Preference for Novelty and Price Behaviour

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Abstract: In this paper we motivate a specific formulation for preference that exhibits both love for variety and love for novelty. This enables to investigate the effects of ageing of imperfect substitutes, as they became progressively old-fashioned, due to the obsolescence of their aesthetic features. First, we assume that the industry is divided into several sub-markets, each dominated by a single firm that produces a variety of a given vintage. We show that equilibrium prices decrease, as goods become older. Assuming a fixed cost to be paid, the evolution of demand determines the equilibrium number of varieties at the point where the oldest vintage firm earns zero profits. Second, we consider the model under a free entry condition assumption. Each sub-market of a given vintage is saturated with a number of varieties such that the market share of each firm is barely sufficient to realise zero profits. We show in a particular case that, in equilibrium, markets of the youngest varieties are characterised by a larger number of firms than markets offering older varieties. More specifically, the lifetime horizon of each variety will be characterised by decreasing prices accompanied by increasing demand levels.

JEL Classification: D43, L11, L13

1. Introduction

Economic literature relating to innovation and differentiation of products make use of standard specification of preference, which enable to model individual's desire to experience "new" goods in two senses. There is first the "new" in the sense of a newly created good. Convexity of preference (Spence, 76; Dixit-Stiglitz, 77) implies that individuals like to consume many types of a given good. Such taste for variety provides the fundamental incentive for basic innovation aimed at introducing differentiated products into the market.

Second, there is the "new" in the sense of an improved good. People like best goods of the last generation whenever they offer a better quality than the older ones. Improved quality of existing goods shifts outwards the utility function, potentially rewarding a successful R&D effort with larger market shares[1]. Therefore, both approaches to product innovation relate the idea of "new" to physical qualities of goods, either in the sense of the improvement of their technical characteristics, or in the sense of a new variety, physically differentiated from those available in the market.

Indeed, several peculiar aspects of modern consumerism do not seem to be entirely concerned with the process of innovation above mentioned. Hirschman (1981) proposes that product innovation can be classified along two dimensions, a symbolic one related to new social meanings of goods and a technological representation by tangible features that are new to the product category. For example, consumers' rate of replacement of manufactured goods such as clothes or shoes appear to be substantially unrelated to any process of wearing out or physical obsolescence. Similar common evidence may be found in other commodity areas such as furniture and furnishing, cultural products, and entertainment activities, and in general it seems to apply to all those sectors in which aesthetics represent a prominent aspect of goods[2].

According to modern sociology, the exceptionally high turnover of goods, accompanied by the raising of the threshold of what consumers consider "worn out" beyond any observable need for their replacement, constitutes the distinctive mark of modern consumerism, and the observable consequence of contemporary hedonism.

In particular, the key factor driving the continual pursuing of pleasure is seen to be closely related to the “desire for the new”, that prompts hedonist consumers towards those goods, which enter the commodity space as novelties, i.e. displaying new aesthetic features, aimed at launching them as fashionable goods[3]. Thus, the sociological approach to contemporary consumerism concerns chiefly with "the nature, origin and functioning of the process through which novelty is continuously created, introduced into society and then disseminated through all social classes" (Campbell (1992), p. 48).

Economic literature relating to the phenomena of fashion and aesthetic innovation considers that consumption externalities, such as ‘bandwagon’ and ‘snob’ effects, arouse

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[1] The relevance of quality improvement is well established in endogenous growth literature. For references and surveys see, for example, Barro and Sala-i-Martin (1995) and Grossman and Helpman (1991).

[2] See Kusamitsu (1991) for a historical perspective of the extension of novelty from exotic items to non-luxury goods.

[3] The novelty character of a commodity may be not the consequence of a true aesthetic innovation - such as that noticeable in the clothing sector - but may be borrowed from the setting surrounding the presentation of the product. Goods that are not very apt to aesthetic revolutions, such as mineral water, rely upon the presence of unusual metaphors in their advertisement presentation to strike the imagination of consumers and gain attractiveness. In *Channels of Desire* (Ewen and Ewen, 1982) the authors investigate how mass images, new advertising, and fashion are channelled into consumption, and into the desire for ever new goods.

signalling strategies among heterogeneous groups of consumers (Becker (1991), Pesendorfer (1995), and Bagwell and Bernheim (1996)).

