

# The Classical Notion of Competition Revisited

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The gravitation of market prices toward natural prices in all markets characterized by free competition was widely affirmed by the classical authors, despite the lack of a formal proof. In the wake of the revival of interest in classical economics fostered by the publication of *Production of Commodities by Means of Commodities* (Sraffa 1960), since the mid-1970s a vast literature has blossomed concerning the stability of long-period equilibrium within multisectoral models of classical inspiration. (For a survey of this literature, see Bellino 2011.) Besides the formal results achieved on the subject of stability, the debate on gravitation has stimulated an in-depth investigation of the classical notion of market competition (Arena 1978; Semmler 1984; Steedman 1984; Duménil and Lévy 1987). This investigation has also highlighted some unsatisfactory aspects in the latter, particularly the actual process of market price determination in a situation of market disequilibrium:

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1 Little is said concerning the actual process [which governs the func-  
 2 tioning of the market for commodities]. For example, it is not clear who  
 3 is changing prices, what information is used, when this change occurs,  
 4 what the outcome is on the market etc. (Duménil and Lévy 1987, 136)

5 [L'originalità della teoria classica della libera concorrenza] non è però  
 6 in grado di nascondere certe insufficienze: l'economia politica classica  
 7 si scontra infatti con il problema centrale dell'articolazione tra prezzi di  
 8 mercato e prezzi naturali. La soluzione di queste difficoltà richiede una  
 9 nuova definizione di questa articolazione. (Arena 1978, 323)<sup>1</sup>

10  
 11 The aim of this article is to detect and highlight those elements present  
 12 in classical texts that may be fruitfully employed to overcome the above  
 13 drawbacks of the classical view of market competition. Moreover, as recent  
 14 commentators of classical economics have emphasized, in a situation of  
 15 disequilibrium, when the quantity of a given commodity brought to the  
 16 market differs from Smithian effectual demand, the likely outcome is that  
 17 of a dispersion of prices: "Whereas natural price is by definition a singular  
 18 magnitude for each kind of commodity, the competitive processes whereby  
 19 market prices deviate from natural price under conditions of market  
 20 imbalance are consistent with, indeed likely to cause, transactions at non-  
 21 uniform prices. That is to say, market price as literally the actual prices  
 22 at which transactions occur when there is such market imbalance, is not  
 23 in general a singular magnitude" (Aspromourgos 2009, 72; see also pages  
 24 85 and 88). Accordingly, we claim that the classical theory of market prices  
 25 gives scope to the analysis of the behavior of the agents acting in situa-  
 26 tions of market imbalance through some of the analytical tools and formal  
 27 results achieved by the modern game-theoretic approach to oligopoly the-  
 28 ory, namely, the notion of mixed (i.e., nondeterministic) price-strategy.

29 In what follows, we distinguish and compare two different conceptions  
 30 of market competition: the Walrasian notion of perfect competition and  
 31 the classical notion of free competition, focusing in particular on Adam  
 32 Smith and Karl Marx. We stress that while the Walrasian notion may be  
 33 described as an equilibrium state in which atomistic agents treat prices  
 34 parametrically, the classical notion is a situation in which agents employ  
 35 their market power by setting prices strategically. The absence of a price-  
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37 1. [The originality of the classical theory of free competition] is not, however, able to hide  
 38 certain inadequacies: the classical political economy clashes with the central problem of the  
 39 articulation between market prices and natural prices. The solution of such difficulties  
 requires a new definition of this articulation (our translation).

taking assumption in the classical authors is the main reason why the theoretical difficulties besetting the Walrasian notion outside market-clearing equilibrium do not plague the classical notion as well. Yet though for the classical authors price undercutting or outbidding are the typical phenomena that occur in any market characterized by free competition, it is fair to say that they went no farther than to provide only some unsystematic guidelines on how to analyze in due detail the competitive process of market price determination. Among other things, we show that Marx's extensive use of metaphors and numerical examples hides the modern taxonomy of buyers' market, sellers' market, and mixed strategy equilibrium in the capacity space of a standard Bertrand duopoly model. In particular, we argue that Marx was conscious that between the buyers' market, in which the price is determined by the reservation price of sellers, and the sellers' market, in which the price is determined by the reservation price of buyers, there is something in which the price is not unique and any equilibrium can concern only distributions of probability (mixed strategies) on the behavior of the traders. We substantiate this fact by using a formalism derived from the contemporary analysis of Bertrand competition. (The elements required to identify a necessary and sufficient condition to separate these three different market outcomes are sketched in an appendix.) We are aware that our analysis, once duly developed, needs to be related to contemporary gravitation literature. Yet we defer investigation of this issue to a future paper.<sup>2</sup>

The structure of the article is as follows. Section 1 compares two different notions of the concept of market competition, the classical notion of free competition and the neoclassical notion of perfect competition, and highlights some problematic aspects of the latter, absent in the former. Sections 2 and 3 assess the classical theory of free competition, as developed by Adam Smith and Karl Marx, with particular concern for market price determination. Section 4 investigates how the classical notion of competition has percolated into the modern literature on so-called Bertrand competition. Section 5 concludes.

