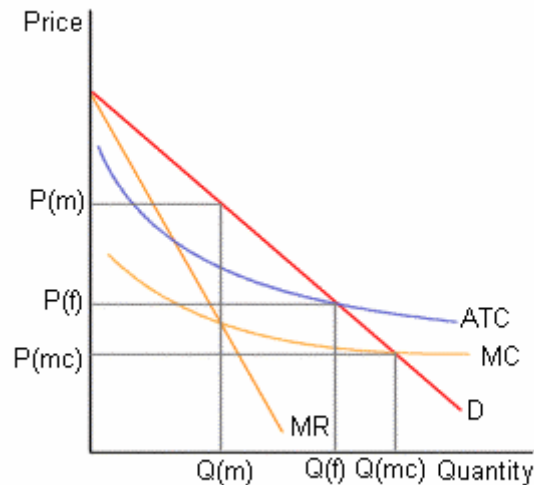


## Introduction

In microeconomics, industrial organization, and public economics handbooks<sup>1</sup>, natural monopoly is described as a situation in which, for structural reasons, only one firm finds it profitable to produce in the market; the diagrams used are similar to the following.



In the first edition of Samuelson's handbook (1948), and until the end of the 1970s, natural monopoly was considered to occur in cases of scale economies<sup>2</sup>; as we know, with these average costs decline when output increases throughout the entire range of market demand. In this literature, economies of scale were attributed to high fixed costs and low or zero variable costs; they were also considered a barrier to entry. Due to the monopoly power derived from it, natural monopoly was seen as a market failure, and Government intervention was required (in the forms of nationalization, regulation, or antitrust)<sup>3</sup>.

This theory has been criticized. For example, part of the Austrian monopoly theory denies the existence of non-legal barriers to entry<sup>4</sup>. However, the most influential criticism came from a number of articles published in the 1970s – dealing with natural monopoly in

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<sup>1</sup> For Microeconomics see Kreps (1990: 302); for Industrial Organization see Cabral (2000: 75), for Public Economics see Stiglitz (2000: 291).

<sup>2</sup> "Some of the basic factors responsible for monopoly are inherent in the economies of large-scale production" (Samuelson 1948: 40).

<sup>3</sup> See the interesting contribution on the history of the treatment of natural monopoly in introductory textbooks by Ulbrich (1991).

<sup>4</sup> Actually, monopoly theory is one of the most controversial areas in Austrian economics. In short, there are three different views: 1. Mises and Kirzner; 2. Rothbard and Armentano; 3. O'Driscoll. Although this is not the place to analyze these views, we can say that not all of them deny the existence of natural monopoly.

multiple output production<sup>5</sup> – and from the theory of “contestable markets”<sup>6</sup>. They caused a radical change in the definition of natural monopoly. Nowadays it means a situation characterized by the sub-additivity of cost functions (production costs less if it is done by one firm only), and by sustainability (entry is not profitable). Not only does this new theory demonstrate that scale economies do not help us to define natural monopoly properly, but also that they alone may not constitute a barrier to entry<sup>7</sup>. It implies that “if there is a free entry, this will prevent the monopolist from setting high prices, as they would trigger entry” (Motta 2004: 70). The systematization of the new viewpoint on natural monopoly was carried out by Sharkey (1982).

But apparently the story does not end here. There have also been strong criticisms of the new theory. Shepherd, for example, radically claims that the theory of contestable markets “has been mainly a detour” (1995: 299)<sup>8</sup>. In short, we can summarize the present state of research as follows: if there are economies of scale with sunk costs, as in the cases previously considered as natural monopolies, the behavior of the potential entrant and the reaction of the incumbent are now seen as depending on the strategic context in which they operate. In general, recent models show that monopoly power might persist under free entry, and market mechanisms might not prevent a monopolist from exercising market power (Motta 2004: 2.6)

The purpose of this article is to begin writing the history of the concept of natural monopoly, and of its policy implications. While it would certainly be very interesting to inquire into the reasons and the consequences of the change that this concept underwent in the 1970s, this paper focuses on the reconstruction of its origins, long before Samuelson’s first edition. Very few studies have been devoted to this topic. We have found some synthetic reconstruction of the initial history of natural monopoly in Sharkey (1982, ch. 2)<sup>9</sup>, Hazlett (1985), and DiLorenzo (1996); there are hints in Ekelund and Hébert (1981), O’Driscoll (1982) and Stigler (1982); we can also cite Ekelund and Hébert (2003),

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<sup>5</sup> The question of multiproduct natural monopoly was dealt with from 1977 by Baumol, Bayley, Panzar, and Willig.

<sup>6</sup> The idea of contestability was dealt with in a series of articles from 1980 by Baumol, Bayley, Panzar, and Willig. See for all Baumol, Panzar and Willig (1982).

<sup>7</sup> There are actually two definition of entry barriers in the literature, one proposed by Bain, the other by Stigler. As Schmalensee points out “An updated Bain definition would not rule out scale economies as an antitrust barrier to entry when sunk costs are important, while the Stigler definition would” (2004: 471).

<sup>8</sup> And he adds: “The theory is internally inconsistent, difficult to relate to reality, and hazardous for policy treatments of market power” (Shepherd 1995: 300).

who deals with the theory of Dupuit and of Walras, and Béraud (2004), mainly focused on Walras<sup>10</sup>. The secondary literature is therefore rather scarce.

But the main reason why we think it is worthwhile to make a new contribution to it doesn't lie in its scarcity; it lies rather in a source of confusion that we think needs to be revised. The confusion derives from the fact that the concept of natural monopoly is composed of different elements and, as is shown in this article, every element has its own different history. We are therefore dealing with a complex concept, requiring a separate analysis of the particular paths followed by its various components. In other words, we think that an accurate historical analysis of the notion of natural monopoly cannot be written without breaking it down into all its component parts. In this paper we have identified the following features which go to make up that notion: 1. the expression itself; 2. the singling out of the concrete situations to which it is applied; 3. the inquiry into economies of scale; 4. the consideration of their compatibility with competition; 5. the drawing of the diagram; 6. the request for Government intervention. If each of these elements is not considered separately, it is hard to correctly identify original contributions, and to properly reconstruct the influence of ideas. Hence, in every section of the paper, each of the above features is separately examined from a historical perspective, highlighting the originality of economic theories in that specific respect, as well as the way those theories influenced one another.