In the present paper we depart from the assumption of heterogeneous consumers, trying an alternative economic investigation of aesthetic innovation within a baseline setting of monopolistic competition; the demand side of the model arises from the choices of a representative consumer who displays preference for novelty.

To model this particular aspect of the observed behaviour of consumers within a standard specification of preferences, we consider the love for novelty to affect individual utility as a particular discount rate. Let us consider two goods that differ as to their vintage, i.e. one is fashionable whereas the other one is out of date. We assume that consumers evaluates the older type in terms of the vintage of the newest one through a particular discount rate, which expresses their subjective rate of preference for novelty. Furthermore, we motivate our preference specification proposing an alternative aggregation procedure among imperfect substitutes, when the discount factor accounts for different qualities of goods.

The demand side of the model is then described by a representative consumer who exhibits both love for variety - in the sense originally proposed by Spence (1976) and Dixit-Stiglitz (1977) - and for novelty. The latter aspect brings an asymmetry in preferences, which have the crucial consequence to let the price elasticity of demand depend on the firms' price strategy.

On the supply side, we assume that each firm retains a perpetual monopoly power over the variety it produces[4]. Firms maximise profits setting prices so as to exploit all the market power resulting from the physical differentiation of goods and from their relative age.

In particular, we take into consideration two alternative conditions of equilibrium for the market as a whole. First, we assume that only one firm populates each sub-market[5]. Under this hypothesis we show that equilibrium prices decrease, as goods become older. The optimal price change rate, however, only partially compensates consumers for the ageing of goods. As a result, each firm faces a declining market share over the lifetime of its product. In particular, assuming a fixed cost to be paid each period, the evolution of demand determines the equilibrium number of varieties at the point where the oldest vintage firm earns zero profit[6].

Second, we consider the model under a free entry condition assumption. In particular, as we rule out imitation, each firm can freely enter the market by introducing a new differentiated variety. In this context each sub-market of a given vintage is saturated with a number of varieties such that the market share of each firm is barely sufficient to realise zero profits. We show that, in equilibrium, markets of the youngest varieties are characterised by a larger number of firms than markets offering older varieties. In particular, the lifetime horizon of each variety will be characterised by decreasing prices accompanied by increasing demand levels. Therefore, assuming a free entry condition, we obtain a result, which seems consistent with the continual process of creation and destruction of aesthetic patterns, observed in mass

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[4] This assumption applies to those sectors, such as fashion, in which the monopoly power gained by a successful aesthetic innovation is copyrighted by the "name", or "griffe" of the firm, in a similar way as an artwork piece is protected by the signature of the artist. In both cases fakes are illegal.

[5] This would be the same as to assume that on average only one firm per period is able to enter the market as a consequence of a successful R&D effort.

[6] Each type available in the market is characterised by a vintage date. The vintage provides a pseudo-dynamic interpretation of the model, which is static in nature. In equilibrium, the price set by a firm producing a good of vintage v one period later will be the same price set in the current period by the firm operating in the market of vintage (v +1). Therefore, the equilibrium number of varieties corresponds to the lifetime of each single variety.

consumption societies, where the highest demand levels for a single good are associated with a "sale", that concludes its lifetime cycle.

2. The commodity index under quality vs. novelty differentiation

To model preferences that exhibit both love for variety and love for novelty, we start from a general specification of the market commodity space defined by a matrix

$\mathbf{X} = \{x_i(\mathrm{v})\}$; $i = 1, 2, ...$; $v = 0, 1, ...$

$$\mathbf{X} = \begin{bmatrix} x_1(0) & x_1(1) & \dots & x_1(v) & \dots \\ x_2(0) & x_2(1) & \dots & x_2(v) & \dots \\ \vdots & \vdots & & \vdots & \\ x_i(0) & x_i(1) & \dots & x_i(v) & \dots \\ \vdots & \vdots & & \vdots & \end{bmatrix}$$

where the generic element, $x_i(v)$, represents the variety i of vintage v. The dimension of **X** is given by the number of firms ($n(v)$) populating each sub-market by the number of sub-markets T, each supplying differentiated types of a given vintage. The dimension of **X** is endogenous, and depends on the assumed market structure. The **X** space is characterised by goods that imperfectly substitute for each other. In addition, we assume that each variety displays peculiar characteristics, which are specific to the period since it was first put on the market. These vintage-specific features introduce a vertical dimension of differentiation which, in principle, reflect either a process of improved quality of goods or a process of aesthetic renovation. It seems reasonable to assume that these two alternative dimensions of the product innovation are perceived distinctively by consumers. This implies that aesthetic attributes and quality standards of goods should enter the utility function differently. To synthesise the **X** space through a commodity index we proceed first by aggregating varieties along the vintage dimension, deriving two alternative procedures that account for quality and aesthetics. Then we aggregate horizontally in a standard manner.

