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Variety, growth and demand

Pier Paolo Saviotti

INRA-SERD, Université Pierre Mendés-France, BP 47, 38040 Grenoble, Cédex 9, France
(e-mail: saviotti@grenoble.inra.fr)

Abstract. A dynamic model of demand compatible with a changing composition of the economic system is presented in this paper. Consumers are not expected to have completely formed preferences for radically new objects of consumption. Consumers adopt new goods or services ,created by innovation, only if three barriers are overcome: 1) a critical (minimum) level of income, 2) critical human capital, 3) critical fitness. However, even a new good or service with a fitness higher than that of pre-existing ones, will not be immediately adopted. Consumers'.limited knowledge will slow down the rate of adoption of any new good or service.

Key words: Demand – Critical income – Imitation – Uncertainty – Human capital

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1 Introduction

The underlying motivation of this and of a number of other papers written by the author is the role of qualitative change in economic development. Modern economies contain a large number of entities (products, services, methods of production, competencies, individual and organisational actors, institutions), which are qualitatively novel and different with respect to those existing in previous economic systems. In other words, the composition of the economic system has changed enormously during economic development. The observation that there has been a very great deal of qualitative change in economic development would probably not be denied by any economist. Where, however, there would be differences is about the role of qualitative change. In order to facilitate the discussion two extreme hypotheses can be introduced: first, qualitative change is an accidental by product of economic development; second, qualitative change is an essential component of economic development. The first hypothesis is the one implicitly present in most economic growth models, where qualitative change is not denied, but it can only be accepted ex-post. The second hypothesis is central to a Schumpeterian approach, in which radical innovations change the nature of the economic system and allow the long term continuation of economic development. In some previous papers by the author of this, it is argued that the concept of variety is crucial in order to overcome the gap between modelling without qualitative change and more descriptive approaches which can encompass this phenomenon (Saviotti, 1988, 1991, 1994, 1996; Saviotti and Mani, 1995). The most important considerations about variety contained in those papers are summarised in the following section. The main objective of this paper, however, is the analysis of the implications of variety for demand. Demand is seen here not on its own but as one of the components of economic development. As it will be pointed out in Sect. 2, one of the potential bottlenecks in economic development is constituted by the imbalance between productivity growth and demand growth within given sectors. A way to overcome such bottleneck is represented by the emergence of new sectors, providing compensation for the displacements caused by the imbalance in pre-existing sectors. Long-term economic development and growth then depends on the ability of the economic system to create the new goods and services leading to new sectors. Yet such new goods and services must be purchased by consumers if they are to contribute to economic development. The dynamics of development of demand is thus a fundamental determinant of economic development.

2 The role of variety in economic development

The considerations in this section are a summary of previous papers (Saviotti, 1994, 1996). Qualitative change is here represented by variety, defined as ’the number of actors, activities and objects necessary to characterise the economic system’. Such definition, while not being perfect, captures the essential features of qualitative change and can be the basis of quantitative and analytical treatments of economic development. The relationship between qualitative change and economic development is based on two hypotheses:

Hypothesis 1: The growth in variety is a necessary requirement for long-term economic development.

Hypothesis 2: variety growth, leading to new sectors, and productivity growth in pre-existing sectors, are complementary and not independent aspects of economic development.

These have to be considered very strong working hypotheses, having a considerable empirical and theoretical support, but not yet definitively proved. Furthermore, these hypotheses can be valid in the long run and at sufficiently high levels of aggregation, for example that of a national economy.

The justification for these hypotheses comes mainly from Pasinetti's work (1981, 1993). The bottleneck created by the imbalance between demand saturation and continuous productivity growth in pre-existing sectors can be compensated by the emergence of new sectors. On the other hand, the resources required to perform search activities and thus to create new sectors can only come from productivity improvements in pre-existing sectors. In this sense the complementarity between variety growth and productivity growth in pre-existing sectors bears a considerable similarity to that between productivity growth in agriculture and investment in the new industries during the process of industrialisation (see Kuznets, 1965; Landes, 1998). Further support for the role of variety in economic development comes from Romer's models (1987, 1990) that include growth in the number of capital goods amongst the consequences of innovation.

3 Variety and demand

The qualitative change taking place in economic development creates new goods and services. Consumers have available a much wider range of these than was the case in previous economies. The demand theory that is normally presented in textbooks can deduce the behaviour that follows from a given set of preferences. Preference formation is not considered a legitimate subject of analysis for economics, but it is left to other disciplines in the social sciences. Such an approach would be perfectly adequate if consumers did not change. However, if we are concerned with long term economic development the assumption of static consumers is inadequate. As Georgescu-Roegen (1954) remarked a long time ago 'man is a continuously changing structure'. Unless we assume that they were already present in mankind before objects of consumption came into existence, wants and preferences have to be formed during the process of economic development. The problem of wants and preference formation becomes particularly urgent, if, as Schumpeter tells us, radical innovations are essential for the long-term continuation of economic development. In fact we can argue that the more radical an innovation is, the less predictable its properties and uses are. Neither consumers and users on the one hand, nor producers on the other hand, can always estimate what goods and services will be demanded. Perhaps the most spectacular example of failure to estimate demand occurred in the case of mainframe computers, the total demand for which in both the USA and the UK was assessed at 4-5 machines, to be greatly outperformed by real demand. This was not just a failure by producers or marketing experts to estimate a demand which was clearly there, but a case in which the demand itself was not formed because the potential users did not know about the properties of the object they were later to demand. In general, we can assume that the mental categories required to understand the properties of a good/service and the ways in which it can be used are not there before the good/service is created. Therefore, wants and preferences will be created gradually during the lifecycle of a good/service, and the mechanisms of their formation are a problem at least as interesting as the behaviour that can be deduced from them, if we are interested in long term economic development (about this point see also Teubal, 1979; Teubal et al., 1991, 1994). In a recent paper Aversi et al. (1999) summarized a considerable evidence that preferences are constructed through the very process of deliberation (p. 362) and that their construction corresponds to a satisficing inferential machinery (ibid.). Moreover, habits and routines coexist with deliberative decision processes (p. 363). In general we can say that demand theory may require a number of modifications if our main emphasis is on long term behaviour. We now proceed to discuss some of the implications of the previous considerations on variety for demand theory.