The approach mostly followed by this paper is known as "rational reconstruction": we extract from the whole of the economists' work those parts concerning the different elements composing the traditional notion of natural monopoly, with the aim of finding out priorities and influences. We are aware of the limits of this perspective, and we sometimes suggest some interpretation and contextualization, but our main purpose here is to take only a first step, clarifying the confusion we mentioned above, and thus providing a sound basis for a further "historical reconstruction", which will be our next task.

Our investigation ends with the formulation of the concept of natural monopoly as it was in the traditional view, although the new developments of the theory after the 1970s

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<sup>9</sup> Sharkey (1982: 15) also cites Lowry (1973).

<sup>10</sup> All these works will be recalled later in the paper.

will be taken into account during the examination of the economists' thought, and some reflections related to the new view will be also discussed in the conclusion.

### 1. *The expression "natural" monopoly*

Aristotle was the first to talk about monopoly (De Roover 1951: 492; Langholm 2006: 397), but who was the first to talk about "natural" monopoly? When did this expression start being used in its current sense? And why was the word "natural" employed? This is what we look at in this section. We limit our analysis here to the meaning and the definition of natural monopoly; the identification of its distinctive features by the economists under analysis will be discussed in the next sections.

Smith never uses the expression "natural monopoly", but he gives a detailed description of the characteristics of what this was to be called immediately after him: "Some natural productions require such a singularity of soil and situation, that all the land in a great country ... may not be sufficient to supply the effectual demand"; the consequent "enhancements of the market price are evidently the effect of natural causes which may hinder the effectual demand from being fully supplied, and which may continue, therefore, to operate forever" (1776: I.7.24). The earliest explicit use of the term that I have found in the literature is in the essay *The Nature of Rent* by Malthus, where natural monopoly is distinguished from artificial monopoly. For Malthus there are: "peculiar products of the earth ... which may be called natural and necessary monopolies" ([1815] 1969: 13). As an example of natural monopolies, he takes "certain vineyards in France, which, from the peculiarity of their soil and situation, exclusively yield wine of a certain flavour" (13-14)<sup>11</sup>. The expression turns up again in Bastiat, who wrote: "People who class together artificial monopoly and what they call natural monopoly ... are quite blind or quite superficial" ([1850] 1864: 180). So far, we have seen that classical economists did use the expression natural monopoly, but we haven't found a definition of the concept yet. This is supplied by J.S. Mill, who explains that natural monopolies are "those which are created by circumstances, and not by law" ([1848] 149: 499). In general we can say that the expression was used to indicate those cases of monopoly deriving from natural agents supplied in fixed quantity, also including talent and location (Cairnes 1861). Economists always regarded them favorably. Hence, we think that the reason for the use of the

adjective was aimed at distinguishing natural monopoly (created by nature) from an artificial one (created by law). While the former was seen with favor, classical economists were strongly against the latter, considering it “unnatural”.

We now have to go back to J.S. Mill, to point out the important fact that, among his examples of natural monopolies, he includes the production of gas and water (1848: II.15.9). To tell the truth, these examples of natural monopoly are mentioned together with others which are not, such as productions in which the entry barriers are due to capital requirements or to the action of combinations<sup>12</sup>. But still, we can state that he was the first to apply the expression to cases similar to those where it was used later by neoclassical theory<sup>13</sup>. We move now to France, where we find the term employed with more precision by Walras, who writes that transport networks such as railways, roads, and canals “make up a natural monopoly” ([1875] 1936: 232)<sup>14</sup>. Then, after a period in which it was possible to find the old and the new senses used side by side, even in the same text<sup>15</sup>, the new one became consolidated, due particularly to the numerous important contributions by Ely (1886, 1889, 1894). In effect, in his 1894 article, where the expression even appears in the title<sup>16</sup>, Ely defines natural monopoly as those “undertakings which are monopolies by virtue of their inherent properties” (1894: 294), and lists the following cases: “railways, telegraphs, telephones, canals, irrigation works, harbors, gasworks, street-car lines, and the like” (294). It is interesting that Marshall proposed a different definition for that “class of industries, which are often called monopolies, but which are perhaps better described as *indivisible* industries” ([1890b] 1964: 106; Marshall’s italic). Leaving Marshall aside, we

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<sup>11</sup> Note that Malthus uses the same phrase as Smith: “soil and situation”.

<sup>12</sup> J.S. Mill writes: “All the natural monopolies (meaning thereby those which are created by circumstances, and not by law) which produce or aggravate the disparities in the remuneration of different kinds of labour, operate similarly between different employments of capital. If a business can only be advantageously carried on by a large capital, this in most countries limits so narrowly the class of persons who can enter into the employment, that they are enabled to keep their rate of profit above the general level. A trade may also, from the nature of the case, be confined to so few hands, that profits may admit of being kept up by a combination among the dealers. It is well known that even among so numerous a body as the London booksellers, this sort of combination exists; though individual interest is often too strong for its rules, nor, indeed, does the combination itself include the whole trade. I have already mentioned the case of the gas and water companies” ([1848] 1849: 499-500).

<sup>13</sup> Sharkey writes: “John Stuart Mill ... was the first economist of note to speak of natural monopoly” (1982: 14). We think that he was absolutely the first, if we limit our concern to the new meaning of the expression. Also Hazlett states that it was J.S. Mill “who introduced ... the term *natural monopoly*” (1985: 2, author’s italics); again, he should have added: in its new meaning.

<sup>14</sup> According to Ekelund and Hébert: “Walras may have been the earliest writer to employ the actual term in its modern sense” (2003: 665); but we have seen that J.S. Mill did this earlier.

<sup>15</sup> As in the case of Hadley (1886), who used “natural monopoly” both for highways and for land ownership.

can see here that there has been a gradual shift from the first meaning to the second, with a period of overlapping of the two; we can also see that the new sense crowded out the first in a period in which it was generally thought that the new natural monopolies were much more important than the old ones<sup>17</sup>.

## *2. The singling out of the concrete situations to which it is applied*

Natural monopolies typically occur in two kinds of production: the first is characterized by the need of a large infrastructure to start the operation, as in transport networks and some public utilities; the second is due to the presence of network effects (Liebowitz and Margolis 1996). Over the years economists have identified some industries in which monopoly is spontaneously generated for reasons linked to the production process itself. In this section we analyze the writings of the economists who identified new situations in which this phenomenon occurs. We will show here that the singling out of this kind of industry by economists has not necessarily to do with the development of the theory of natural monopoly. In actual fact, the justifications they gave to explain these cases are not always based on technological reasons, such as economies of scale. It should be also remembered that the expression “natural monopoly” was not necessarily used to describe these situations.