Let $0<\varepsilon<1$ be the average degree of substitution between any pair of goods in the market commodity space. Consider the i-th row of **X**; we suggest the following index (x_i^Q) to be appropriate, when the vintage dimension reflects the quality progress of a given variety:

$$x_i^Q = \left[\sum_v (1+\lambda)^{-v\varepsilon} x_i(v)^{\varepsilon}\right]^{\frac{1}{\varepsilon}} \qquad [1]$$

On the other hand, when the vintage dimension reflects the aesthetic pattern evolution, the following alternative index (x_i^N) is appropriate:

$$x_i^N = \left[\sum_v (1+\lambda)^{-v} x_i(v)^{\varepsilon}\right]^{\frac{1}{\varepsilon}} \qquad [2]$$

the discount factor λ in [1] and [2] captures two kind of obsolescence. In [1] it reflects the ageing of goods due to the better quality of the most recent varieties. In [2] it measures the distance, in terms of aesthetic features, of a given variety from the most on fashion one.

To motivate the employment of x_i^N as a proper index to capture the aesthetic obsolescence of goods, we consider [1] and [2] as varieties tend to be independent (ε→ 0). We get two different Cobb-Douglas specifications:

$$\lim_{e \to 0} x_i^Q = \prod_v x_i(v)^q \qquad \text{where} \quad q = \frac{1}{T} \tag{3}$$

$$\lim_{e \to 0} x_i^N = \prod_v x_i(v)^{q(v)} \qquad \text{where} \quad q(v) = \frac{(1+l)^{T-v}}{\sum_{v'} (1+l)^{v'}}; \quad \frac{\partial q(v)}{\partial v} < 0 \tag{4}$$

Since quality assessments are made in relative and not in absolute terms, the vintage effect disappears as goods tend to be independent. In other words, it is common evidence that individuals can weigh the quality level of a given good only in comparison with similar goods able to satisfy the same need. As a result, with independent goods the asymmetry in [1] vanishes and consumers allocate a constant fraction 1/T of their income resources for each of the available commodities.

On the other hand, the aesthetic dimension of commodities may be still comparable among independent goods. It might be considered an idle question to ask which, between a Giotto painting and petrol can, is characterised by the highest quality in a physical sense. On the contrary, it might have sense to submit Giotto and petrol can to a pure aesthetic judgement – and in a post-pop art society it cannot be quite taken for granted a preference for Giotto! In particular, as the aesthetic pattern of goods is characterised along a vintage dimension, potentially we can account for two phenomena, strictly connected, and crucial to the current mass consumption pattern: fashion and love for novelty.

Now, under the profile of fashion and novelty, the observed behaviours lead us to admit that even independent goods are comparable. Therefore, specification [2], considered when goods are independent in the limit, formalises the idea that modern consumers are willing to allocate relatively more resources to the newest good, to the extent they are perceived as most on fashion (or trendy) and/or most distinguished as novelties.

For the above explained reasons, we consider [1] to be an appropriate index when imperfect substitutes are differentiated along a quality dimension; whereas, specification [2] is consistent with imperfect substitutes vertically differentiated as far as their fashion/quality character is considered. Finally, the two aggregate commodity indices synthesising the **X** space under the two alternative interpretations of λ are obtained summing x_i^Q and x_i^N in a standard way along the number of brands available:

$$c_j = \left[\sum_i \left(x_i^j \right)^e \right]^{\frac{1}{e}} \quad ; \qquad j = Q, N \tag{5}$$

We want to study the different interpretation of λ as preference for quality opposed to λ as preference for novelty.

λ as preference for novelty is a complex psychological parameter which results from the cultural, social, and moral ground that surrounds and characterises individuals in a given historical time. On the other hand, the preference for quality derives from the rational effort to objectively evaluate technical features of commodities, such as safety, handiness, maintenance costs and so on, which depend on the profit maximising strategy of firms. In this sense we might say that the preference for quality is a parameter endogenously determined by the evolution of the market, whereas the preference for novelty derives from a more general evolution of the society as a whole.