3.1 A hierarchical theory of wants and preferences?

A hierarchical theory of wants has been discussed by several amongst the leading neo-classical economists, such as Walras (1896, 1988), Jevons (1924), Marshall (1949), but it has received its most explicit and detailed treatment in the work of Menger (1950). Such theory implies that wants can be ranked in order of absolute importance, with most basic wants at the bottom of the list (lower wants) and with the most sophisticated (higher wants) at the top. For example, the uses of corn for an isolated farmer can be ranked in order of importance (Menger, ibid., p. 129): food, seeds for next season, alcoholic beverages, fodder, growing parrots. Of course, we expect that the list of wants of the average individual will grow longer as his/her income rises during economic development. In this sense we can imagine preferences to be a pre-established ranking order that consumers apply to any choice they make. For example, when they have to choose between two goods they compare the goods to the ranking order and allocate to them a corresponding share of their income. A problem arises when a new good is encountered. Then the ranking order has to be modified to include the new good. The problem would be relatively simple if all new goods and services corresponded to higher wants, that is, if they had to be added 'on top' of the existing ones. However, we cannot expect the actual ranking order of goods and services to be unique for all individuals. Like other types of economic agents consumers are heterogeneous. Furthermore, we can expect that, as income per head rises individual consumption will become more and more differentiated, giving rise to a divergence of consumers'choices, thus increasing their heterogeneity. Even though this divergence will be limited by imitation, and even though the wants of individuals will tend to converge more if they live within the same culture than in different ones (Georgescu-Roegen, 1954, p. 517), we cannot assume that at higher levels of economic development the order of wants will be the same for all individuals. Second, if mechanisms of demand formation show increasing returns to adoption, demand development is likely to show path-dependence (Arthur, 1988, 1989). Thus, an initial choice of some wants, however 'rational', might lead to a non unique demand development path. Moreover, another form of path dependence may be induced by past patterns of consumption. If the goods and services that were consumed in the past increase differentially the probability of consumption of some present goods, then a form of path dependence which originated in the past can be extended to the future (David, 1985). In summary, and remembering that these are preliminary considerations, we can point to the non-uniqueness of the ranking order of wants at high levels of economic development. A number of other implications for demand theory follow from the hypotheses on growing variety.

A hierarchical theory of wants and preferences can be translated into an analytical treatment by means of the concept of critical income. Critical income is defined (Bonus, 1973) as the minimum income level that a consumer would need to purchase a given good. From here onwards we will refer only to goods. Most of the considerations are in fact applicable to services. However, to simplify things in what follows we refer only to goods. Of course, we expect critical income to be low for very basic wants and to increase for higher level wants. However, the higher the level of the want the higher the uncertainty attached to it, this uncertainty being a measure of consumer heterogeneity. We can represent the relationship between critical income and the hierarchical level of the good/service purchased in the following way:

$$I_{c,i} = k_c\,(i \pm \sigma_i) = k_c\,(i \pm k_\sigma i) \qquad (1)$$

where:
$I_{c,i}$ = critical income for the consumption of good i; σ_i, = uncertainty attached to the good/service i; k_c, k_i = constants.

In fact what will then determine the rate of growth of a population of consumers is the difference between the actual income and the critical income for the consumption of the good of level i.

3.2 Non satiety and growth of wants

Variety can only increase if consumers from time to time add new goods and services to their consumption baskets. This addition is not compatible with the non-satiety of wants usually assumed in demand theory. Such assumption, while useful for the normal analytical purposes of demand theory, is highly unsuitable for the analysis of long term economic development. In fact it is an assumption which can be valid only in the very short run and within limited ranges of quantities consumed. The reasons for the existence of non-satiety are diminishing marginal utility and increasing consumption costs. Consumption costs are due either to knowledge/information costs or to the costs arising from the externalities created by consumption. The consumption of goods requires always some knowledge and information, and this is particularly evident in the case of some new complex goods (e.g. computers, information on shares etc). The lack of this information and knowledge delays consumption. Furthermore, consumption creates externalities, which tend to limit the further development of the same type of consumption. For example cars create pollution and noise, which must be limited if further diffusion is to take place. Some externalities may be perceived ex-ante by consumers and act as a barrier to the beginning of the diffusion of some types of goods. The use of GMOs (genetically modified organisms) is a case in point. Clearly regulation has a very important role to play in the development of consumption by defining the conditions of use of goods to avoid or reduce negative externalities. These costs can be reduced or eliminated in a number of ways. Thus consumers' knowledge and information can be increased by means of advertising, education, specialised tv programmes and magazines, etc. Negative externalities can be reduced either by changing the conditions of production and use of goods or by regulation.

Satiety does not imply that the absolute quantities consumed will fall. If new goods and services are to be introduced into consumption patterns the percentage of the resources allocated to the previous goods has to fall. Old goods and services are likely to occupy a decreasing share of individual and household budgets, thus making room for the adoption of new ones.

Non satiety had been predicted in Gossen's *principle of satiable wants* (Georgescu-Roegen, 1954, p. 514). Two other principles can be combined with it to provide a basis for variety growth in demand theory. First, there is the *principle of subordination of wants*, due, in different forms, to Banfield (1844) and to Jevons (1924):

> . . . the satisfaction of every lower want . . . creates (Banfield)/ . . . merely permits (Jevons) the higher want to manifest itself. (Georgescu-Roegen, 1954, p. 514)

Second, there is the *principle of the growth of wants*: . . . not only does one have to reach satiety before the next one can manifest itself, but it appears that there is always a next want. (ibid., p. 514)

These two principles, combined with satiety, provide a microeconomic basis for the saturation of given wants and the increase in the overall number of wants. The two principles combined imply that the marginal utility of adding a new good to the pre-existing pattern of consumption is greater than that of adding an extra unit of a pre-existing good. The two principles are then compatible with utility maximisation. However, whether utility can increase indefinitely by adding any new goods is not clear. In spite of the previously mentioned means of increasing knowledge and of reducing costs and negative externalities some rigid barriers to consumption exist. For example, many goods cannot be consumed simultaneously, and the time consumers have available is finite. However, a consumer can establish an inter-temporal consumption pattern in which he/she consumes different goods at different times. Moreover, diffusion of new goods can continue through a growing differentiation of consumption. In advanced industrialised societies consumption patterns are very differentiated. At higher incomes the number of items present in individual budgets grows, with each item occupying a smaller and smaller fraction of the budget itself. Consequently, collective inter-temporal consumption is not subject to satiety to the same extent as the consumption of an individual good. The principle of the growth of wants, while not necessarily applicable to all future periods of economic development, seems a reasonable assumption for the recent historical past and for the foreseeable future.