2. The basic model used to represent the classical gravitation process is the so-called cross-dual model, in which (1) sectoral outputs change in response to differentials in the rates of profit; (2) market prices change in response to excess demand of the various commodities. While the first adjustment process is widely accepted as a fair formalization of the classical principle of capital mobility, the second appears as a mechanical transposition of the Walrasian price adjustment process and is the ultimate culprit behind the intrinsic instability of cross-dual gravitation processes. The present article proposes a totally different market price formation and should be able to resolve the instability problem envisaged in this literature.

## 1. Two Different Notions of Market Competition or Just One?

Few commentators would disagree with the following statement: “Although the concept of competition has always been central to economic thinking . . . it is one that has taken on a number of interpretations and meanings, many of them vague” (Vickers 1995, 3). In particular, Vickers distinguishes the notion of perfect competition—a “seemingly tranquil equilibrium state in which well-informed agents treat prices parametrically”—from the “original and ‘real’ concept” of competition, a “rivalrous behaviour with respect to prices and other variables in a world characterized by flux, uncertainty and disequilibrium” (7).

Despite the differences between these two notions, many authors have come (more or less explicitly) to consider the classical notion of free competition nothing but a primitive and pre-analytical version of the neo-classical theory of perfect competition, a version still imbued with casual empiricism: “It is a remarkable fact that the concept of competition did not begin to receive explicit and systematic attention in the main stream of economics until 1871. This concept . . . was long treated with the kindly casualness with which one treats of the intuitively obvious. . . . ‘Competition’ entered economics from common discourse, and for long it connoted only the independent rivalry of two or more persons” (Stigler 1957, 1). Such an interpretation has deeply influenced many of the leading exponents of neoclassical economics. (See, e.g., Arrow and Hahn 1971, in particular chapter 1, “Historical Introduction,” and Samuelson 1978.) Even outside the neoclassical camp this interpretation has found supporters, such as Nicholas Kaldor (1972, 1241), when he claims that “one can trace a more or less continuous development of price theory from the subsequent chapters of Smith [the fourth chapter of the *Wealth of Nations*] through Ricardo, Walras, Marshall, right up to Debreu and the most sophisticated of present-day Americans.” Vickers (1995, 7) himself concludes that “the claim that there are two concepts of competition is somewhat misleading.”

Nonetheless, historians of economic thought who have endorsed an alternative point of view have not been lacking. Paul McNulty (1967, 397) not only argued that the classical notion of competition as a behavioral process is radically different from the neoclassical notion of competition as an equilibrium state but also went so far as to claim that the neoclassical assumption of individual price-taking behavior is entirely alien to

the classical analysis:<sup>3</sup> “Smith’s concept of competition was decidedly not one in which the firm was passive with respect to price but was, rather, one in which the market moved toward equilibrium through the active price responses of its various participants.” Therefore, what in the previous interpretation appears simply as a process of analytical refinement, in McNulty’s view is no less than “a basic conceptual change” (397). Moreover, McNulty adds that, pace George Stigler, the classical notion of competition is far from being derived from casual empiricism. Smith is the great systematizer of the analysis of the concept of market competition carried out by a series of authors before him (most notably, Cantillon and Turgot) and his specific contribution was to raise the concept of competition to a “general organizing principle of economic society. . . . After Smith’s great achievement, the concept of competition became quite literally the *sine qua non* of economic reasoning” (McNulty 1967, 396–97; see also McNulty 1968, 646–47).<sup>4</sup>

McNulty’s interpretation raises the matter of investigating the theoretical conditions that have led to such a dramatic change of meaning in the original notion of competition. A first step in this direction may be found in the distinction between two different notions of economic science: (1) economics as the science that studies a system of forces and (2) economics as the science that studies a system of relations—a distinction introduced by Marco Dardi (1983) that was recently emphasized by Nicola Giocoli (2005):

According to the system-of-forces (SOF) view, economics is a discipline whose main subject is the analysis of the economic processes

3. From this point of view, McNulty’s interpretation is akin to those of Samuel Hollander (1973) and John Eatwell (1987). The former claims that “the Smithian conception of competition must be carefully distinguished from the modern conception which envisages sellers (and consumers) as ‘price-takers’ rather than ‘price-makers’” (126), while the latter points out that “the characteristics of ‘perfect’ competition (notably the conditions which ensure price-taking) are often read back, illegitimately, into Classical discussions of competition” (63). See also High 2001, xiv–xv; and Machovec 2005, chap. 8. While Blaug defines Arrow and Hahn’s 1971 tribute to Adam Smith as a forerunner of perfect competition (and Pareto optimality) analysis no less than “a historical travesty” (Blaug 2001, 153), a more balanced position is endorsed by Michael Bradley (2010, 238), who argues that “Smithian ‘liberty’ contains the seeds of perfect competition, but perfect competition is different from ‘perfect liberty’ in some critical respects, particularly the nature of competition and the role of entrepreneurs.”