3. The demand side of the model

A single representative consumer, whose preferences exhibit both love for variety and love for novelty, describes the demand side of the model. The former quality implies that individual are better off spreading a given amount of resources among a variety of differentiated goods, instead of allocating it on a single variety. The latter one entails that newer types are more desirable than older ones, in the sense that consumers gradually distaste goods as they move away from the time of their invention.

We first assume that T sub-markets supply T imperfectly substitutable varieties of vintage $v = 0, 1, ..., T - 1$. We will consider the opposite case in section 6, where imperfect substitutes of the same vintage can freely enter the market. Under the assumption of a single firm operating in each of the T sub-markets, the **X** space reduces to a row vector $\mathbf{X} = [x(0)\ x(1) \ldots x(v) \ldots x(T\text{-}1)]$. In this case the aggregate commodity c reduces to

$$c_N = \left[\sum_{v=0}^{T-1} (1 + l)^{-v} x(v)^e \right]^{1/e}; \qquad l > 0; \quad 0 < e \leq 1. \qquad [6]$$

Again, the λ parameter represents the rate of preference for novelty. It captures the psychological attraction of consumers towards varieties that enter the commodity space with the label “new” or “novel” attached to them. In other words, λ represents the rate at which types of a given brand become less valued due to the fact that at each period newer varieties are available[7].

The choice problem faced by the representative consumer can then be stated as follows (we suppress the N subscript):

$$\begin{aligned} &\max \quad u(c) \\ &s.t. \quad \sum_{v=0}^{T-1} p(v) x(v) = E \end{aligned}$$

where $u(.)$ is a utility function with standard properties, $p(v)$ is the price of type $x(v)$, and E is the constant fraction of total income resources allocated to the commodity space **X**[8].

The solution of the above static maximisation problem yields the demand function for the good of vintage v:

$$\begin{aligned} x(v) &= \frac{E}{P} \left[(1 + l)^v p(v) \right]^{-s} \\ P &= \sum_{v'=0}^{T-1} (1 + l)^{-s v'} p(v')^{1-s} \end{aligned} \qquad [7]$$

[7] Middleton (1986) proposes a theoretical apparatus to model the preference for subjective novelty based on experimental psychology.

[8] We are implicitly assuming a Cobb-Douglas specification of a general utility function, whose arguments are the varieties in **X** through the aggregate index c and a numeraire commodity collecting all the other existing goods.

where $\sigma = 1/(1- \varepsilon)$ is the elasticity of substitution between pairs of varieties, and P is the weighted sum of the purchasing power of one unit of nominal expenditure allocated to all the available varieties[9].

The price elasticity of demand relevant to the firm producing $x(v)$ is then:

$$e(v) = -\left[s + (1-s)\frac{p(v)x(v)}{E} \right] \qquad [8.1]$$

or, substituting from [7]:

$$e(v) = -\left[s + (1-s)\frac{(1+l)^{-sv}\, p(v)^{1-s}}{P} \right] \qquad [8.2]$$

Equation [8.1] and [8.2] illustrate the sources of market power enjoyed by firms. The price elasticity of demand is higher the lower is the elasticity of substitution σ and the larger the fraction of E allocated to $x(v)$. In particular, the first component of $\varepsilon(v)$ measures, from the standpoint of consumer's preference, the average degree of physical differentiation between pairs of varieties, which is exogenous. Instead, the second component of $\varepsilon(v)$ shows that the decline of the market share due to the ageing of goods depends on the price strategy set by firms.

Furthermore, the second component of the price elasticity cannot be disregarded even for an increasingly large number of firms[10]. Since the terms in the price index are non-negative we apply the criterion of ratio to investigate the convergence property of P. Sufficient condition for P to converge is

$$\lim_{v \to +\infty} (1+l)^{-s} \frac{p(v+1)}{p(v)} < 1$$

which is always satisfied, as we will show (section 4) that firms optimally choose to decrease prices at a rate greater than $[(1+\lambda)^{\sigma/(1-\sigma)} - 1]$ [11].

In the next section we show how the behaviour of firms determines the optimal path of decay of their market share, as goods become progressively old-fashioned.