3.3 The independence of individual utilities

In demand theory the utility function of a consumer is considered to depend only on the quantities or on the characteristics of the goods owned by him/her. Georgescu-Roegen (1965, 1970, 1976), criticised this assumption for what concerns peasant communities. According to him the choice function of a peasant in a village can be represented by $\psi(Y;Y_s)$, where Y is the quantity of goods/services owned by the individual and Y_s the effect of the village institutions on the behaviour of each village member. However, it is not obvious that this non-independence assumption applies only to peasant villages and that it becomes irrelevant for modern industrialised societies. According to Hirsch (1976) with increasing affluence people do not feel better off unless they are relatively better off. In other words, individual utilities depend on the *ratio* of the quantities of goods owned by an individual and of those owned by other members of the same society. A consequence of this interdependence of utilities is imitative behaviour. Individual consumers may imitate others who have already adopted either to reduce uncertainty or to gain status. The ultimate result is that individual choice depends on the ratio of the quantities of goods owned by an individual to those owned by the members of the same society.

An interesting analysis of interpersonal effects in consumer behaviour has been done by Granovetter and Soong (1986). They find that imitative behaviour can lead to ‘bandwagon’ and to ‘reverse bandwagon’ effects. In the former case the correlation between one’s purchases and those of the others is positive. Before purchasing a new good/service consumers wait for a given percentage (lower threshold) of other consumers to have done it. In the latter case the goods/services are purchased mainly for the status they confer. When adopters of a given good exceed a given percentage status seeking consumers switch out of it. A complex behaviour, only sometimes reducible to the one described by the classical demand curve, ensues.

3.4 Demand behaviour, uncertainty and learning

Especially in the case of radical innovations consumers and users are not fully aware of the properties and uses of the new goods. In these conditions consumers’ rationality is limited (Hall, 1994, p. 91), and the process of choice is subject to a great uncertainty, which creates a barrier to the adoption of new goods and services. Such uncertainty is higher for goods being the result of radical innovations than for those resulting from incremental innovations. Even when the utility afforded by the new good can increase total consumer utility more than the consumption of an extra unit of a pre-existing good, the uncertainty attached to the new good will slow down its adoption.

The barrier to the consumption of a new good can be overcome either by increasing consumers knowledge or by redesigning the good so as to reduce the barrier. In whatever way knowledge is acquired, demand formation takes place gradually and requires learning. The faster is the rate of qualitative change, the more new learning will have to take place as innovations emerge. The greater the novelty of a product, the less the potential consumer will be able to estimate how useful this new product will be. However, as consumers/users start using it, they will begin to learn the properties of the new product and how it can serve their purposes. The importance of learning by doing has long been known in economics (Arrow, 1962), (David, 1975). More recently Rosenberg (1982) pointed out that *learning by using* is important as well. Many improvements in the performance of some technologies take place as they start to be used. Customer feedback is essential in this respect (see also Von Hippel, 1976). Aspects of technological performance and reliability, such as service intervals, the progressive improvement of different parts of the technology (e.g. the engine and wings of an aircraft) are gradually improved due to information gathered by using the technology. This same information gathered through learning by using, allows users to improve their understanding of the performance of the technology for their purposes. The demand for a given technology is going to be influenced by learning by using. More specifically, the present demand for a product is based on learning how to use the services supplied by previous vintages of the same product. Alternatively one could say that consumers learn how to form expectations about the performance of given products. Thus, according to Clark (1985) consumers learn about new goods by 'interpreting' them with the concepts used for the old goods. Only gradually the new goods acquire an independent significance.

That the extent of learning required by consumers and producers is particularly high for radical innovations is a result of the *local character* of knowledge, which implies that individuals or organisations learn more easily knowledge similar to the one they previously held than completely new one. If we represent the learning process as the internalisation of external knowledge, we can express the local character of knowledge in slightly more formal terms by saying that the probability of learning new external knowledge is inversely proportional to the difference or distance between internal and external knowledge (Saviotti, Mani, 1995). The ability of both consumers and producers to judge the demand for a radical innovation at the beginning of its life cycle is subject to a particularly high uncertainty, because it involves completely new knowledge. The enormous flow of information being supplied in technical magazines and in the manuals accompanying consumer goods such as refrigerators, washing machines, hi-fi equipment, photographic cameras, personal computers, etc. is a partial solution to the problem of educating consumers, a function that Schumpeter had already predicted for entrepreneurs. Also, this knowledge is equivalent to the absorption capacity (Cohen and Levinthal, 1989, 1990) of firms on the producers' side.

Analytically the requirements for knowledge and learning can be represented by means of the human capital that consumers accumulate in the particular good

i. First of all there will be a barrier, because human capital needs to reach a minimum/threshold value in order for consumption to take place. Second, the actual value of human capital relative to the particular good considered can increase in the course of time due to various types of learning effects. We can represent the human capital relative to the consumption of good i as:

$$H_i = k_H \left(1 - e^{-\frac{\alpha_i q_i}{D_X D_Y}}\right) \tag{2}$$

and

$$H_i' = \left(H_i - H_{c,i}\right) \tag{3}$$

where:
H_i = human capital relative to the consumption of i; $H_{c,i}$ = minimum value of human capital required for the consumption of good/service i; $H_i^{'}$ = effective value of human capital than can be used for the consumption of i; D_x, D_y = distances in technical and service characteristics spaces between i and pre-existing goods; q_i = quantity of i consumed; k_H = constant determining the maximum value of human capital required for the consumption of good/service i that can be achieved; α_i = constant, determining the rate of accumulation of human capital useful for the consumption of i.

H_i' is the value of human capital that should enter into the equations for the dynamic development of the demand for the good i, since it is the excess over the minimum/threshold value required for consumption. α_i represents the ability of consumers to learn the knowledge required to use i. Of course a higher value of α_i would lead to faster diffusion rates for new good and would reduce a bottleneck to economic growth. In the meantime this ability to learn is related to the past human capital of the consumer. Both a general ability to learn and the past use of goods similar to i should increase α_i.