Adam Smith, discussing the subject of joint stock companies, explains that businesses cannot expand without running into problems of mismanagement; however he believes there are domains where large size firms can work better than small ones; they are “those of which all the operations are capable of being reduced to what is called a routine, or to such a uniformity of method as admits of little or no variation. Of this kind is, first, the banking trade; secondly, the trade of insurance from fire, and from sea risk and capture in time of war; thirdly, the trade of making and maintaining a navigable cut or canal; and, fourthly, the similar trade of bringing water for the supply of a great city” (1776, V.1.121). Notice that Smith speaks only of “large size firms”, not of monopolies<sup>18</sup>.

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<sup>16</sup> The title of the article is: Natural monopolies and the workingman.

<sup>17</sup> See for instance Hadley: “This monopoly, due to the advantages of large organizations of capital, is characteristic of the present day. ... Natural monopolies, like that of land ownership, are still important; but they are not the matter of supreme importance in productive industry any more than in transportation” (1886: 40).

<sup>18</sup> Elsewhere, talking about wages, Smith claims that where there are few agents, competition cannot work: “The masters, being fewer in number, can combine much more easily” (1776: I.8.12); the same reasoning

After him, it is J.S. Mill who explains in which sectors production on a large scale is preferable to production on a small scale, giving the example of the postal service, and the supply of water and gas (1848: I.9.1). And he goes further than Smith, when he argues that the possible disadvantages of a change from a small to a large scale “are not applicable to the change from a large to a still larger” ([1848] 1849: 175); this reasoning leads him to conclude that firms belonging to these sectors are in general destined to become monopolies: “where competitors are so few, they always end by agreeing not to compete” ([1848] 1849: 176). As we will see later, this is not the only, nor the most interesting reason J.S. Mill gives to explain why monopolies are spontaneously generated in these sectors.

A French contemporary of J.S. Mill, the engineer Jules Dupuit, identifies another situation of natural monopoly, *i.e.* transport networks, which he calls a “de facto monopoly”. The reasons he found for this phenomenon are quite different from those given by the economists already examined. In his opinion, it is impossible for a new firm to enter the market of transport networks because: 1. the huge size of capital requirement cannot be available to more than a very limited number of entrepreneurs; 2. the new firm takes customers away from the monopolist and the profit will not be enough to cover the fixed costs of both; 3. the first business uses the best conditions, leaving the less favorable ones to the new one; in short: “instead of one good business, there will be two bad ones” (1852-53: 340). We have seen in the previous section that also for Walras monopoly is inevitable in transport networks; but the reasons he gives are different from Dupuit’s. According to Walras, competition cannot work because the expropriation of the land needed to build the communication networks can be decided only by the Government. The same occurs, he says, to public utilities, due to the impossibility of laying pipes under public roads without authorization; as such permission can be granted only to very few firms, a monopoly is necessarily created because: “Competition between a limited number of entrepreneurs is rationally nothing but a passing phase after which there is the definitive creation of a sole monopoly based on the ruin of the others, or a monopoly of all of them or of some of them in coalition” ([1875] 1936: 202). We will see later that Walras also provides other much more interesting technological reasons for natural monopolies.

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could be applied also to this case, and we could push his argument to the statement that when firms are large, they are few, and when they are few, competition cannot work; but this would be forcing Smith’s meaning.

Another important and original voice on this issue comes from Italy. It is that of the public economist De Viti de Marco (1890), who applies the notion of natural monopoly to the telephone industry<sup>19</sup>. He states that such industry always tends to become a monopoly, and he gives different reasons for this: some are similar to those found in the writings of the economists already examined, while others, very inventive, will be discussed later because they are related to technology. We stop here, with the recognition of the network effects by De Viti de Marco<sup>20</sup>, because all the concrete situations in which natural monopolies occur have already been pointed out, and nothing original was added in this respect by later economists.

### 3. *The inquiry into economies of scale*<sup>21</sup>

Natural monopoly is due to technological reasons; it is some specific technologically-determined production process which generates it. In the traditional view of natural monopoly, the fundamental characteristic of technology responsible for its emergence is economies of scale<sup>22</sup>. It is well known that economies of scale are a more general category than increasing returns<sup>23</sup>: increasing returns to scale occurs with the same proportional change in all the inputs, while for economies of scale inputs increase by some amount; for example productions with high fixed costs and low marginal costs give rise to economies of scale, without exhibiting increasing returns to scale. It is also worthwhile recalling that until the 1920s, the expression “increasing returns” was used, as it implied changes in input proportions<sup>24</sup>. In this section we see that economists of the past followed three different paths to identify decreasing costs. The first concerns those who focused on increasing returns, considering at the same time (more or less explicitly or approximately) their symmetry with the reductions in costs. The second is related to those who identified scale economies by the distinction between fixed and variable costs. The third includes

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<sup>19</sup> De Viti de Marco’s article on the telephone industry is examined in Mosca (2007).

<sup>20</sup> It seems to be the earliest recognition of network effects in economic literature: “The consumers enjoy a utility which is greater, the greater the number of subscribers with whom they can communicate when necessary” (De Viti de Marco[1890] 2001: 521).

<sup>21</sup> While for the aspects examined in the previous sections there is only the secondary literature focused on the specific issue of natural monopoly, the topics dealt with from now on have been widely studied from many historical points of view; the literature cited here only shows a part of this abundance of references.

<sup>22</sup> We have seen in the introduction that on this point the perspective changed after the 1970s.

<sup>23</sup> This is true if the price of inputs doesn’t change.

<sup>24</sup> For the meaning of “increasing returns” in Marshall, see Loasby (1989: 62), while on the terminology concerning the laws of returns used in the cost controversy see Aslanbeigui (1996: 278-280).



those who clearly understood the functional relation between costs and output. Again, we would like to point out that economists' ideas on economies of scale do not necessarily have to do with their ideas about the other elements composing the notion of natural monopoly: for example, not all of them used the expression, or even considered economies of scale related to monopoly. We will see in the next section if the decrease in costs was considered to lead necessarily to monopoly.

We limit our inquiry here to economics scholars, and we do not mention all those who applied the decreasing average cost concept to their businesses, like, for example, Gottfried Härtel, a German music publisher (see Scherer 2001). So we start again with Adam Smith. Despite the role that the division of labor plays in his analysis<sup>25</sup>, Smith does not take into the slightest consideration the possibility that increasing returns may be at the origin of monopolies<sup>26</sup>. Schumpeter ([1954] 1986: 585) recalls that from Smith onwards every classical economist, and especially West and Senior, assumes the existence of a law of increasing returns in manufacturing, in contrast to that of decreasing returns in agriculture<sup>27</sup>. The advantages of the division of labor are well expressed by Babbage (1832), who was to be the fundamental reference point for later economists on this issue (Loasby 1996: 307-308).