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9 To gain more interpretation of P, let consider the indirect utility function $V = E\, P^{1/(\sigma - 1)}$. Thus, $P^{(\sigma - 1)}$ represents the average cost of acquiring one unit of indirect utility which is precisely P when $\sigma = 2$.

10 The effects of the aggregate price index on the price elasticity can be found in Yang and Heijdra (1993) considering symmetric preferences. However, the assumption of symmetry has the implication that the elasticity approaches a constant as the number of firms increase.

11 It is worth noting that assuming the set of potential varieties to be a continuum would give price elasticity precisely equal to σ, involving misleading conclusions about firm's behaviour. See Helpman and Krugman (1986, page 119).

4. Price setting and the ‘evolution’ of demand

In a monopolistically competitive setting the T firms operating in the market maximise profits setting prices such that marginal costs are equalised to marginal revenues. This condition for the price of good $x(v)$ can be expressed in terms of the price elasticity of demand:

$$p(v) = w\left[1+\frac{1}{\varepsilon(v)}\right]^{-1} \qquad [9]$$

where w is the constant marginal cost. By replacing $\varepsilon(v)$ with its expression (equation 8.2) we obtain an equation of degree σ, that embodies the optimal pricing rule followed by firms:

$$p(v) = \frac{\sigma}{\sigma-1}w + (1+\lambda)^{-v\sigma}\; p(v)^{1-\sigma}\;\frac{p(v)-w}{P} \qquad [10]$$

The optimal price is equal to the Dixit-Stiglitz price plus an additional factor, which is higher the younger is the variety[12].

As it is not possible to obtain an explicit solution of the above equation, we work out the optimal price strategy of firms by examining the behaviour of γ_p, the price change rate between $(v + 1)$ and v. From equation [9] we obtain:

$$\gamma_p \equiv \frac{p(v+1)-p(v)}{p(v)} = \frac{\varepsilon(v)+\sigma}{\varepsilon(v)[1+\varepsilon(v+1)]}\left[(1+\gamma_p)(1+\gamma_x)-1\right] \qquad [11]$$

where γ_x is the demand change rate between varieties of vintage $(v + 1)$ and v. The first factor in equation [11] is positive; as a consequence the sign of γ_p depends on the sign of $[(1+ \gamma_p)(1 + \gamma_x) - 1]$:

$$\gamma_p \gtreqless 0 \quad \leftrightarrow \quad (1+\gamma_p)(1+\gamma_x)-1 \gtreqless 0 \qquad [12]$$

From the demand equation (equation 7) we derive the expression for γ_x as a function of γ_p:

$$1+\gamma_x = (1+\lambda)^{-\sigma}(1+\gamma_p) \qquad [13]$$

Substituting equation [13] for γ_x into condition [12] we get:

$$\gamma_p \gtreqless 0 \quad \leftrightarrow \quad (1+\gamma_p)^{1-\sigma}(1+\lambda)^{-\sigma} \gtreqless 0 \qquad [14]$$

As $\sigma > 1$ and $\lambda > 0$, $\gamma_p \geq 0$ can never be verified. Therefore, in equilibrium γ_p must be negative and greater than:

[12] Fisher *et al.* (1962) estimate that the 25% of the purchase price of a new car includes the cost of its aesthetic novelty.

$$\gamma_p > (1+\lambda)^{\sigma/(1-\sigma)} - 1$$

Given that it is optimal to decrease prices, as goods become progressively outdated, the demand change rate behaviour γ_x can be deduced from equation [11]. By noting that the fraction is a number less than one, we have that:

$$\gamma_p > (1+\gamma_p)(1+\gamma_x) - 1$$

which, in turn, implies that γ_x be negative.

The behaviour of demand is fundamentally driven by the lure exerted on consumers by new varieties entering the market. The consequent distaste for older types erodes progressively firms' market share. Firms react by making only partial price compensation to consumers, and let their monopoly power then decline. In other words, emphasising the pseudo-dynamic side of the story, each firm knows that each period a new variety enter the market. As a result the objective to protect its market share through full price compensation is not feasible. It is optimal to partially offset the ageing of goods with successive price reductions in order to maximise overall profits over the firm's lifetime.