4. McNulty (1967, 395–96) provides a discussion of Cantillon and Turgot as forerunners of Smith on competition. An extensive treatment of the evolution of the notions of price, cost, and competition before Smith may be found in Aspromourgos 2009, 101–10.

1 generated by market and not-market forces, including—but by no  
 2 means exclusively—the processes leading the system to an equilib-  
 3 rium. According to the system-of-relations (SOR) view, economics is a  
 4 discipline whose main subject is the investigation of the existence and  
 5 properties of economic equilibria in terms of the validation and mutual  
 6 consistency of given formal conditions, but that has little if anything to  
 7 say about the meaningfulness of these equilibria for the analysis of  
 8 real economic systems. (Giocoli 2005, 180)

9  
 10 According to Giocoli, the SOF view was the dominant vision up to the  
 11 years between the two world wars, while the SOR view gained popularity  
 12 only in the second postwar period when considerable intellectual effort  
 13 was devoted to the project of a full axiomatization of economic science  
 14 (180). Similarly, in a series of papers Blaug (1997, 2002, and 2003) indi-  
 15 cated in the formalist revolution of the 1950s and the parallel rise to dom-  
 16 inance of the Walrasian general equilibrium theory the two driving forces  
 17 that led to the decline of the classical (and early neoclassical) notion of  
 18 competition as a process and its replacement with the modern notion of  
 19 competition as an end-state (with the associated first and second funda-  
 20 mental theorems of welfare economics).

21 Thus it may be claimed that the semantic shift in the notion of competi-  
 22 tion is part of a more general process of redefining central categories and  
 23 concepts of economic analysis started in the 1930s with the rediscovery of  
 24 Walrasian general equilibrium theory (Donzelli 1990, chap. 9) and fully  
 25 accomplished in the late 1970s with the rediscovery of the Nash equilib-  
 26 rium concept (Giocoli 2003, chap. 5): the classical notion of market com-  
 27 petition makes little sense outside the SOF view, while the Walrasian  
 28 notion of competition perfectly fits the theoretical standards set by the  
 29 SOR view.

30 There are at least two reasons why the distinction between the classical  
 31 notion of competition and the neoclassical one and careful analysis of the  
 32 theoretical domain of the latter is not simply a historiographical exercise:

- 33 1. The neoclassical theory of perfect competition carries with it some  
 34 theoretical difficulties alien to the classical notion of free competition.
- 35 2. The classical notion of competition can be made analytically precise  
 36 in terms of the modern concept of mixed strategies equilibrium.

37 The final part of this section is devoted to substantiating point 1 above,  
 38 while we defer analysis of point 2 to section 4.  
 39

As pointed out by Jerry Green (1974), every market equilibrium concept requires the specification of a consistent set of behavioral postulates that prescribe what happens in equilibrium and what happens outside equilibrium. In the Walrasian framework, the behavioral postulates that define the situation of equilibrium differ from those that define the adjustment mechanism in disequilibrium. As regards the former, the behavioral postulate is that every agent assumes market prices as parametrically given and, on the basis of such prices and other constraints, maximizes his or her own objective function. By contrast, in disequilibrium, the behavioral postulate is that a meta-agent, the auctioneer, determines market prices according to market excess demands. Moreover, no transactions among the agents are allowed to take place during the adjustment process.<sup>5</sup> As a consequence, the price-taking behavior assumption implies that each individual firm in a given market has no incentive to set a price different from the ruling market price and has no incentive to carry on transactions at a price other than the Walrasian market-clearing price. Thus such an assumption drastically reduces the theoretical domain of the theory to equilibrium, market-clearing situations.<sup>6</sup>

To our knowledge, Kenneth Arrow (1959) was the first to highlight the logical difficulties besetting the neoclassical theory of perfect competition:

the Law [of supply and demand, Arrow's equation 3:  $dp/dt = h(S - D)$  with  $h' < 0$  and  $h(0) = 0$ ] is not on the same logical level as the hypotheses underlying equation 1 [ $D = f(p)$  and  $S = g(p)$ ]. It is not explained whose decision it is to change prices in accordance with equation 3.

5. From this perspective Edgeworth's concept of equilibrium (*core*) and his adjustment process in disequilibrium (*recontracting*) are superior to the Walrasian ones: "The recontracting process . . . is based on the same behavioral postulate, blocking by coalitions, that is used to define the solution concept, the core [The core is defined to be the set of all unblocked allocations. That is, it is the set of all allocations such that no subset of the participants can improve the position of all its members by withdrawing from the system and using only resources of its members]. This seems to be a desirable property. It is, however, not shared by most studies of disequilibrium price dynamics because these involve price changes brought about by a market manager or other artificiality. Prices do not vary as a consequence of the maximizing behavior of individuals" (Green 1974, 22).