Senior had a very clear understanding of economies of scale when fixed costs incur; referring to the spinning of cotton in a mill he writes: "As the quantity produced is increased, the relative cost of production is diminished" (1836: 4.53). A few years later, Cournot, as we know, used the total cost function and its derivative; concerning the latter, *i.e.* the marginal cost, he believed that this function was usually diminishing for "*manufactured articles*", because of "a better organization of the work, ... and ... [the] reduction [of] *general expenses*" ([1838] 1960: 59, author's italics). As for the shape of this function, he adds that: "it may happen however ... that when the exploitation is carried beyond certain limits ... [the function] ... again begins to increase" (60), thus indicating the

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<sup>25</sup> Of course Smith was not the originator of the idea that the division of labor gives rise to increasing returns.

<sup>26</sup> "Adam Smith did not appear himself to be in the least troubled by the thought that competition and increasing returns might not be able to coexist" (Richardson 1975: 354); see also Stigler (1951) and Groenewegen (1999).

<sup>27</sup> Schumpeter writes: "Senior - or West and Senior - must be held responsible for the tradition, which took such time in dying, that agriculture was the domain of the latter [decreasing returns] and 'industry' the domain of the former. This quite misleading arrangement was not set right until the next period" ([1954] 1986: 585).

possibility that the marginal cost curve might be U-shaped. It is to Babbage that J. S. Mill (1848, I.9) refers in the discussion on increasing returns, but he goes further, explicitly stating that a large scale of production gives rise to savings in costs: “as a general rule – he writes – the expenses of a business do not increase by any means proportionally to the quantity of business” (I.9.3). On this issue, Walras cites J.S. Mill and especially Dupuit (1949 and 1952-53). In examining the distribution of water and gas, he recognizes that average costs decrease, because: “the expenses of the initial set-up, and up to a certain point in its utilization, can be spread over a varying number of products” (Walras [1875] 1936: 210).

H.C. Adams classifies industries into three types, according to their returns to scale: “All industries, as it appears to me, fall into three classes, according to the relation that exists between the increment of product which results from a given increment of capital or labor” ([1887] 1969: 105). A similar classification, but seen from the costs side, is made by the Italian marginalist Pantaleoni when he writes: “we may ... divide all products into various classes: [1] commodities of which a greater quantity than that available.... may be obtained *by a simply proportionate increase of cost*; [2] products which can be increased at a *less than proportionate cost*; [3 other products require] *a more than proportionately increased cost*” ([1889] 1957: 187). As we can see, he clearly states here the existence of a functional relation between costs and output. But Pantaleoni goes further, claiming that the three cases he has listed are not alternative and do not rule each other out, but can coexist in the same business: “an increase of the quantity produced is, within certain limits, accompanied by a diminution of cost – writes Pantaleoni – but ... beyond those limits, it involves increased cost” (193). We have to add that he never considered the possibility that decreasing costs could generate a monopoly (146)<sup>28</sup>. Another of the Italian marginalists, De Viti de Marco, makes an important contribution to a much more detailed identification of the cost features related to natural monopoly: he identifies industries with high fixed costs (part of which are described as sunk) and low marginal costs (transport networks, telegraph and telephone industries), or zero marginal costs (the production of non-rival goods, like theatres) and on this basis he explains the reason why costs decline

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<sup>28</sup> And he will never consider that possibility, even in his later work on combinations and associations, where he doesn't see any actual danger for the competitive process, because he believes that the threat of entry by new firms is always at work (Pantaleoni 1903 [2001]: 164-165). Pantaleoni's view of market power is examined in Mosca (2007).

as the scale of production increases. The importance attributed by Marshall to the “law of increasing returns” is well known (Loasby 1996). The aspect of his theory that interests us in this paper is his internal economies which, according to him, depend on “the resources of the individual houses of business engaged in [the industry], on their organization and the efficiency of their management” (Marshall 1890a: IV.IX.25). Internal economies are very important in Marshall’s *Economics of Industry*, and also in his *Principles*<sup>29</sup>. The “reconciliation problem” to which they could give rise will be discussed in the next section.

What Pareto describes vaguely in the following terms: “for each type of production, there is a certain size of enterprise which corresponds to the minimum cost of production” ([1906] 1971: 243), is expressed with perfect clarity by Barone. As a matter of fact, perhaps for the first time in the economic literature, he gives a precise, complete description of the shape of the average cost curve: “if [one drew] a diagram with the *unit* costs of production on the y-axis, [the curve] would slope downward until a certain point, and then upward” ([1908] 1936: 23, author’s italics). Apparently, it is the first time in the history of economics that a diagram with the average cost curve is verbally described<sup>30</sup>. Historians of economic thought like Stigler (1941: 112) and Schumpeter (who quote Stigler) agree that “Edgeworth’s analysis of the law of returns is one of his most important contributions to economic theory”. In fact he examines increasing returns in relation to marginal and average costs, separately considered (Edgeworth 1911a, 1911b). Moreover, his 1913 article has probably the first diagram of the U-shaped average and marginal cost curve, and the demonstration that the marginal costs curve intersects a U-shaped average costs curve at its minimum (1913: 214, fig. 3). We recall briefly that it was first Harrod (1930) and then Viner (1931) who found and diagrammed the relation between the U-shaped average and marginal costs curves for the short and long run, both for the single firm and for the whole industry<sup>31</sup>. After having examined economists’ analysis of the variation in costs as output increases, we pass now to their consideration of *generalized* economies of scale, and to the problem of monopoly that they could imply.

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<sup>29</sup> Marshall devotes the entire chapter IX of book IV of his *Principles* to internal economies. See Stigler (1941: 76- 83) and Marchionatti (1992: 559-561) among others.

<sup>30</sup> Scherer states that only in 1912 did Fisher give “a correct verbal discussion of the short-run relationships between average cost and volume when fixed costs are incurred (2001: 900).

<sup>31</sup> See Harrod (1931), Robbins (1934) and the literature cited in Aslanbeigui & Naples (1997).