A second way in which the uncertainty bottleneck can be overcome is by means of routines or imitation. For the time being the two are treated together, since they both allow the consumption of the good in presence of imperfect knowledge about it. Routines are a knowledge saving device (see for example Nelson and Winter, 1982), providing a constant response to environmental stimuli contained within a given range. Thus, as long as the uncertainty attached to new goods remains within a pre-determined range, consumption is in principle possible. How actual consumption routines are created is an important research subject. In this paper the most important routine creating mechanism is imitation. Even when non adopters' knowledge about a new good is limited, the fact that other consumers have already adopted it constitutes a powerful inducement to adopt. Thus the example of those who have already become adopters constitutes an information and knowledge saving device. Imitative behaviour, which in the previous section was considered the result of the interaction of different consumers, reduces the amount of learning required to purchase particular goods. Individuals do not have to be fully aware of the properties of goods to the extent that they choose by imitating their neighbours or the people whose consumption patterns they read about. Such behaviour has been the object of research both in diffusion models (see Stoneman, 1996; Metcalfe, 1988 etc) and in the marketing literature about the product life cycle. In spite of the differences amongst the different models of innovation, in general the dynamics of this phenomenon leads to sigmoid adoption curves for most goods. Such curves imply than when an income level which allows the consumption of a given good exists, demand for it will grow at a growing rate first, until saturation is eventually reached. That is, the presence of uncertainty and imitative behaviour is at least compatible with demand saturation, which coupled with productivity growth can lead to under-utilisation of resources (see Sect. 2), with adoption being slow at the beginning, then gradually accelerating, and finally slowing down when saturation is approached. We can expect a similar behaviour in the case of routine formation. According to Feichtinger (1995) (but see also Becker and Murphy, 1988; Becker, 1992) addictive behaviour in presence of a threshold gives rise to a sigmoid adoption curve. In fact addictive behaviour can be considered an extreme case of habitual behaviour, of which routines are an example. While the treatment of this subject given here is obviously insufficient, for the moment we can consider that imitation is an example of habitual behaviour leading to dynamic properties similar to those that we can predict for habitual behaviour in general.

Summarising this section we can say that the formation of demand requires learning, that learning can occur by means of different mechanisms, one of which is imitation, that imitation reduces uncertainty, couples the utility/choice functions of different consumers and leads to sigmoid diffusion curves.

3.5 Demand and product characteristics

It was previously pointed out that the formation of demand for a new good faces uncertainty and requires learning. The extent of learning is greater for a radical than for an incremental innovation. In what follows the uncertainty and the amount of learning required will be measured by the product of two distances in characteristics space. Reference is here made to the representation of a product by means of two sets of characteristics (Saviotti and Metcalfe, 1984; Saviotti, 1996), corresponding to the internal structure of the technology (technical characteristics) and to the services performed for the users (service characteristics) respectively. $D_X(i, i_+)$ indicates the distance in technical characteristics space between goods i and i_+. To the extent that consumers need knowledge of the internal structure of a product in order to use it $D_X(i, i_+)$ represents a barrier involved in adopting i_+ after having used i. $D_Y(i, i_+)$ represents the distance between i and i_+ in service characteristics space. The greater this distance the more difficult it is for consumers to understand how useful the new good can be for them. The product $D_X(i, i_+) * D_Y(i, i_+)$ is a measure of the total learning required by consumers in order to adopt a new good i_+.

3.6 Demand, supply and innovative activity

As it ws previously stated, at the beginning of the life cycle of a radically new product there can be no demand in the traditional sense, that is of a relationship between quantity demanded and price, or between the characteristics of the product and its price. Demand as we know it is created gradually by means of the interactions between producers and consumers and of the gradual learning effects that this entails. Both producers and consumers will learn during this process (see Teubal, 1979; Teubal et al., 1991,1994). As a consequence the evolution of demand can show irreversibility and path dependence (Georgescu Roegen, 1966).

As Schumpeter had foreseen in these conditions it is the role of producers to create new goods and to educate consumers to their use (Schumpeter, 1934, p. 65). Another important role that can be played by producers in the evolution of demand consists in the provision of infrastructures. Infrastructures can be considered as complementary inputs that expand the scope of the product by allowing it to be used more productively and in more circumstances than it would otherwise have been possible. In other words, the complementary inputs expand the range of the selection environment in which the product can operate. Conversely, the absence of complementary inputs can make the product virtually worthless and, therefore, limit severely its diffusion. Thus expansion of the relevant portion of the selection environment would have an effect similar to postinnovation improvements on the diffusion (Metcalfe, 1981, 1988).

In summary, producers must play a very large role in the creation of the demand for a new product, the more so the greater the degree of novelty of the new product. Furthermore, producers can considerably shape the subsequent evolution of the demand for a new product by the provision of the infrastructures that facilitate and amplify its consumption.

4 A replicator dynamics model of demand evolution

In what follows a population approach to the analysis of demand is adopted. This means that if we are talking about consumers we will study the dynamics of a population of consumers, thus taking into account not only the representative consumer, that is the average properties of the population, but also the distribution of the properties we wish to study within the population. The heterogeneity of agents is an important feature taken into account in evolutionary theories. In particular, recent theories of demand have stressed consumer heterogeneity as an important influence on the dynamics of demand (Cowan, Cowan and Swann, 1997). Consumer heterogeneity will be reflected here in the properties of the different members of the population.

When treating the evolution of demand there are a number of interacting populations that we need to consider. First, populations of differentiated products are underlying both consumer and producer populations. According to the discussion in Sect. 3.6) we can expect a radically new good to emerge before the demand for it has been created. A population of differentiated products is defined as the collection of all the product models contained in a separable region of characteristics space. Once a new product has been created as a prototype, firms can start producing it and consumers purchasing it. The purchase of a new product *i* by a consumer is considered an instance of entry into the population. The first consumer that purchases i creates the population *i*. Any consumer who subsequently purchases the product *i* for the first time enters the population. A population of consumers is defined as the collection of all consumers consuming a product contained in a product population. The consumer and producer population are continuously interacting. A product selected by many consumers has greater chances of being improved than one that is rarely chosen. Of course, during development new products will continue to enter the economic system. Thus, as new products emerge, consumers may add them to those they were previously consuming, or add the new ones while abandoning a previous item of consumption. Thus exit from a consumer population may be induced by the emergence of a new product. The dynamics of a consumer population will be given by the balance of entry and exit in the course of time.

The previous considerations can, at least in part, be translated into an analytical model of the evolution of demand. The central goal of this model is to be able to represent qualitative changes in the composition of consumption, that is entry into consumers' consumption baskets and budgets of qualitatively different goods. Such a model is not only expected to be better able to account for the dynamic features of demand than static models, but also to do it in a way which is compatible with a treatment of long range economic development. Aversi et al. (1999) develop a model, based on genetic algorithms, which bears some similarity to the one presented in this paper. The reason for the choice of replicator dynamics made here is the general applicability of this technique to model different types of populations. Previous applications of this same technique by the author of this paper were to technological product models (Saviotti and Mani, 1995) and to populations of firms (Saviotti, 1998).