Finally, the equilibrium number of varieties (or, equivalently, the optimal lifetime of the firm) depends on the technology prevailing in the industry. We take a fixed cost to be paid by each firm operating within the market. Given that prices and demand decrease as the goods grows older, the presence of some fixed factor of production entails that the older the vintage the higher the average costs faced by firms. This, in turn, implies that prices and average costs as a function of *v*, will intersect at a point that determines the equilibrium value of *T*, the number of varieties, or, which is the same, the life duration of a single variety.

In next section we will consider a special case of the model to work out an explicit solution to *T*.

5. The optimal brands' life

In this section the optimal number of varieties supplied in the market, or equivalently, the optimal life of each variety will be determined[13]. A firm supplies a brand as far as costs do not exceed revenues. We can depict a price curve describing the optimal price setting for all brands, with vintage $v = 0, 1, ..., (T-1)$. Moreover, a corresponding average cost curve can be obtained for the same types. From the results obtained in section 4, it is easy to show that the former curve is decreasing and the latter one is increasing, as the brand becomes older. There will be a variety for which price is equal to average cost, indicated at the intersection of the price curve and the average cost curve. Older types do not guarantee non-negative profits, so exit the market is the optimal action.

In order to obtain an explicit solution we assume $\sigma = 2$[14]. Moreover, we consider normalised prices, setting $p(0) = 1$. As a consequence, we consider relative prices. *E, CF*, and *w* are expressed in relative terms as well. For example, our result stating that optimal prices

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[13] Rink and Swan (1979) investigate the strategy of introducing aesthetic variations in a given good to extend its 'life cycle'.

[14] A second order equation is obtained. Only one solution is admitted, since the other one does not guarantee a unit relative price of the good with $v = 0$.

are greater than the constant Dixit-Stiglitz prices, which implies $p(v) > 2w$, restricts now the marginal cost w to be less than one half. For simplicity we do not change the notation, so from now on, all variables are normalised. It is easy to show that

$$
\begin{aligned}
&P = \frac{1-w}{1-2w} \equiv f \\
&x(v) = \frac{E}{f}(1+l)^{-2v}\, p(v)^{-2} \\
&p(v) = w\left[1+\left(1+\frac{1}{4}\frac{(1+l)^{4v}}{f^2 w^2}\right)^{1/2}\right] + \frac{1}{2f}(1+l)^{2v}
\end{aligned}
$$

The oldest firm $v = (T-1)$ realises zero profits. In order to find T, we substitute the above expressions in the firm's zero profit condition. This in turn is equal to the number of varieties, which is

$$
T = 1 + \frac{\ln\left[1-\left(\frac{CF}{E}\right)^2\right] - \ln\left(4wf\,\frac{CF}{E}\right)}{2\ln(1+l)}
$$

T is positive and greater than 1 for CF sufficiently smaller than E. In particular, the time-life of a single variety or, equivalently, the number of brands depends both on parameters characterising preference and technology. The effect of a higher degree of preference for novelty is a lower number of brands[15]; higher expenditure levels rises T. On the technology side, higher marginal costs and fixed costs reduce the time-life of goods.

6. A model of free entry

So far we have assumed that firms face only the competition of types with different vintages provided that in each sector of vintage v only one firm is present.

We can ask which is the possible behaviour when (horizontal) monopolistic competition within sub-markets is admitted with an assumption of imperfect substitution. The commodity space is now described by the general specification **X**, so that we proceed as showed in section 2 to obtain the aggregate commodity index. The resulting consumer's maximisation problem can be stated as follows:

$$
\begin{aligned}
&\max \quad u(c) \\
&s.t. \quad \sum_{v=0}^{T-1}\sum_{i=1}^{n(v)} p(v)x_i(v) = E
\end{aligned}
$$

[15] By numerically simulating the model for different values of the elasticity of substitution σ we can state that the increase of the degree of preference for novelty always implies a decrease in the optimal life for all brands. Results for different σ show only scale effects without qualitative changes in our conclusions.