6. Current textbooks also acknowledge this fact: "Strictly speaking, it is *equilibrium* market prices that [consumers and producers] will regard as unaffected by their actions. . . . For the price-taking assumption to be appropriate, what we want is that [consumers and producers] have no *incentive* to alter prices that, if taken as given, equate demand and supply (we have already seen that [consumers and producers] *do* have an incentive to alter prices that do not equate demand and supply) (Mas-Colell, Whinston, and Green 1995, 314n1, 315; emphasis added).

1 Each individual participant in the economy is supposed to take prices  
 2 as given and determine his or her choices as to purchases and sales  
 3 accordingly; there is no one left over whose job it is to make a deci-  
 4 sion on price. (Arrow 1959, 43)<sup>7</sup>

5 In short, for Arrow in the perfect competition setup there is no place  
 6 left for “a rational decision with respect to prices” thus implying the con-  
 7 clusion that “perfect competition can really prevail only at equilibrium”  
 8 (41). The solution proposed by Arrow to study market price dynamics out-  
 9 side market-clearing equilibrium consists in turning to the theory of the  
 10 monopoly: “When supply and demand do not balance, even in an objec-  
 11 tively competitive market, the individual firms are in the position of  
 12 monopolists as far as the imperfect elasticity of demand for their products  
 13 is concerned” (46). However, Arrow claims that standard monopoly theo-  
 14 ry must be modified so as to remove the assumption that monopolists  
 15 know perfectly their own demand curve (besides their own cost curves):  
 16 “Uncertainty [as to the demand curve] is a crucial consideration in the  
 17 theory of monopolistic price adjustment” (44). In such circumstances,  
 18 monopolists will vary their own price, in a process of trial and error, until  
 19 they find the price that maximizes their expected profits.

20 For our purpose, the salient points of Arrow’s analysis are the following:

- 21 1. Jevons’ law of indifference, which states that there is only one price  
 22 ruling in a competitive market, ceases to be valid in disequilibrium:  
 23 “Although the broad tendency will be for prices to rise when demand  
 24 exceeds supply, there can easily be a considerable dispersion of  
 25 prices among different sellers of the same commodity” (46–47).
- 26 2. By assuming that competition takes place on both sides of the mar-  
 27 ket, that is, competition among sellers and competition among buy-  
 28 ers, a buyers’ market may be distinguished from a sellers’ market:  
 29 “By a parallel argument each buyer on a market with an inequality  
 30 between supply and demand can be regarded as a monopsonist. . . .  
 31 *In disequilibrium, the market consists of a number of monopolists*  
 32 *facing a number of monopsonists.* The most general picture is that  
 33 of a shifting set of bilateral monopolies. . . . In general, it is reason-  
 34 able to suppose that if the selling side of the market is much more  
 35

36  
 37  
 38 7.  $D(S)$  is the quantity demanded (supplied) of a given commodity  $X$ ,  $p$  its price,  $f(p)$  and  
 39  $g(p)$  the demand and supply functions, respectively, while  $dp/dt = h(S - D)$  is the time deriva-  
 tive that formalizes the law of motion of market price in relation to market excess demand.



concentrated than the buying side, the main force in changing prices will be the monopolistic behavior of the sellers. . . . Similarly, if the buying side of the market is the more concentrated, as in non-unionized labor markets, the dynamics will come from that side” (47; emphasis added).

In the following two sections we make it clear that these two elements of Arrow’s contribution may be found in Smith’s and, even more explicitly, in Marx’s treatment of market prices, thus paving the way for a restatement of the classical notion of competition through contemporary game-theoretic analysis.<sup>8</sup>

## 2. The Classical Notion of Free Competition:

### Adam Smith

George Richardson (1975, 350–51) has convincingly argued that “competition features within *The Wealth of Nations* in two different contexts; first, in the account given of the balancing of supply and demand in particular markets, and, secondly, in the explanation of structural and technological development. Smith offers us in effect both a theory of economic equilibrium and a theory of economic evolution; and in each of these competition has a key role to play.” In what follows we concentrate on the static aspect of the Smithian notion of market competition, concerned with market price determination, leaving aside its dynamic aspect (see Lavezzi 2003).

As far as the classical notion of market competition is concerned, the locus classicus is book 1, chapter 7 of Smith’s ([1776] 1976) *Wealth of Nations* (*WN*).<sup>9</sup> Smith’s working assumption is that it is possible to classify the economic forces in action in a given moment into two broad categories, (1) those erratic and short-lived forces that determine the market values both of commodity prices and of the distributive variables and (2) those systematic and persistent that determine the natural values of the same magnitudes. Classical economists generally hold the view that

8. Arrow’s 1959 contribution with its emphasis on the role of monopoly theory in explaining competitive price convergence is the ideal starting point for the subsequent neo-Walrasian literature on disequilibrium trading (see Donzelli 1990, chap. 9).

9. As is well known, Ricardo (1951, 91) devotes to the distinction between natural and market magnitudes just the short chapter 4 of his *Principles*, where he explicitly refers to chapter 7 of *WN*, where “all that concerns this question is most ably treated.”