#### *4. The compatibility of scale economies with competition*

The decisive step in identifying a situation of natural monopoly is to recognize that generalized scale economies lead to the survival of a single firm in the market; graphically, if the intersection between the demand curve and the average costs curve is found in the downward part of the latter, that market will be served by a single firm. The question under examination in this section is what economists thought would happen to the market structure as the average cost decreased over the entire relevant range of market demand.

It is well known that Senior divided monopolies into four kinds; he considered one kind to be due to scale economies, but he doesn't explain how it happens that economies of scale lead to monopoly; moreover he applies this feature to production in which there are also "certain exclusive facilities as a producer" such as "patent machinery" (1836: 4.51)<sup>32</sup>. Cournot was the first to clearly pose the problem: if the marginal cost function is diminishing, he writes, "nothing would limit the production of the article" and a monopoly would occur ([1838] 1960: 91). Albeit basing his case on different arguments, J.S. Mill reaches the same conclusion. As we have seen, he identifies many causes of cost savings in large scale production; in these cases, according to Mill, the presence of numerous small businesses is a useless waste. All this leads him to conclude that when competition could bring about only a multiplication of costs, a single firm will survive (1848: I.9.7). As we have seen in the previous section, J. S. Mill and Dupuit inspired Walras to write: "Laying a second system of water or gas pipes in a city where there is already one that could satisfy all the needs, building a second network of roads in a country where there is already one that is enough for all the communications, would be an absurd way of chasing after economies" ([1875] 1936: 211). Ely just briefly mentions the question, but hits the nail on the head: "there is great economy and convenience in the conduct of the transportation ... by those operating on a vast scale ... and this gives to that industry its inherent and irresistible impulse toward monopoly" (1886: 574). Like many other economists, he also takes up J.S. Mill's argument about waste, stating: "One telegraph company can send telegrams all over the country cheaper than two" (Ely 1889: 44). Hadley makes an interesting comment on the process toward equilibrium: since the railroad "is

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<sup>32</sup> This is perhaps one of the reasons why Stigler writes that Senior "was wholly promiscuous in his use of the concept of monopoly" (1957:3).

not subject to the law of the diminishing return ... there is ... no direct limit to [the] cut-throat competition" (1886: 35); such price competition generates, in his opinion, the survival of only one firm, and therefore a monopoly. For De Viti de Marco the telephone industry tends to be a monopoly not only due to cost features, but also due to network effects.

The position taken by Marshall (1890a) in this respect is much more complex. The literature on this aspect of his thought is massive<sup>33</sup>. We need only recall here that in his *Principles*, Marshall cites Cournot's statement on the contradiction between economies of scale and competition, but criticizes him for following only the abstract logic of mathematics. He tries, as we know, various ways of solving what he called the "Cournot dilemma", without abandoning either internal economies or competition<sup>34</sup>. Like Marshall, also Pareto critically examines the theory that economies of scale necessarily lead to monopoly, and concludes that "the facts are not in accord with this theory" ([1906] 1971: 243).

A truly complete examination of the concept of natural monopoly can be found in *Principi di economia politica* by Barone, who explains it in the following terms: "If the unit cost of the product were to diminish indefinitely, as the quantity of output increases, it would be advantageous for the production of every good to be concentrated in a single firm" (1908 [1936]: 20-21). "And this can occur - he adds - when ... there is ... a type of firm such that, while its costs decline toward a limit, its size is enough to satisfy the entire market demand" (289)<sup>35</sup>.

Schumpeter writes that Marshall had "all the clues that are needed for a satisfactory treatment of decreasing costs in all its meanings and aspects"; then he adds: "the only thing to wonder at is that this discussion took so long to burst into print and to present results to the scientific public at large" ([1954] 1986: 1046). In actual fact, contributions to the issues reappear only in the 1920s<sup>36</sup>. It is well known that incompatibility was one of the

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<sup>33</sup> We just mention Stigler (1951), Schumpeter (1954), Whitaker (1990), Marchionatti (1992), Loasby (1996), Groenewegen (1999), Whitaker (2003), Hart (2004).

<sup>34</sup> We also know that Marshall changed his views over the years on this question (Whitaker 2003).

<sup>35</sup> The same concept is found in his *Principi di economia finanziaria* (Barone 1911-12: 120-121).

<sup>36</sup> Buchanan and Yoon (1999) believe that, after the success of the U-shaped cost curves, neoclassical authors gave up the hypothesis of generalized increasing returns because of the difficulties it created for their theory of distribution.

focuses of Sraffa's critique of Marshallian supply function<sup>37</sup>. His 1925 article opens with the quotation of Pantaleoni's classification of industries based on different returns; he then states the contradiction between internal economies and competitive equilibrium<sup>38</sup>. He returned to this in his 1926 article: "reductions in cost connected with an increase in a firm's scale of production – he writes – arising from internal economies or from the possibility of distributing the overhead charges over a larger number of product units, [are] incompatible with competitive conditions" (1926: 540). In a brief historical reconstruction of Smith's theorem on increasing returns, Stigler (1951) does not mention Sraffa, while he cites Knight's criticisms of Marshall's solutions for the reconciliation problem. In fact, in the first half of the 1920s, Knight dealt with the problem several times<sup>39</sup>, reaffirming that the necessary outcome of generalized decreasing costs due to large scale production was monopoly (Marchionatti 2003: 60). We can thus ascribe to Sraffa and Knight the definitive statement on the incompatibility of increasing returns and perfect competition. Of course, in the 1920s both of them, together with many other economists inside and outside Cambridge, contributed to the well known "cost controversy", which was focused exactly on whether increasing returns and competition could be compatible or not. It's worth noting that those participating in this conference didn't mention any concrete example of industries exhibiting generalized economies of scale; moreover, the expression "natural monopoly" to identify those industries was never used. Once more, we see that the different components of the concept followed different paths.

