1-\varepsilon)(1-\rho)}{\rho}}.$$

First best The Marshallian welfare can be written as:

$$W = H(A)L + EL + n\left[(p-c)\left|v'(p)\right|H'(A)L - F\right].$$

Maximizing it with respect to p and A under the constraint $A = nv(p)$ we get the FOCs:

$$\begin{aligned} H'(A)L + n(p-c)\left|v'(p)\right|H''(A)L &= -\lambda, \\ \left[\left|v'(p)\right| - (p-c)v''(p)\right]H'(A)L &= \lambda v'(p), \end{aligned}$$

which can be rearranged as

$$\left(\frac{p-c}{p}\right)\zeta(p)\rho(A) = \left(\frac{p-c}{p}\right)\varepsilon(p),$$

$$\lambda = \left[-1 + \left(\frac{p-c}{p}\right)\varepsilon(p)\right]H'(A)L.$$

These conditions are satisfied for $p^* = c$ and $\lambda = -H'(A^*)L$ (while they would require $\rho(A^*) = \eta(p^*)$ for $p^* > c$). Assuming $p^* = c$ we immediately obtain

$$q^* = \frac{\zeta(c)}{c}\frac{F}{L} \text{ and } \frac{F}{L} = v(c)H'(n^*v(c)),$$

so that the optimal firm size q^*L does not depend on market size L, while the optimal number of firms n^* increases with respect to L/F.

To compare the equilibrium allocation to the optimal, notice that it must be the case that

$$H'(n^*v(c)) = \Phi(c)H'(nv(p)),$$

where $\Phi(c) = \frac{v(p)}{v(c)\eta(p)}$. Accordingly, $\Phi(c) < 1$, which holds if v is log-convex, ensures that $A^* > A$. When H is the logarithmic transformation we immediately get $n^* = \frac{L}{F}$, and since in the equilibrium $n = \frac{L}{\eta(p)F}$ and it must be the case,

[11] In this LSE setting $q = \frac{\alpha}{n}$ whenever all firms use the same price, and indeed $\Psi = 0$ in such a case.

to satisfy convexity of preferences, that $\eta(p) \geq 1$, we get $A^* > A$ and that the number of firms is in general suboptimal. This happen for instance in the cases of the surplus functions exhibiting a constant η, for which computation shows that $\zeta(c) = \varepsilon(p) - 1$ and then the equilibrium firm size is instead optimal (moreover, since in these cases $\Phi < 1$, we also get that $A^* > A$ for any admissible transformation H). Accordingly, the total amount of resources allocated in the monopolistic equilibrium to the differentiated sector under a logarithmic transformation is generally insufficient, and the consumption of the *numéraire* too large. However, in the case of the LSE specification (since $\eta = 1 = \rho$) also the equilibrium number of firms is optimal, and optimal must then be the overall allocation (the fact that $A^* > A$ is compensated in the optimal allocation by the alleged profit loss due to marginal cost pricing).

More in general, when $H(A) = \frac{A^{1-\rho}}{1-\rho}$ and the surplus function exhibits a constant $\eta \neq 1$, with $\eta \geq \rho > 0$, we get

$$n^* = nf\Phi^{-\frac{1}{\rho}} = \eta^{\frac{\eta-\rho}{(\eta-1)\rho}}.$$

Accordingly, the equilibrium number of goods is in general sub-optimal, unless when $\eta = \rho$ and the overall allocation is efficient, as in the LSE example.

Second best Suppose that the planner can control the number of firms n but cannot affect the monopolistically competitive pricing. Then the Marshallian welfare becomes:

$$\widehat{W} = H\left(\widehat{A}\right)L + EL + \widehat{n}\left[\frac{v(p)}{\eta(p)}H'\left(\widehat{A}\right)L - F\right],$$

where $\widehat{A} = \widehat{n}v(p)$ and the derivative with respect to the number of firms is:

$$\frac{d\widehat{W}}{d\widehat{n}} = H'\left(\widehat{A}\right)v(p)L + \left[\frac{v(p)}{\eta(p)}H'\left(\widehat{A}\right)L - F\right] + \widehat{n}\frac{v(p)}{\eta(p)}H''\left(\widehat{A}\right)v(p)L,$$

where we can distinguish the three welfare effects of the introduction of an additional firm: a positive consumer surplus effect, a profit effect which is null in the equilibrium and a negative business stealing effect. This derivative can be rewritten as:

$$\frac{d\widehat{W}}{d\widehat{n}} = H'\left(\widehat{A}\right)v(p)L\left[1 - \frac{\rho\left(\widehat{A}\right)}{\eta(p)}\right] + \frac{v(p)}{\eta(p)}H'\left(\widehat{A}\right)L - F,$$

where the last two terms add to zero in equilibrium. Hence, equilibrium is second-best optimal only if $\rho\left(\widehat{A}\right) = \eta(p)$, and equilibrium entry is (weakly) insufficient since $\eta(p) \geq \rho(A)$ to satisfy convexity of preferences.

References

Anderson Simon P., André de Palma and Jacques-François Thisse, *Discrete Choice Theory of Product Differentiation*, MIT Press: Cambridge (USA).

Bertoletti, Paolo, 2018, A Note on Ramsey Pricing and the Structure of Preferences, *Journal of Mathematical Economics*, 76, 45-51.

Bertoletti, Paolo and Federico Etro, 2016, Preferences, Entry and Market Structure, *RAND Journal of Economics*, 47, 4, 792-821.

Bertoletti, Paolo and Federico Etro, 2017, Monopolistic Competition when Income Matters, *Economic Journal*, 127, 603, 1217-43.

Bertoletti, Paolo and Federico Etro, 2021, Monopolistic competition with Generalized Additively Separable preferences, *Oxford Economic Papers*, 73, 2, 927-52.

Bertoletti, Paolo, Federico Etro and Ina Simonovska, 2018, International Trade with Indirect Additivity, *American Economic Journal: Microeconomics*, 10, 2, 1-57.

Dhingra, Swathi and John Morrow, 2019, Monopolistic Competition and Optimum Product Diversity Under Firm Heterogeneity, *Journal of Political Economy*, 127, 196-232.

Dixit, Avinash and Joseph Stiglitz, 1977, Monopolistic Competition and Optimum Product Diversity, *American Economic Review*, 67, 297-308.

Etro, Federico, 2021, Product selection in online marketplaces, *Journal of Economics and Management Strategies*, 30, 3, 614-37.

Etro, Federico, 2023a, Hybrid marketplaces with free entry of sellers, *Review of Industrial Organization*, in press.

Etro, Federico, 2023b, Platform competition with free entry of sellers, *International Journal of Industrial Organization*, in press.

Mankiw, N. Gregory and Michael D. Whinston, 1986, Free entry and social inefficiency, *Rand Journal of Economics*, 17, 1, 48-58.

Melitz, Marc, 2003, The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity, *Econometrica*, 71, 6, 1695-725.

Melitz, Marc and Gianmarco Ottaviano, 2008, Market Size, Trade, and Productivity, *Review of Economic Studies*, 75, 1, 295-316.

Mrázová, Monika and Peter Neary, 2019, Selection Effects with Heterogeneous Firms, *Journal of the European Economic Association*, 17, 4, 1294–334.

Nocke, Volker and Nicolas Schutz, 2018, Multiproduct-firm oligopoly: An aggregative games approach, *Econometrica*, 86, 2, 523-557.

Spence, Michael, 1976, Production Selection, Fixed Costs, and Monopolistic Competition, *Review of Economic Studies*, 43, 2, 217-35.