1 only the latter can be the proper subject of scientific inquiry (Ciccone  
2 1999, 70).<sup>10</sup>

3 The data from which the Smithian argument starts are the natural rates  
4 of wages, profits, and rents that, sectoral specificities apart, depend mainly  
5 on the conditions of prosperity of the economic system under scrutiny, its  
6 “advancing, stationary, or declining condition” (*WN* I.vii.1). The natural  
7 price of (re)production of the various commodities derives from the sum-  
8 mation of these three elements. The natural price is therefore a magnitude  
9 that is not immediately formed in the market but that, given some appro-  
10 priate conditions, may come true in the market. Indeed, the natural price  
11 constitutes a sort of a floor for the market price in the sense that the latter  
12 cannot remain for long below the former without seriously jeopardizing  
13 the reproduction of the commodity in question: “The competition of the  
14 different dealers obliges them all to accept of [the natural price]; but does  
15 not oblige them to accept of less. . . . The natural price, or the price of free  
16 competition . . . is the lowest which can be taken, not upon every occasion,  
17 indeed, but for any considerable time together . . . is the lowest which the  
18 sellers can commonly afford to take, and at the same time continue their  
19 business” (*WN* I.vii.11). The theoretical importance of natural prices cons-  
20 sists in providing a guide to the theorist for explaining the dynamic path  
21 followed by market prices: “The natural price, therefore, is, as it were, the  
22 central price to which the prices of all commodities are continually gravi-  
23 tating. Different accidents may sometimes keep them suspended a good  
24 deal above it, and sometimes force them down even somewhat below it.  
25 But whatever may be the obstacles which hinder them from settling in this  
26 center of repose and continuance, they are constantly tending towards it”  
27 (*WN* I.vii.15).

28 To study the genesis of market prices and the existing relations between  
29 market prices and natural prices, Smith introduces the concept of *effec-*  
30 *tual demand*, that is, “the demand of those who are willing to pay the  
31 natural price of the commodity.” It is to be stressed that the relationship  
32 between the quantity brought to the market and the effectual demand  
33

34 10. Ricardo (1951, 91–92) clearly states that the *focus* of his analysis is only natural magni-  
35 tudes: “Having fully acknowledged the temporary effects which, in particular employments of  
36 capital, may be produced on the prices of commodities, as well on the wages of labour, and the  
37 profits of stock, by accidental causes, without influencing the general prices of commodities,  
38 wages or profits, since these effects are equally operative in all stages of society, we will leave  
39 them entirely out of consideration, whilst we are treating of the laws which regulate natural  
prices, natural wages and natural profits, effects totally independent of these accidental causes.”

determines only the market price of a commodity and not also its natural price.<sup>11</sup> Moreover, “demand” and “supply” are treated by Smith as given quantities and not as functional relationships between price and quantity characterized by well-defined formal properties, as they would be in the neoclassical theory (Garegnani 1983; Aspromourgos 2009, 83–84).<sup>12</sup>

Given the unplanned nature of market economies, at the end of a productive cycle, entrepreneurs may not face in the market a demand able to absorb the whole of their production at the natural price (at least). This requires the specification of an adjustment mechanism powerful enough to bring about effective convergence to a situation in which the produced quantity coincides with the effectual demand: in the absence of such a mechanism, natural prices may not constitute a reliable guide to explain the movements of market prices.<sup>13</sup>

In short, the adjustment mechanism envisaged by classical authors is as follows. At the end of a productive cycle, the entrepreneur brings to the market a given quantity of produced commodity resulting from the production decisions taken at the beginning of the cycle just concluded. Of course, this quantity cannot be modified to adjust to the demand actually encountered on the market. Thus the adjustment variable is constituted by the commodity’s selling price. Smith assumes that, in the presence of a gap between production and effectual demand, a sort of auction starts among the agents that happen to be on (what we today would call the) long side of the market: such agents are prepared to offer higher and higher prices (in case of excess demand) or lower and lower prices (in the case of excess supply).

Once the market price of any commodity happens to be different from its natural price, this causes an imbalance in the distributive sphere

11. See Ricardo’s (1951, 1:382) rejection of the opinion that price depends solely on the proportion between these two quantities.

12. Differences between the classical and the neoclassical theories of value and distribution have been emphasized by such authors as Krishna Bharadwaj (1978), Alessandro Roncaglia (1978), and Pierangelo Garegnani (1984). Nonetheless, historiographical controversies are still very much alive: see Blaug 1999 and 2009 versus Kurz and Salvadori 2002 and 2010.