## 5. *The diagram*

We have seen that Barone perfectly described the shape of average cost curves and the situation in which natural monopoly occurs, using both cost curves and market demand. He did it in words, and didn't draw the diagram. It was Edgeworth, in one of his four famous articles on the theory of railway rates<sup>40</sup>, written between 1911 and 1913, who drew a diagram in which natural monopoly was perfectly represented, probably for the

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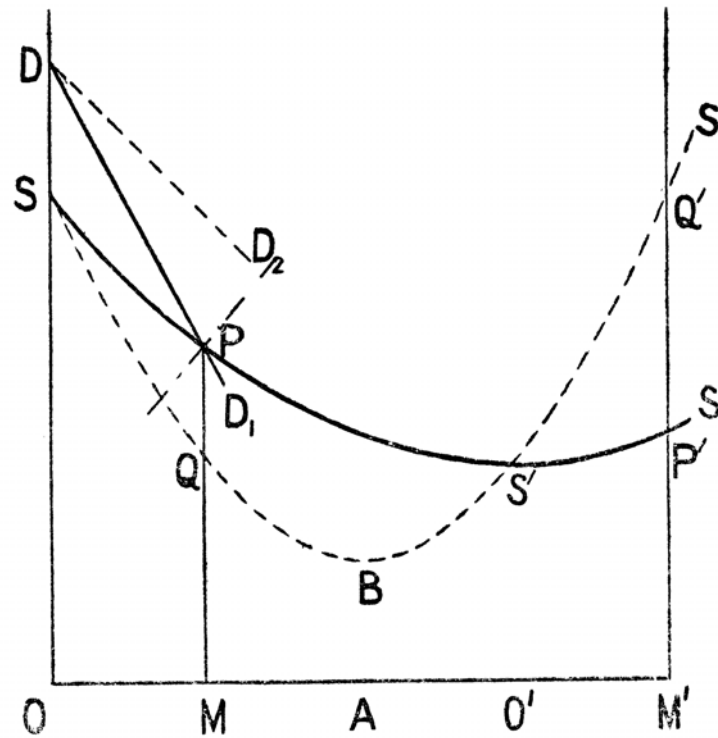
<sup>37</sup> The literature devoted to Sraffa's criticisms of Marshall's theory is also massive; see the up-to-date references in Rosselli (2005).

<sup>38</sup> For an interpretation of Sraffa's 1925 article see Roncaglia (1991).

<sup>39</sup> In particular we remember Knight (1921).

<sup>40</sup> We have already mentioned three of these four articles in the section on economies of scale.

first time, with the two cost curves (average and marginal) and the demand function (1913, 214, fig. 3). In the section called *Graphical Representation of Cost*, he treats a variety of aspects. He analyzes the case in which the demand curve intersects the supply curve in the increasing part of the marginal cost curve, and then he turns to its decreasing part.



In his diagram, DD<sub>1</sub> is the demand curve, SS<sub>1</sub> is the average cost curve, and SS<sub>2</sub> is the marginal cost curve. Edgeworth writes that, while a decreasing average cost curve is “insignificant in a régime of competition ...” (1913: 213), it is perfectly possible under a monopoly regime.

## 6. Government intervention

We go now briefly to natural monopoly as a rationale for Government intervention. We are aware that a subject of such importance should be treated with much more depth; at the same time we think that a short synthesis of the different positions taken by the economists mentioned above is enough for the limited scope of this paper.

And we start with J.S. Mill, who states that: “when ... a business of real public importance can only be carried on advantageously upon so large a scale as to render ... competition ... illusory ... it is much better to treat it at once as a public function” ([1848] 1849: 176). As Ekelund and Hébert point out, he proposes a: “decentralized provision of service at the municipal level under government ownership and locally elected board

management” (1981: 470). It’s well known that J. Dupuit was a very strong supporter of free markets; nevertheless he was convinced that, as the transport network is a monopoly, the private monopolist could abuse of his position; for this reason Dupuit was in favour of public intervention: “L’exploitation par l’Etat d’une industrie quelconque – he writes – est un fait exceptionnel qui doit toujours être justifié par des circonstances exceptionnelles. Or ici [transport network, water distribution, lighting, heating] la circonstance est le monopole” (1852-53 : 852)<sup>41</sup>. The same opinion was expressed by Walras (1875), who wanted the Government to intervene in the railways, either by directly controlling, or by regulating them<sup>42</sup>. The importance of nationalization for the railways is strongly expressed by Ely (1886 and 1889)<sup>43</sup>, while Hadley finds the necessity for Government regulation in the very difficult aim of controlling “the abuses of monopolies without destroying the industries” (1886: 28), and H.C. Adams (1887) sees social harmony restored by extending the duties of the State in the “industries of increasing returns”<sup>44</sup>. It is to these American writers that Marshall refers when he says: “arguments are now used, especially in America (as for instance by Mr H. C. Adams), in support of the active participation of the State in industries which conform to the law of increasing return” (1890a: V.XIII. fn.129). On the contrary, Marshall suggests that “such undertakings, though always under public control, and sometimes even in public ownership, should whenever possible be worked and managed by private corporations” ([1890b] 1964: 106). The proposal of De Viti de Marco (1890) is very interesting: he writes that the Government can regulate entry in a natural monopoly through a system of competitive bidding; it can award a franchise to the most efficient firm and can refuse to renew it if the firm behaves as a monopolist. As is well known the same proposal was made by Chadwick in 1859, and by Demsetz in 1968<sup>45</sup>.

## 7. An overview

Expression	Concrete situations	Scale economies	Incompatibility	Diagram	Government intervention

<sup>41</sup> There are many other occasions, like the monthly meetings of the Société d’économie politique between 1853 and 1864, in which Dupuit expressed his opinion in favor of public management of natural monopolies. See Mosca (1998: 265).

<sup>42</sup> For a different analysis of Dupuit and Walras on railroads see Ekelund and Hébert (2003).

<sup>43</sup> See the criticisms of Ely’s belief in government superiority for the regulation of natural monopolies by O’Driscoll, who thinks that: “he was in error in almost all his contentions” (1982: 197-199).

<sup>44</sup> On Adams’ opinion of regulation see Sharkey (1982: 15-16).

<sup>45</sup> For the proto-history of franchise bidding see the very interesting article by Ekelund and Hébert (1981).