where

$$x_i \equiv \left[\sum_{v=0}^{T-1} (1+l)^{-v} x_i(v)^e \right]^{1/e}$$

$$c \equiv \left[\sum_{i=1}^{n(v)} x_i^{\,e} \right]^{1/e}$$

In the Spence and Dixit-Stiglitz framework, commodities enter the utility function symmetrically so in equilibrium it is true that for all v $x_i(v) = x_j(v) = x(v)$ and $p_i(v) = p_j(v) = p(v)$, when firms face the same costs. It is easy to check that, similarly as in equation [7], the demand for any variety i of vintage v is

$$\begin{aligned} x_i(v) &= \frac{E}{P}\left[(1+l)^v p_i(v)\right]^{-s} \\ P &= \sum_{v'=0}^{T-1} n(v')\left[(1+l)^{-sv'} p(v')^{1-s}\right] \end{aligned} \qquad [15]$$

where P is the aggregate index, which measures the purchasing power of one unit of expenditure E in terms of utility. The corresponding price elasticity is

$$e(v) = -\left[s + (1-s)\, n(v) \frac{p(v)x(v)}{E} \right] \qquad [16]$$

The standard optimal pricing condition, marginal costs equal to marginal revenues, provides the following equation:

$$-(1-s)n(v)(1+l)^{-sv}\frac{p(v)^{2-s}}{P} + (1-s)p(v) + (1-s)wn(v)(1+l)^{-sv}\frac{p(v)^{1-s}}{P} + sw = 0 \qquad [17]$$

As we cannot work out an explicit solution for any σ, we consider the relevant variables (p, n, and x) expressed in terms of change rates (γ_p, γ_n, and γ_x respectively).

All the change rates can be calculated from a three-equation system given by: *i*) the necessary first order condition to find the maximum profit; *ii*) the optimal demand of any good of vintage v that warrants a maximum utility level; iii) the zero profit condition. The conditions provide the following relations respectively

$$\begin{aligned} g_p &= a\left[(1+g_n)(1+g_p)(1+g_x) - 1\right] \\ g_x &= (1+l)^{-s}(1+g_p)^{-s} - 1 \\ g_p &= -r\frac{g_x}{1+g_x} \end{aligned} \qquad [18]$$

where

$$a \equiv \frac{e(v)+s}{[1+e(v+1)]e(v)} \qquad 0<a<1$$

$$r \equiv \frac{CF}{wx(v)+CF} \qquad 0<r<1$$

The non-linear system [18] cannot be solved for any $\sigma > 1$. However, we can state some general insights without solving it. It is easy to check that the system implies that only one of the following set of inequalities is consistent with the conditions in [18]:

$$\{\gamma_n > 0\,,\ \gamma_p > 0,\ \gamma_x < 0\}$$

$$\{\gamma_n < 0\,,\ \gamma_p < 0,\ \gamma_x > 0\}.$$

At the moment, we can state that price lowers (increases) and the market share increases (decreases) as the good becomes older if the number of firms is higher (lower) in relatively young sectors. But we do not know if the number of firms increases or decreases with the vintage.

We can show in the particular case where $\sigma = 2$ that the number of firms in the old sector is lower than the number of firms in the young sector by exploiting the condition of equal profits in all (old and new) markets when firms set the optimal price.

For $\sigma = 2$ equation [17] can be easily solved

$$p(v) = \frac{n(v)(1+l)^{-2v} + 2fwn(0) + \left[n(v)^2(1+l)^{-4v} + 4f^2w^2n(0)^2\right]^{1/2}}{2fn(0)} \qquad [19]$$

where $f \equiv (1-w)/(1-2w)$. To have a real solution the following condition must be satisfied for all $v > 0$:

$$0 < w \le \frac{1}{2} - \frac{1}{2}\left[1-(1+l)^{-2v}\right]^{1/2} \qquad [20]$$

The marginal cost has to be lower than a certain value as a necessary condition to ensure the existence of both old and young markets. If the condition is not verified only the youngest variety will be supplied by each of the $n(0)$ survived firms at the Dixit-Stiglitz price.

We assume for simplicity that $v = 1$ and denote the share of the number of old firms to the number of young firms with N, $n(1)/n(0) \equiv N$. Then equation [19] becomes

$$p(1) = \frac{N(1+l)^{-2} + 2fw + \left[N^2(1+l)^{-4} + 4f^2w^2\right]^{1/2}}{2f} \qquad [21]$$

Again, as in section 5, we consider the relative price of good of vintage $v = 1$ imposing the price of the newest variety equal to one, $p(0) = 1$. Demand for goods $v = 0$[16] and $v = 1$ are respectively given by the following expressions:

[16] To guarantee the existence of several firms with $v = 0$, $n(0) \ge 1$, it suffices that the fixed cost of production CF be lower than (or at least equal to) $E(1-2w)$.