We can now start dealing with the factors determining entry and exit into and from a consumer population. Critical income, the critical values of human capital and fitness can be considered barriers to consumption: only when these barriers are overcome consumption can take place. At any time only some consumers will have both the critical income and the critical human capital required for the consumption of a product i. Thus the population of the consumers of *i* will be a subset of the general consumers population. Neither critical income nor critical human capital can be considered as fixed barriers: as the production efficiency of the new product *i* increases, the critical income required for its consumption falls, thus leading to an expansion of the population of i. Also, the critical human capital can fall if the new product is modified to make it more user friendly. If simultaneously there is an effort to educate consumers, thus raising their level of human capital, we can again expect the population of consumers of *i* to expand. Thus initial consumer heterogeneity, represented by the distribution of income and of human capital in the population, can be expected to change in the course of time. A third type of barrier consisting of the minimum level of fitness required of the new product, can be expected to influence entry into population i. Fitness can in general be defined as the capacity to adapt to the external environment. This general definition is difficult to apply to specific cases. A more easily usable approximate definition is the ratio of the services performed to product price. Such definition corresponds to a measure of value for money. This barrier does not depend on consumer characteristics, but on characteristics of the product. In summary we can say that the adoption of a new good i, and thus entry into the corresponding consumer population depends on ability to enter, determined by income and by human capital, and by the attractiveness of the product itself.

We can then expect the rate of entry to be proportional to the excess of income, of human capital and of fitness with respect to their critical values. However, whatever their human capital, agents face uncertainty. Any innovator, and in this context the consumer has to considered an innovator, cannot fully anticipate the outcome of a process of choice. A criterion for decision that could be adopted in these circumstances, and is actually adopted in many cases, is imitation. This amounts to introducing into the criteria for choice not only the objective properties of products, but also the behaviour of other consumers purchasing similar goods (Cowan et al., 1997). Moreover, imitative behaviour implies an interdependence of the utilities of different consumers. Imitative behaviour can be expected to lead to a sigmoid diffusion curve. The actual shape of the diffusion curve depends on the extent of consumer heterogeneity Here we need to conceive imitation in both a negative and a positive sense. Consumers' imitative behaviour may depend on the relative social position of other social groups who have already adopted (Cowan et al., 1997). Previous choices of groups considered as socially desirable can be imitated, whereas the choices of groups deemed socially inferior can lead to exit from a consumer population. Similarly the desirability of a good can depend on the extent of its previous adoption. A greater differentiation or individuality can be achieved by adopting a good that very few consumers have adopted than one that has already been purchased by the majority of consumers. Limited previous adoption can be expected to induce further adoption, while a widespread adoption would rather induce exit (see also Granovetter and Soong, 1986).

Exit can thus be determined by the behaviour of other consumers, but also by the emergence of new products. Let us imagine that a new product i_+ is created after that the product i has already acquired a relatively stable population of consumers. i_+ might be preferred by consumers either because it is at least a partial substitute for i or because, while not being functionally comparable to i, can create a new niche that consumers find attractive.

Entry and exit of consumers determine the net number of members existing at a given time in consumer population i. Even if a consumer population reached an equilibrium number of members and remained stable after that, further changes could still take place. For example even consumers who have adopted i can change the share of their income allocated to it after adoption. The population income share allocated to i can be expected to increase as result of the increasing number of adopters and of the increasing percentage of individual income allocated to i. Thus entry increases income share and exit reduces it. To the extent that income and human capital can increase we could expect consumers who already adopted i to increase the share of their income allocated to i at first and subsequently to reduce it. The initial surge could be due to a reduction in the uncertainty surrounding the product, or to an improvement in its fitness. On the other hand, the subsequent decline could be due either to a considerable cheapening of i or to the emergence of other goods deemed more desirable than i.

A third aspect that needs to be taken into account when analysing the evolution of demand is the change in the composition of the economic system. As pointed out before, consumers can start entering a new population after the new product has been created. The more consumers buy a particular product model, the more such model can be improved and acquire further economic weight within the population. Furthermore, exit from an existing consumer population can be influenced by the emergence of a new product. Thus a complete analysis of the evolution of demand involves understanding the factors that determine the creation of new product populations and the extinction of pre-existing ones. We have to take into account both the dynamics of each individual population and the overall dynamics of the economic system, constituted by the emergence of new and distinguishable populations. The factors that could lead to the creation of new and distinguishable populations are of two types:

a) Inducements to exit from/to avoid pre-existing product populations
b) Inducements to create a new product that will occupy a niche, that could subsequently become a market

The inducements to exit a pre-existing population can be either the increasing intensity of competition or the saturation of demand in that population (Saviotti, 1996, 1998). The inducements to create a new population are constituted by the accumulated search activities, leading to greater fitness, and by the scope of the product occupying the new niche, measured by the volume of the niche in service characteristics space. It is to be pointed out that the processes leading to a change in the composition of the economic system occur at a higher level of aggregation than those concerning only one population. Thus, in addition to the dynamics of the individual populations, determined by the rate of entry and of exit into and out of each population, we need to take into account the dynamics of the 'population of populations' that constitutes the economic system. Thus, in order to analyse the evolution of demand we need to take into account three types of equations:

Eq. type 1) describing the change in the net number of members of the population, given by the difference between the birth and the death rates.
Eq. type 2) describing the change in the share of the consumers' income corresponding to the new good/service.
Eq. type 3) describing the change in the net number of technological/product populations. Such equation is common to the model of firm dynamics representing the evolution of production (Saviotti, 1998).