		<i>Smith 1776</i> Division of labour			
<i>Malthus 1815</i> Old sense					
		<i>Senior 1836</i> Scale economies	<i>Senior 1836</i> Only a relation		
		<i>Cournot 1838</i> Marginal cost function	<i>Cournot 1838</i> Based on mathematics		
<i>J.S. Mill 1848</i> New sense	<i>J.S. Mill 1848</i> Postal service Water and gas	<i>J.S. Mill 1848</i> Large-scale = saving in costs	<i>J.S. Mill 1848</i> Waste due to competition		<i>J.S. Mill 1848</i> Provision at municipal level
	<i>Dupuit 1852-53</i> Transport networks				<i>Dupuit 1852-53</i> Public management
<i>Walras 1875</i> More precision	<i>Walras 1875</i> Public utilities	<i>Walras 1875</i> Initial set-up costs	<i>Walras 1875</i> Duplication		<i>Walras 1875</i> Public direct control or regulation
<i>Ely 1880s</i> Consolidation					<i>Ely 1886</i> Nationalization
			<i>Hadley 1886</i> Process of adjustment		<i>Hadley 1886</i> Regulation
		<i>Adams 1887</i> Three classes of returns to scale			<i>Adams 1887</i> State duty
		<i>Pantaleoni 1889</i> Variations in costs			
	<i>De Viti de Marco 1890</i> Telephone	<i>De Viti de Marco 1890</i> Cost features of natural monopoly	<i>De Viti de Marco 1890</i> Network effects		<i>De Viti de Marco 1890</i> Franchise bidding
<i>Marshall 1890</i> Indivisible industries		<i>Marshall 1890</i> Internal economies	<i>Marshall 1890</i> Criticisms to Cournot		<i>Marshall 1890</i> Managed by private corporations
		<i>Barone 1908</i> Shape of the average cost curve	<i>Barone 1908</i> Description with consideration of market demand	<i>Barone 1908</i> Verbal description	
		<i>Edgeworth 1913</i> Average and marginal cost functions with diagram		<i>Edgeworth 1913</i>	
			<i>Knight, Sraffa 1920s</i> Cost Controversy Definitive statement		
		<i>Harrod 1930</i> <i>Viner 1931</i> Definitive refinements			

## 8. *The history of the idea*

Now that the analysis of all the elements has been carried out, we can sum up. According to Stigler, Smith – “that great manufacturer of traditions” – created also in the area of monopoly the traditions “that were faithfully followed in English economics for almost 100 years” (1982: 1). However, as far as natural monopoly is concerned, we can say that Smith gave nothing more than suggestions. In actual fact, the earliest economist to mention here is Senior (1836), who was the first to establish a certain relation between scale economies and monopoly. Then we owe to Cournot (1838) not only the elaboration of the mathematical apparatus, but also the analysis of the decreasing marginal cost function, and the statement of its incompatibility with competition. As we can see from the above overview (section 7), J.S. Mill (1848) is present in all the columns (with the exception of *The diagram*); this shows that he had all the elements to identify situations of natural monopoly, and he actually did it properly, even using the expression, but without any analytical tools. The same can be said with respect to Walras (1875): compared with that of J.S. Mill, his analysis was much more focused on the issue, as his essay was specifically devoted to the railways, but he also did not use mathematics in dealing with it. A very important place is taken by the American economists: for Schumpeter Hadley’s theories are realistic, “embedded in a forceful presentation of the institutional framework” ([1954] 1986: 866); O’Driscoll (1982), despite a critical tone, stresses the importance of the legacy of Ely, and Hazlett (1985) does the same with H.C. Adams. The link between network effects and monopoly we certainly owe to De Viti de Marco, while the consideration of market demand, which is essential to qualify a natural monopoly, comes from Barone.

But the pivotal figure for the definition of the concept of natural monopoly is Edgeworth. We have mentioned him mainly as the one who drew the diagram, but we have to add that he did this in a context in which the various elements that make up that concept were all present – except the expression. In fact, the articles in which the diagram is included are specifically devoted to constructing an abstract theory of railways economics, and Edgeworth specifies that railways are there “considered as the leading type of a wider class, ... public works, characterized by monopoly of such a kind as to justify the intervention of the State” (1911: 346). Therefore we find there the analysis of a typical situation of natural monopoly, a deep understanding of increasing returns, and the study of “the monopolistic power of discrimination” (1912: 216). And although he didn’t

write the promised final section on the issue of Government regulation, the work does contain a brief discussion of the topic. These articles are striking: Edgeworth mentions a huge amount of literature from many countries, and deals with a much greater number of subjects than those mentioned here.

## *Conclusions*

The research carried out so far highlights some interesting aspects.

1. We have seen that Senior, Cournot, J.S. Mill, Walras, the American marginalists, the Italian ones, and Edgeworth, all identified natural monopoly. They realized that some firms became monopolies just because in those industries competition couldn't work. The idea that monopoly implies the absence of competition is linked to a specific notion of competition, that of *perfect* competition. The history of the theory of competition has been widely studied in the literature<sup>46</sup>. It is often stated that the notion of perfect competition emerged slowly, and that only in the 1920s did it start to be generally employed. If we compare the historical reconstructions of the notion of perfect competition with our history of the concept of natural monopoly, we can see that there is a remarkable overlapping between the economists who elaborated that notion, and those who played a role in identifying natural monopolies. This suggests that the traditional notion of natural monopoly emerged gradually as the classical notion of competition was substituted by the neoclassical one. The link between the notion of competition and that of natural monopoly is also confirmed if we consider the criticisms to the traditional notion of natural monopoly occurring after the 1970s, and the related different notions of competition. On the one hand, the Austrian theory of competition as a process leads to consider market power as an expression of competitive rivalry, so the Austrians do not find anything wrong in monopolies, which they consider temporary by definition<sup>47</sup>. On the other hand, the Baumol group replaced the notion of perfect competition with that of contestability: their fundamental idea is that the multiproduct monopolist would be compelled by the threat of new entry to behave according to the principles of the perfect competitive model. In opposition to these approaches, the most recent developments of microeconomics

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<sup>46</sup> In addition to the references cited in Blaug (1997), see DiLorenzo and High (1988), Groenewegen (1999), Machovec (1995), Morgan (1993).

<sup>47</sup> A paper on *The Austrian theory of "unnatural" monopoly* was presented at the 1<sup>st</sup> ESHET-JSHET meeting in Nice (France) in December 2006.

employ still other different notions of competition<sup>48</sup>. For example, according to Shepherd, mainstream is not “*static efficiency only, perfect competition only, and total natural monopoly only ...* Instead there is an entirely satisfactory competitive standard: effective competition, rather than the pure theorist’s textbook idea of perfect competition” (1995: 305-306, author’s italic). Also Vickers states that “the concept of competition as equilibrium resource allocator is not the only model of a modern microeconomist” (1995: 18); he uses the “advances in economics of imperfect information, imperfect competition, and dynamic processes” (7) to discuss “incentives, selection and innovation ... three of the fronts on which advances are being made” (18). We finally cite Blaug, who encourage scholars to “abandon the concept of perfect competition” (1997: 79), as well as “its near-neighbour, the theory of perfectly contestable markets” (80), to promote the study of “every chapter in every textbook on imperfect or monopolistic competition, on oligopoly, duopoly and monopoly, in short, ... industrial organization” (80). With the help of game-theoretic analysis, today’s industrial organization, as we have seen in the introduction, studies the strategic contexts in which the potential entrants and the incumbents operate, and in general concludes that there are “a number of reasons why market forces alone are unlikely to reduce market power ... Unfortunately even when entry is in principle free, reasons to worry about monopolies still exist” (Motta 2004: 71).