$$x(0)=\frac{E}{f\,n(0)} \qquad [22]$$
$$x(1)=x(0)[(1+l)p(1)]^{-2}$$

We insert equations [21] and [22] in the arbitrage condition of equal profits in all markets, $\pi(1) = \pi(0)$, obtaining the following equation

$$(1-w)(1+l)^2\,p(1)^2 = p(1)-w \qquad [23]$$

Expression [21] for the price of age 1 can be inserted into equation [23] to get a non-linear equation, which can be solved by setting

$$A \equiv N(1+l)^{-2}+\left[N^2(1+l)^{-4}+4f^2w^2\right]^{1/2}$$

We find two solutions for A. Solving back for N we find

$$N=\frac{(1+l)^2}{2A}\left(A^2-4f^2w^2\right)$$

so we have two roots for N, a negative and a positive one. We reject the former one. The latter solution is the following

$$N \equiv \frac{n(1)}{n(0)}=\frac{\left[1-4w(1-w)(1+l)^2\right]^{1/2}}{1-2w}$$

For its existence as a real number, it needs to satisfy the condition

$$1-4w(1-w)(1+l)^2>0$$

which corresponds to condition [20] when $v = 1$. We have already remarked that the condition guarantees the existence of varieties born at different dates. We also know that $(1 – 2w) > 0$ (or $w < ½$). Therefore N is a positive number and we can easily show that $N < 1$. Therefore, the number of firms in the old market with age $v = 1$ is smaller than the number of firms in the youngest market with $v = 0$. In general, we have

$$\frac{n(v)}{n(0)}=\frac{\left[1-4w(1-w)(1+l)^{2v}\right]^{1/2}}{1-2w}$$

where again $n(v) < n(0)$. Moreover, it is also easy to show that $n(v) > n(v + \tau)$, for all $\tau > 0$, implying that the number of firms' change rate is always negative, $\gamma_n < 0$.

7. Concluding remarks

In this paper we have modelled a market in which a single good is offered in many varieties, differentiated along two dimensions. The first relates to the process of physical differentiation of goods. The second captures the effects of ageing of goods, as they became progressively old-fashioned, due to the obsolescence of their aesthetic features.

On the demand side, we have extended a standard specification of preference to include both love for variety and love for novelty. This latter aspect has been introduced through a particular discount rate that weights the utility derived from goods of different vintage. Therefore, our setting is able to represent an important aspect of the observed pattern of consumption, where the lifetime of goods is largely unrelated to their physical duration, but depends decisively on the aesthetic cycle determined by the phenomenon of fashion.

In the first part of the paper we assume that the market is divided into several sub-markets dominated by a single firm, that produces a variety of a given vintage. Within this context the market power of each firm, gained through physical and aesthetic innovation, is progressively eroded by the entry of new varieties. This effect is captured by the elasticity of demand, which is the sum of two elements. The first, which measures the average degree of physical differentiation, and the second, which shows the decline of market power as time passes due to the increasing distaste for older types. The latter element is not worthless even if the number of varieties goes to infinity.

The optimal firms' behaviour consists of making only partial price compensation to consumers due to the ageing of goods, so the objective of maintaining the market share constant is rationally not achieved. The decline of demand is transferred into an expansion of average costs. The decreasing performance of prices and the increase of average cost, as goods become older, implies that the equilibrium number of brands is finite. Or, conversely, reading the result in a pseudo-dynamic way, the optimal life of firms is finite.

In the second part of the paper we explore the implication of the model under a free entry condition. In this setting each market is populated by a given number of firms, which produce horizontally differentiated goods of a given vintage.

Monopolistic competition among varieties of the same age causes zero profits. In this framework assuming a particular value of the elasticity of substitution, we have shown that the optimal price strategy is similar to that one applied in the monopoly model. Each firm's price declines, as time passes. It cannot resist both the declining of market power due to the ageing of the good and the additional market power deterioration due to the entrance of varieties of the same age. The lifetime of products is shorter than the former model of monopoly. Furthermore, the number of firms is smaller in old sectors than ones in the new sectors, so the market is populated by a relatively higher number of new varieties, at expenses of the old ones. Because of price decreasing and relatively youth of disposable varieties, the welfare improves with respect to a world without free entry.

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