13. This consideration may explain Ricardo’s (1951 1:90; emphasis added) emphasis on the effectiveness of the adjustment mechanism: “When we look to the markets of a large town, and observe how regularly they are supplied both with home and foreign commodities, in the quantity in which they are required, under all circumstances of varying demand . . . without often producing either the effect of a glut from too abundant a supply, or an enormously high price from the supply being unequal to the demand, *we must confess that the principle which apportions capital to each trade in the precise amount that is required, is more active than is generally supposed.*”

1 in the sense that the remunerations of those people that have contributed  
 2 to the production of the commodity prove different from their respective  
 3 natural values. In the absence of entry/exit barriers and in the presence  
 4 of market transparency the difference between the market price and the  
 5 natural price brings about (1) an intersectoral reallocation of economic  
 6 resources in search of the highest market remuneration and (2) a variation  
 7 in the produced quantity of the commodity in the following periods. This  
 8 process comes to a halt only when the produced quantity and demanded  
 9 quantity balance in correspondence of the natural price and the market  
 10 values of wages, profits, and rent equal their respective natural values.<sup>14</sup>  
 11 Therefore the imbalance in the sphere of circulation (discrepancy between  
 12 natural price and market price of a commodity) spills over to the sphere  
 13 of distribution (discrepancy between natural values and market values  
 14 of wages, profits, and rent) and, finally, to the sphere of production (inter-  
 15 sectoral reallocation of productive resources and variation in quantities  
 16 produced in the following periods).

17 The assumed tendency of market values toward their respective natural  
 18 values is based on two assumptions: (1) the owners of the employed inputs  
 19 consider, besides the outlay costs, also the opportunity costs in their deci-  
 20 sions as to where to allocate their economic resources (Aspromourgos  
 21 2009, 67, 98) and (2) there are but negligible barriers to the intersectoral  
 22 mobility of economic resources (91):

23  
 24 When the price of any commodity is neither more nor less than what is  
 25 sufficient to pay the rent of the land, the wages of the labour, and the  
 26 profits of the stock employed in raising, preparing, and bringing it to  
 27 market, according to their natural rates, the commodity is then sold for  
 28 what may be called its natural price. The commodity is then sold pre-  
 29 cisely for what it is worth, or for what it really costs the person who  
 30 brings it to market; for *though in common language what is called the*  
 31 *prime costs of any commodity does not comprehend the profit of the*  
 32 *person who is to sell it again, yet if he sell it at a price which does not*  
 33 *allow him the ordinary rate of profit in his neighbourhood, he is evi-*  
 34 *dently a loser by the trade; since by employing his stock in some other*  
 35 *way he might have made that profit. . . .* Though the price, therefore,  
 36 which leaves him this profit is not always the lowest at which the dealer

37  
 38 14. However, classical economists were perfectly aware of the existence of profit and wage  
 39 rate differentials. For a modern treatment, see Kurz and Salvadori 1995, chapter 11.

may sometimes sell his goods, it is the lowest at which he is likely to sell them for any considerable time; at least where *there is perfect liberty, or where he may change his trade as often as he pleases.* (WN Lvii.6; emphasis added)

The above shows that Smith devotes much care to determining natural values and to the gravitation process of market magnitudes to their natural counterparts. The same cannot be maintained as regards the question of market price determination, particularly when the market is not in a situation of long-period equilibrium. Taking stock of Smith's sparse hints on this subject it is possible to point out what follows.

First, in those markets in which competition is not free (e.g., because of legal monopoly and/or the presence of a guild, a collusive agreement, a law or a rule that somehow prevents economic agents allocating their resources in the sector they prefer) or where there are industrial secrets, entrepreneurs voluntarily limit the produced quantity so that the market is left understocked and the market price stays artificially high:

The exclusive privileges of corporations, statutes of apprenticeship, and all those laws which restrain, in particular employments, the competition to smaller number than might otherwise go into them, have the same tendency, though in a less degree. They are a sort of enlarged monopolies, and may frequently, for ages together, and in whole classes of employments, keep up the market price of particular commodities above the natural price, and maintain both the wages of the labour and the profits of the stock employed about them somewhat above their natural rate. (WN Lvii.28)

Conversely, where competition is free and industrial secrets absent, price undercutting starts as soon as at least two competitors are present in the market. This process is amplified by increasing the number of competitors, since this fact makes the establishment of a collusive agreement more unlikely:

The quantity of grocery goods, for example, which can be sold in a particular town is limited by the demand of that town and its neighbourhood. The capital, therefore, which can be employed in the grocery trade cannot exceed what is sufficient to purchase that quantity. If this capital is divided between two different grocers, their competition will tend to make both of them sell cheaper than if it were in the hands of one only; and if it were divided among twenty, their competition would

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1 be just so much the greater, and the chance of their combining together,  
2 in order to raise the price, just so much the less. (*WN* II.v.7)

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4 Second, Smith's explanation for the determination of market prices in  
5 situations of disequilibrium includes not only elements that are seemingly  
6 the fruit of a casual observation and that he does not analyze in greater  
7 detail (the wealth of the buyers and their desire to get the commodity *ver-*  
8 *sus* the necessity of the sellers to dispose of their own commodities) but  
9 also elements that he instead systematically applies in his analysis of the  
10 various markets. Of the latter, the most significant is the relative number  
11 of sellers and buyers and their relative ability to make a binding agree-  
12 ment. The market price will be high or low depending on whether buyers  
13 are more numerous than sellers (and vice versa): the buyers "bid against  
14 one another" offering higher and higher prices, the sellers "bid against one  
15 another" offering lower and lower prices. The relative number of the buy-  
16 ers in relation to the sellers is therefore the crucial element: every time that  
17 the agents on one side of the market are few and are able to communicate  
18 (e.g., because they operate in the same place such as a town) while the  
19 agents on the other side of the market are many and are unable to com-  
20 municate (e.g., because they are isolated and scattered in the countryside),  
21 the bargaining from which the market price springs will obviously be  
22 more favorable to the former. This is particularly evident in Smith's analy-  
23 sis of the labor market:

24 What are the common wages of labour, depends every where upon the  
25 contract usually made between those two parties, whose interests are  
26 by no means the same. The workmen desire to get as much, the mas-  
27 ters to give as little as possible. The former are disposed to combine  
28 in order to raise, the latter in order to lower the wages of labour. It is  
29 not, however, difficult to foresee which of the two parties must, upon all  
30 ordinary occasions, have the advantage in the disputes, and force the  
31 other into compliance with their terms. The masters, being fewer in  
32 number, can combine much more easily; and the law, besides, autho-  
33 rises, or at least does not prohibit their combinations, while it prohibits  
34 those of the workmen. . . . When in any country the demand for those  
35 who live by wages; labourers, journeymen, servants of every kind, is  
36 continually increasing; when every year furnishes employment for to  
37 greater number than had been employed the year before, the work-  
38 men have no occasion to combine in order to raise their wages. The  
39 scarcity of hands occasions a competition among masters, who bid  
against one another, in order to get workmen, and thus voluntarily break

through the natural combination of masters not to raise wages. (*WN* 1.viii.11–12, 17)

In the following section we show how Marx draws on and develops these elements of Smith's treatment of market prices.

### 3. The Classical Notion of Free Competition:

#### Karl Marx

In chapter 3 of *Wage-Labour and Capital* (Marx [1847] 1933) it is possible to find a vivid description of price determination in the market of a raw material, cotton. We think that such a description provides a clue to the young Marx's view of the competitive process. The chapter bears the title "By what is the price of a commodity determined?" and Marx's answer is the quite conventional one: "By the competition between buyers and sellers, by the relation of the demand to the supply, of the call to the offer" (21). Yet, immediately after, he adds that "the competition by which the price of a commodity is determined is *threefold*" (21; emphasis added). The first element highlighted by Marx is competition among the sellers: "Whoever sells commodities of the same quality most cheaply, is sure to drive the other sellers from the field and to secure the greatest market for himself. . . . [It is competition among the sellers] which forces down the price of the commodities offered by them" (21). The second element is competition among the buyers that "causes the price of the proffered commodities to rise" (21). These two aspects of competition are *not* considered sufficient to fully determine the outcome of the competitive process. In fact, Marx adds a third and last element:

Finally, there is *competition between the buyers and the sellers*: these wish to purchase as cheaply as possible, those to sell as dearly as possible. The result of this competition between buyers and sellers will depend upon the relations between the two above-mentioned camps of competitors—i.e., upon whether the competition in the army of sellers is stronger. Industry leads two great armies into the field against each other, and each of these again is engaged in a battle among its own troops in its own ranks. The army among whose troops there is less fighting, carries off the victory over the opposing host. (21)<sup>15</sup>

15. Marx's treatment of competition in this passage echoes James Steuart's notion of double competition. Marx was well acquainted with the work of Steuart, with whom he often took issue (Denis 1999). On Steuart's notion of double competition, see Menudo and Tortajada 2009.

1 We claim that the metaphor of the two armies that, at the one and the  
2 same time, are engaged in fighting one another and in their own ranks,  
3 coupled with the suggestion that the result of the battle is eventually  
4 decided by the interplay of these two levels of fighting, paves the way to  
5 an interesting analytical intuition. In our view Marx's rhetoric foreshad-  
6 ows the modern notion of a mixed strategy equilibrium: the outcome of  
7 market competition needs not be univocally determined, even if optimal  
8 (mixed) strategies are.

9 To clarify his thought Marx goes on to provide a concrete example.  
10 Marx's choice of a raw material market for this didactic purpose is illumi-  
11 nating. In the market of a consumption good it is quite obvious to assume  
12 a multitude of atomistic buyers. In such a case, competition among buyers  
13 would be reduced to their reservation prices and, eventually, described  
14 through a demand curve. It may not be so in the case of a raw material  
15 market, where the number of buyers may exceed that of sellers, and, in  
16 some cases, it is even possible to reverse the image of atomistic buyers to  
17 that of atomistic sellers. Marx's example starts with the analysis of what,  
18 in modern terminology, is called a sellers' market: "Let us suppose that  
19 there are 100 bales of cotton in the market and at the same time purchas-  
20 ers for 1,000 bales of cotton" (21). The fact that the demand is many (ten!)  
21 times greater than the supply is very likely to be intentional: if there were  
22 100 bales and purchasers for 110, conditions would have not been, in  
23 Marx's opinion, those of a sellers' market. On the contrary, 100 to 1,000 is  
24 considered enough to obtain that