2. Schumpeter, referring to cost function, calls it: “a striking instance of the slowness and roundaboutness of analytic advance”, and asks the question: “why results were established in and after 1930 that might easily have been established by 1890” ([1954] 1986: 1049). The same could be said about the historical development of the concept of natural monopoly. In fact, as we have seen, the process of moving toward the standard notion of natural monopoly had been slow and roundabout. But if we gather together and examine all those ideas that here, in order to follow this particular notion closely, we have decided to exclude from our account, it will be seen that we could reconstruct another, quite different history of the concept of natural monopoly, by no means less rich. For example we could reconstruct the history of the idea that natural monopoly is always exposed to competition, or that it is itself an expression of competition. It would be sufficient to follow the historical development of the concept of potential competition, or that of competition defined only in terms of freedom of entry, or that focused on the competitiveness of large

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<sup>48</sup> For a history of the concept of competition up until recent times see Backhouse (1990).

firms. Also in these cases we could find that many great economists would readily lend themselves to quotation. This is what Sharkey does, for example, when he points out that before 1970s many economists already noted that “the test for economies of scale is an incomplete test of natural monopoly” (1982: 21). This is what Hazlett does, too, highlighting those economists who believed in “the universality of the competitive assumption” (1985: 5). And DiLorenzo and High di the same, when noticing that economists at the turn of the century “thought that the advantages of competing in large-scale units increased output and benefited the consumer” (1988: 426). Elsewhere DiLorenzo(1996) denies that the theory of natural monopoly was ever accepted before the 1920s; he refers only to the American economists, but we think that his comments could be extended to many European ones, who at that time shared the same view. On comparing those histories and the one recounted here, one would be surprised to find many of the same economists in both. And since we have seen that the ideas on natural monopoly are influenced by different views of competition, this outcome would confirm the thesis, , which many hold, that for a long time in economic thought different, “competing” notions of competition<sup>49</sup> co-existed side by side<sup>50</sup>.

3. If it is true, as O’Driscoll says, that: “surely few would argue that monopoly is a concept of any interest independent of policy implications” (1982: 209), then it is well worth reflecting on these implication, too. They are important also because the critics of the concept of natural monopoly claim that it was even intended precisely for its policy implication<sup>51</sup>. And there is no lack of symmetrical allegations from the opposite perspective: the Baumol group, for example, is in fact accused of proposing “the recurrent arguments favoring a cutback to minimal antitrust policies” (Shepherd 1995: 299). In section 6 we have seen that, as soon as natural monopoly was considered a market failure, the economists, including those who supported the free market, put forward claims for antimonopoly policies. This position was adopted by those economists who accepted

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<sup>49</sup> I twill remembered that this is the title of an article by Mary Morgan (1993).

<sup>50</sup> Also Blaug (1997), Backhouse (1990), and Machovec (1995), find that the first marginalists (up until the 1920s) had this dual vision of competition. We can confirm that this is also true for the Italian marginalists (Mosca 2005 and 2007). Vickers thinks that even at present “the claim that there are two concept of competition is somewhat misleading” (1995: 7), while the Austrians believe that the two views are completely antithetical.

<sup>51</sup> The “fundamental importance of natural monopoly is a legalistic entity that facilitates the efforts of political coalitions to restrict output in the manner predicted in the capture view of regulation” (Hazlett 1985: 2).

perfect competition as an ideal benchmark, and who later adhered to the structure-conduct-performance paradigm<sup>52</sup>. In effect, if monopolistic power depends on market structure, and if the market is concentrated due to entry barriers, then competition policies are needed. On the other hand, the literature which holds that natural monopoly is not to be considered a market failure does not require Government interventions, such as public ownership or regulation for utilities, and antitrust policies for networks. This view belongs to different school of thought. One is the Chicago school: they reject government regulation of natural monopoly, public enterprise, and any antitrust policy beyond preventing the restriction of output, combating cartels, horizontal mergers and predatory practices (Posner 1976, Bork 1978). Another is the contestable market approach: it implies that industry structure provides no a priori rationale for regulation and antitrust. A third one is the Austrians school: they are in favor of the total repeal of antitrust, even for the cases of natural monopoly due to network effects (Armentano 1999). In the last twenty year, new challenges have been set by the post-Chicago approach, the dominant view on industrial organization built on a solid game-theoretic framework. As a consequence, today the question of how to design antitrust institutions is still in dispute<sup>53</sup>.

4. We are facing a typical case of economic thought shaped by reality. In fact the spread of the expression “natural monopoly” in its current meaning, and the elaboration of the related theory, came about mainly with the spread of the situation described by the expression. For instance, when Ely says that “various undertakings ... are monopolies by virtue of their own inherent properties”, he also specifies that “these undertakings are nearly all of them comparatively new” (1894: 294); also the article by Hadley (1886) clearly shows, through numerous examples drawn from the economy of the time, that the problem appeared particularly in those years. The public utilities and networks determined the theory; it is true that the tools provided by Cournot already existed, but many economists did not use them for their explanations.

5. A by-product of having kept the history of the various elements that contribute to the concept of natural monopoly separate, has brought out the undoubted importance of the work of economists from many countries, and also of the Italian marginalists. In the

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<sup>52</sup> This is the thesis of DiLorenzo and High: “Perhaps the clearest link between economist’s changing views of competition and their support of antitrust in the post 1920s era is found in the structure-conduct-performance paradigm of industrial organization theory” (1988: 431).

<sup>53</sup> For the present debate see the very illuminating article by Grillo (2006).

secondary literature one often finds the statement that the debate over costs and competition is a phenomenon of the 1920s; we have seen here that the beginning of the debate can certainly be anticipated to the works of the Italian marginalists, and especially to Barone, who deserves priority over the others. Their actual influence on that debate remains to be studied, though in view of their international fame, it was certainly considerable<sup>54</sup>.

To conclude, we are aware that the concept of natural monopoly still contains many features it would be well worth while examining more closely. We hope that with this article we have helped prepare the ground for further research.

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<sup>54</sup> For example, Marchionatti states that both Sraffa and Knight “take the rigorous notion of equilibrium from Pareto and Enrico Barone” (2003: 66).

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