We can start by formulating the equations as follows:

$$\frac{dN_i}{dt} = k_{B,1} I_i' H_i' F_i' M_i N_i \left(1 - \frac{N_i}{M_i}\right) - k_{D,1} \frac{\frac{F_{i+}'}{F_i'}}{D_X(i+,i)\, D_Y(i+,i)} N_i N_{i+} \quad (4)$$

$$\frac{ds_i}{dt} = k_{B,2} H_i' F_i' I_i' s_{M,i} \left(1 - \frac{s_i}{s_{M,i}}\right) - k_{D,2} \frac{\frac{F_{i+}'}{F_i'}}{D_X(i+,i)\, D_Y(i+,i)} \frac{I_{i+}'}{I_i'} \quad (5)$$

with:

$$I' = I - I_{c,i} \quad ; \quad H' = H - H_{c,i} \quad ; \quad F' = F_i - F_{c,i} \quad (6)$$

$$\frac{dn}{dt} = k_6 DS_{i-} \frac{V(Y_i)}{V(Y_{i-})} \frac{F_i'}{F_{i-}'} - DS_i \frac{V(Y_{i+})}{V(Y_i)} \frac{F_{i+}'}{F_i'} \quad (7)$$

where:

$$DS_i = \frac{N_i \rho_i}{D_Y(i_-, i)} \frac{m_i}{M_i} \quad (8)$$

In order to understand the meaning of these equations we can think of a sequence of product populations created at different times. The populations are indexed in order of time of creation. To simplify things here we take into account three populations i_-, i and i_+. i_- was created first, followed by i and by i_+. The meaning of Eq. 7 can be understood as follows. The first term on the right tells us that the inducement of producers to exit population i_- and to enter population i is proportional to the intensity of competition in i_-, represented by $N_{i_-} \rho_{i_-} / D_Y(i, i_-)$, and by the degree of market saturation for i_-, represented by m_{i_-} / M_{i_-}. The combination of growing intensity of competition and of market saturation gives us the overall saturation of a product population as seen by a producer. Such saturation can be interpreted as the combination of a reduced possibility for profits, due to increased competition, and the reduced prospects for market growth. On the other hand $V(Y_i)/V(Y_{i-})$ represents the ratio of the scope of the good/service i to that of i_-, or, alternatively the ratio of the sizes of the corresponding markets. F_i'/F_{i-}' is the ratio of the effective fitness of i and of i_-. So the first term on the right of Eq. 7 tells us that a producer will have an inducement to create a new product population i that depends on, a) the inducement to exit an older product population i_- based on its degree of saturation, and on b) the attractiveness of the new population, based on its scope and on its effective fitness relative to that of the old population. In other words, the inducement to create a new population depends on the combination of the inducements to leave the older population combined with the opportunities presented by the new ones.

Let us now describe the variables contained in these equations before passing to analyse their content.

$S_{M,i}$ = maximum income share to be spent on a given good (or service) i; I= income, $I_{c,i}$ = critical income required to start consuming good/service i; H_i = human capital accumulated in the consumption of i; $H_{c,i}$ = minimum human capital required for the consumption of i; F_i'= effective fitness of i; N_i= number of consumers in population i at time t; M_i= maximum size of population

i, equal to market size; m_i = actual market size at time t; n = net number of distinguishable technological populations at time t; $D_x(i, i_-)$ = distance between technologies i and i_- in technical characteristics space, $D_Y(i, i_-)$ = distance between technologies i and i_- in service characteristics space; ρ_i represents the density of good/service population i in characteristics space.

$N_i \rho_i / D_Y(i, i_-)$ is then a measure of the intensity of competition in technology i and $m_i(t)/M_i$ represents the extent of demand saturation for good/service i. The combined term $N_i \rho_1 m_i(t)/D_Y(i, i_-)M_i$ can then be considered a measure of the degree of saturation of a good/service population as perceived by a producer, in the sense that such a population can be expected to lead to decreasing profit rates and to declining growth rates.

Fitness F_i is defined here as the capacity of product i to adapt to its external environment. This definition is very general but not always easy to apply. An approximate definition of fitness easier to use is the ratio of the services provided to the price at which they are provided (Saviotti and Mani, 1995; Saviotti, 1996). With this definition fitness is equivalent to a measure of the value for money provided by the product. It is to be pointed out that the fitness of a given product can be greater than that of potential competitors in particular regions of characteristics space, but not necessarily everywhere. In order for a new niche to be created the fitness of the new product can be superior to that of other products only in a very restricted region of characteristics space and inferior everywhere else. This differential distribution of fitness will define the new niche. If the niche is to become subsequently a full blown market, the fitness of the product must improve also in other regions of characteristics space.

Intuitively Eq. 3 can be interpreted as follows. Of the parts on the right of the = sign the one before the - sign represents the birth/entry processes and the one after the - sign represents the death/exit processes. Entry takes place after income, human capital and fitness reach a minimum or critical value. The rate of entry is proportional to the excess of income, human capital and fitness above their critical values ($I_c^{'}$, $H_i^{'}$, $F_i^{'}$). Also, the rate of entry is described by a logistic equation, corresponding to the important role played by imitation in consumer behaviour. The rate of exit depends on the differential fitness of a newer good (i_+) with respect to that of the one (i) already adopted and on the distances in technical and in service characteristics space between the two product populations i and i_+. The distance in technical characteristics space is a measure of the knowledge gap that consumers need to overcome in order to switch from i to i_+. The distance in service characteristics space is a measure of the similarity of the services provided by i and by i_+, or, in other words, of the functional substitutability of i and i_+. It is to be remarked that functional substitutability is not the only type of substitutability. Products providing exactly the same services in service characteristic space are perfect substitutes, but owing to the increasing uncertainty prevailing at high income levels, completely different products and services can be substituted for one another.

The second equation (Eq. 5) describing the evolution of the budget share of the given good/service in the course of time, can be interpreted in a similar way.

Entry here occurs as the same barriers (critical income, human capital, fitness) are overcome. However, the rate at which the budget share grows decreases gradually as the maximum share is approached. Exit is again determined by the differential fitness of a newer good i_+ with respect to i and by the distance between the two products in service characteristics space.

It must be pointed out here that exit does not necessarily take place for all populations. For example, a population corresponding to a very basic good (e.g. food) will not necessarily undergo exit, although changes in composition internal to the class of good could take place. Even when exit does not take place the population will saturate in the sense that all consumers will consume the good. Further development of consumption will take place if consumers increase the quantity or quality of their consumption, a phenomenon analysed by Eq. 5. In fact, Eqs. 3 and 4 have a very 'parallel' structure, but their time dynamics can be different. Eq. 3 is likely to saturate first, corresponding to classic market saturation. Eq. 5 will continue to grow as long as consumers keep increasing the quantity or the quality of a given good.

Exit can take place in Eq. 3 when consumers switch from good i to i_+. In some sense consumers have to find i_+ preferable to i. This does not necessarily imply that i and i_+ are substitutes, in the sense that they have similar service characteristics. In fact, they may be very different in this sense. For example, photography may replace playing bridge with friends or dancing. Of course, such greater substitutability in presence of different service characteristics becomes greater for 'higher' goods. We can here distinguish between functional substitutes, those goods that have the same service characteristics, an income substitutes, those goods that are substitutable at given income levels irrespective of the similarity of their service characteristics.

4.1 An application of the replicator dynamics model: conditions for variety growth

The previous model can in principle describe the evolution of a population of consumers and of the product consumed in presence of the interactions between i and either the pre-existing populations i_- or those that emerge later (i_+). Such a model can be used to analyse many different aspects of the behaviour of population i. A complete analysis of these different aspects is outside the scope of this paper. Here we are going to develop the theme already outlined at the beginning of the paper. To the extent that the continuation of long term economic development requires growth in the variety of the economic system and that new goods/services after they are created need to be consumed, the development of demand is a necessary determinant of long run economic development. An interesting application of the above replicator dynamics model consists of the determination of the conditions under which output variety is going to grow. Output variety can increase if new goods/services do not always replace (or exclude) pre-existing ones, but are added to them. At least, the number of new goods entering the system must be greater than the number of those leaving it. We concentrate for the moment on the interactions between population i and a population i_+ that emerges after i. Eq. 3 can then be rewritten as a Lotka-Volterra equation for the competition of two species (Roughgarden, 1996, p. 413).

$$\frac{dN_i}{dt} = N_i \left(r_i - \frac{r_i}{K_i} N_i - \frac{r_i}{K_i} \alpha_{ii_+} N_{i_+} \right) = \tag{9}$$

$$= r_i \frac{K_i - N_i - \alpha_{ii_+} N_{i_+}}{K_i} N_i \tag{10}$$

where r_i is the rate constant for the growth of population i, K_i is the carrying capacity of the environment for population i, α_{ii_+} is the coefficient of interaction of populations i and i_+, N_i and N_{i_+} are the number of members of populations i and i_+.

We can then construct a slightly different version of Eq. 3 which is equivalent to 9 if:

$$r_i = k_{B,1} I_i' H_i' F_i' M_i \quad M_i = K_i \tag{11}$$

$$\alpha_{i,i+} = \frac{1}{D_X D_Y} \frac{F_{i+}'}{F_i'} \text{ and if } k_{B,1} = k_{D,1} \tag{12}$$

Eq. 3 can the be rewritten as:

$$\frac{dN_i}{dt} = k I_i' H_i' M_i \frac{M_i - N_i - \frac{1}{D_X D_Y} \frac{F_{i+}'}{F_i'} N_{i+}}{M_i} N_i \tag{13}$$

Conditions (11) and (12) seem plausible because the rate constant r_i for population growth is likely to increase with the values of effective income, of effective human capital, and of effective fitness. On the other hand K_i, the carrying capacity of the environment for population i corresponds logically to M_i, the maximum market size for i. Furthermore, the interaction coefficient between the two populations i and i_+ can be expected to depend inversely on how easily consumers can understand how to use and to benefit from the goods/services i and i_+ and on their relative fitness.

The advantage of writing the equation in this form is that its dynamic properties have already been well studied. If we concentrate on the interaction between a good i that has already emerged and another one i_+, that emerges later, an equation symmetric with respect to (11) can be written for i_+. The joint study of the two equations allows us to determine the regions of stability of the two populations. [For the solution of this problem the reader is referred to Roughgarden (1996, pp. 413–421)]. This can give rise to four situations:

a1) In the end only population i will survive, and this happens if:

$$\alpha_{i+,i} \succ \frac{M_{i+}}{M_i} \text{ and } \alpha_{i,i+} \prec \frac{M_i}{M_{i+}}$$

a2) In the end only population i_+ will survive, and this happens if:

$$\alpha_{i+,i} \prec \frac{M_{i+}}{M_i} \text{ and } \alpha_{i,i+} \succ \frac{M_i}{M_{i+}}$$

b1) In the end i and i_+ coexist, and this happens if:

$$\alpha_{i+,i} \prec \frac{M_{i+}}{M_i} \text{ and } \alpha_{i,i+} \prec \frac{M_i}{M_{i+}}$$

b2) In the end only one of the two populations i and i_+ survives, but which one depends on their initial abundance.

$$\text{if } \alpha_{i+,i} \succ \frac{M_{i+}}{M_i} \text{ and } \alpha_{i,i+} \succ \frac{M_i}{M_{i+}}$$

Thus in most cases only one of the two populations survives (cases a1, a2, and b2). Only in case b1) the two populations can coexist. Cases a1), a2) and b2) correspond to the complete substitution of a good by another one. Thus they have a zero impact on the variety of the system. The only case that leads to a growth in the variety of the system is b1), in which i and i_+ coexist.

In order to simplify the interpretation of these cases we can start by assuming that $M_{i_+} = M_i$, or that the carrying capacity of the two populations is the same. In these conditions case a1), in which i excludes i_+, occurs when the interaction between i and i_+ (inter-product competition) is stronger than the intra-product competition within i *and* when the effect of i_+ on i is weaker than intra-product competition within i. Case a2), in which i_+ excludes or replaces i, is symmetrical with respect to a1). Case b1), in which i and i_+ coexist, occurs when intra-product competition for both i and i_+ is stronger than inter-product competition. Case b2), in which either i or i_+ predominates and excludes the other, occurs when inter-product competition is stronger than the intra-product competition of either i or i_+. These conditions tell us that the variety of the system increases only when intra-product competition for both i and i_+ is stronger than inter-product competition (see also Saviotti and Mani, 1995).

The situation becomes more complicated if $M_i \neq M_{i_+}$. If we let $M_i \neq M_{i_+}$ then the conclusions have to be modified. Let us take for example the case a1). In this case i can still exclude i_+ even if $\alpha_{i_+,i} < 1$ and $\alpha_{i,i_+} > 1$, provided that the ratio M_{i_+}/M_i is sufficiently smaller than 1, so that relationships a1) still hold. Thus a good cannot tolerate a nearly equal balance of inter-and intra-product competition if its carrying capacity is sufficiently low relative to the other good. Conversely, even when $\alpha_{i_+,i} > 1$ and $\alpha_{i,i_+} < 1$ the two goods may survive together if the carrying capacity of the good that would otherwise be excluded is sufficiently great to compensate for other disadvantages. In summary, the ability of goods to survive competition depends on their intrinsic competitive ability and on their carrying capacity: a very large carrying capacity can compensate for a limited competitive ability. For the detailed analyis of this case the reader is referred to Roughgarden, (1996, pp. 413–421).

We can get a better appreciation of the meaning of these conclusions if we go back to the specific form that $\alpha_{i_+,i}$ and α_{i,i_+} have in this model. Conditions a1) then become:

$$\alpha_{i+i} = \frac{\dfrac{F_i'}{F_{i+}'}}{D_X D_Y} \succ 1 \text{ or } \frac{F_i'}{F_{i+}'} \succ D_X D_Y \tag{14}$$

and

$$\alpha_{ii+} = \frac{\frac{F'_{i+}}{F'_i}}{D_X D_Y} \prec 1 \text{ or } \frac{F'_{i+}}{F'_i} \prec D_X D_Y \tag{15}$$

Let us remember that α_{i_+i} represents the competitive effect of i on i_+, and that condition (13) means that only i will survive if the competitive interaction (inter-product competition) of i with i_+ is greater than the intra-product competition of i with i_+. This condition is satisfied not only if the effective fitness of i is greater than that of i_+, but if the ratio of their fitness is sufficiently large to compensate for the dissimilarity effect. The dissimilarity effect is determined by two components: first, the knowledge gap that consumers have to face to understand and use the new technology represented by D_X, and, second, the extent of product differentiation, represented by D_Y. Thus i will exclude i_+ if its fitness is not only greater than that of i_+ , but sufficiently greater to overcome consumers' knowledge gap and the extent of product differentiation. Eq. 15 means that i can exclude i_+ even if i_+ has a fitness greater than that of i, but not sufficiently greater to compensate for the dissimilarity effect.

Case b1), in which the two goods i_+ and i coexist, correspond to the following conditions:

$$\alpha_{i+i} = \frac{\frac{F'_i}{F'_{i+}}}{D_X D_Y} \prec 1 \text{ or } \frac{F'_i}{F'_{i+}} \prec D_X D_Y \tag{16}$$

and

$$\alpha_{ii+} = \frac{\frac{F'_{i+}}{F'_i}}{D_X D_Y} \prec 1 \text{ or } \frac{F'_{i+}}{F'_i} \prec D_X D_Y \tag{17}$$

In this case the differential fitness of any of the two goods is not enough to compensate for the dissimilarity effect. In other words, the two goods i_+ and i, while being both capable of achieving the minimum fitness required, are sufficiently dissimilar or unknown to be able to coexist. This residual differentiation and inability of the consumers to understand fully the properties of the two goods reduces the intensity of inter-product competition and allows them both to survive. In fact, it might not be just uncertainty about the properties of the two goods i and i_+ that allows them both to survive, but the radical novelty of i_+ with respect to i, that would make the two goods non comparable. Then i_+ would not be a functional substitute of i, in the sense that none of its services would be comparable to those of i, but that i_+ would occupy anyway a share of consumer income. This leads us back to the fact that at high income levels the ranking order of wants is likely not to be unique. Thus, two different consumers at the same income level are unlikely to rank the same good in the same way. Furthermore, even for the same consumer, the parts of the ranking order corresponding to high income levels might be unstable: the consumer could switch between different goods while remaining at the same income level.

5 Summary and conclusions

In this paper an effort was made to develop a dynamic model of demand that is compatible with the qualitative change that takes place in economic development. The emergence of new goods implies that preferences cannot be taken as given, but that they are created during the process of economic development. In this paper a hierarchical theory of wants and preferences is adopted. Consumers will start purchasing goods corresponding to higher wants only when their income reaches a minimum level, called *critical income*. The critical income of a good increases with the hierarchical level of the good, but so does the uncertainty attached to consumer choices. While we can assume that all consumers are likely to include wants of lower level (e.g. food) in their consumption pattern, we cannot assume that all consumers will include photography, sports or theatre in their consumption pattern. Thus at higher levels wants and consumption patterns are likely to become more differentiated. In addition to critical income other barriers to consumption are represented by the knowledge consumers must have in order to understand the properties of given types of goods and by a minimum level of efficiency that new goods must have in order for consumption to begin. These requirements are translated into a minimum level of human capital that consumers must have and into a minimum level of fitness that goods must possess in order for consumption to begin.

Even when these barriers (critical income, human capital, fitness) are overcome consumers' choice is still subject to uncertainty and relies on routines and imitation. This phenomenon is modelled by means of a logistic equation, in which diffusion increases until a maximum value, that represents the carrying capacity of the environment for the given good. In turn, such carrying capacity represents the total market size for the given good. Carrying capacity is not fixed once and forever, but can change during the course of economic evolution. Death or exit of consumers from a population can take place when a new good that consumers consider 'better' emerges.

The particular version of replicator dynamics used in this paper to model the evolution of demand contains three equations, the first describing the change in the net number of members of a population (the consumers consuming the good i), the second describing the share of total income spent on good i, and the third equation representing the net number of distinguishable product populations. This third equation is the one mainly responsible for the emergence of qualitative change in the model and represents Schumpeterian creative destruction. The third equation is also common to a model of firm behaviour.

Some of the dynamic properties of the first equation are discussed in the particularly simple case of competition between two goods i and i_+. In this case the survival of the two goods depends on the intensity of competition within each product population (intra-product competition) relative to inter-product competition, and on the carrying capacities of the environment for the two goods/services. In particular, if we assume equal carrying capacities for the goods, they can only survive together, thus leading to a growth in system variety, if the intensity of intra-product competition for each of the two goods is greater than the intensity of inter-product competition. This can happen for two reasons. First, even if one of the two goods is superior to the other, the knowledge gap that consumers have to face to understand and use it is very large. In this case the good itself may not displace completely the less 'efficient' one. Second, when the extent of differentiation of the two goods is very large they are not substitutes and they can survive simultaneously. This conclusion is important because both consumers knowledge gaps and the extent of product differentiation reduce the intensity of competition. Maximum variety will thus not correspond to the maximum possible intensity of competition. If we remember the hypotheses (1) and (2) at the beginning of the paper, we can conclude that the best conditions for economic development do not coincide with the maximum level of inter-product competition. If all new products were perfect substitutes of older ones, then those with greater fitness would exclude the less fit. However, in this case the system's variety would never increase and the scope for economic development would be far more limited. A similar conclusion was already obtained by Saviotti and Mani (1995). Such a conclusion has important implications for the way we think about competition and about its relationship to economic performance.

This paper represents a first attempt to develop a dynamic model of demand compatible with the analysis of qualitative change in economic development. Of course, much further work is required to work out the dynamic properties of this model and to increase its coherence with several parts of economics.

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