25 the cotton sellers, who perceive the troops of the enemy in the most vio-  
26 lent contention among themselves, and who therefore are fully assured  
27 of the sale of their whole 100 bales, will beware of pulling one another's  
28 hair in order to force down the price of cotton at the very moment in  
29 which their opponents race with one another to screw it up high. So, all  
30 of a sudden, peace reigns in the army of sellers. They stand opposed to  
31 the buyers like one man, fold their arms in philosophic contentment and  
32 their claims would find no limit did not the offers of even the most  
33 importunate of buyers have a very definite limit. (22)

34  
35 Obviously, the ratio of 1 to 10 is, in itself, neither a necessary nor a suf-  
36 ficient condition. This is not the place to find a necessary and sufficient  
37 condition in general, yet an attempt to pinpoint the elements required for  
38 such a condition can be made with the help of a simple symbolism. This is  
39 attempted in a very special case in the appendix. Going back to the exam-



ple, Marx continues by introducing the buyers' market: "It is well known that the opposite case, with the opposite result, happens more frequently. Great excess of supply over demand; desperate competition among the sellers, and a lack of buyers; forced sales of commodities at ridiculously low prices" (22). Marx's text reveals that, for him, the buyers' market and sellers' market are not contiguous in the sense that between them there is something, but apart from the metaphor of the two armies, his readers are just left with the obvious remark that "in the same proportion in which [competition among the sellers] decreases, the competition among the buyers increases. Result: a more or less considerable rise in the prices of commodities" (22).

The Marxian text continues by introducing long-period considerations, that is, the gravitation of market prices toward prices of production (here Marx uses the expression *costs of production*) as a consequence of capital migration from (into) those sectors where market prices are below (above) costs of production. Yet in Marx's view, market prices are not to be dismissed lightly as theoretically insignificant. Marx, in fact, goes so far as to claim that the typical market outcome is a market price above or below costs of production, while the equality between the two should be considered an exception:

The determination of price by the cost of production is not to be understood in the sense of the bourgeois economists. The economists say that the average price of commodities equals the cost of production: that is the law. The anarchic movement, in which the rise is compensated for by a fall and the fall by a rise, they regard as an accident. We might just as well consider the fluctuations as the law, and the determination of the price by cost of production as an accident—as is, in fact, done by certain other economists. But it is precisely these fluctuations which, viewed more closely, carry the most frightful devastation in their train and, like an earthquake, cause bourgeois society to shake to its very foundations—it is precisely these fluctuations that force the price to conform to the cost of production. In the totality of this disorderly movement is to be found its order. In the total course of this industrial anarchy, in this circular movement, competition balances, as it were, the one extravagance by the other. (24)

The reader might think that the elder Marx, equipped with an improved understanding of the classical notion of prices of production and with a more mature version of his own theory of labor-value, would not have

1 endorsed the foregoing analysis by the young Marx. We think that this is  
 2 not the case, as witnessed by book 3, chapter 10 of *Capital* (Marx [1894]  
 3 1909). This chapter, bearing the title “Compensation of the Average  
 4 Rate of Profit by Competition. Market Prices and Market Values. Surplus-  
 5 profit,” is located in part 2, where Marx is confronted with the (insur-  
 6 mountable) problem of reconciling the origin of profit from surplus value  
 7 with a uniform rate of profit and a uniform rate of surplus value among  
 8 sectors. This is not the place to provide a thorough assessment of this  
 9 chapter. It suffices to note the following.

10 After identifying in II.X.14 the conditions to be met in order that “the  
 11 prices at which commodities are exchanged with one another may cor-  
 12 respond approximately to their values,” Marx adds in II.X.15: “[The  
 13 fact that] the commodities of the various spheres of production are sold at  
 14 their value implies, of course, only that their value is the center of gravity  
 15 around which prices fluctuate, and around which their rise and fall tends  
 16 to an equilibrium.” This sentence has been often quoted in the modern  
 17 literature on gravitation. However, it is not clear whether Marx thinks that  
 18 the price is unique at each moment of time or, rather, that there is a con-  
 19 stellation of prices at each moment of time. The difference is substantial.  
 20 If sellers and buyers follow mixed strategies instead of pure strategies,  
 21 there is clearly a constellation of prices at each moment of time. Marx also  
 22 identifies two simple cases. In the first “demand is so strong that it does  
 23 not let up when the price is regulated by the value of commodities pro-  
 24 duced under the most unfavorable conditions” (II.X.16); in this case these  
 25 conditions determine the market value. In the second, “the mass of the  
 26 produced commodities exceeds the quantity which is ordinarily disposed  
 27 of at average market-values” and, as a consequence, “the commodities  
 28 produced under the most favorable conditions regulate the market value”  
 29 (II.X.16). Marx is more interested in the result of this process than in the  
 30 analysis of less simple cases.<sup>16</sup> However, in II.X.51 he claims:

31 That side of competition, which is momentarily the weaker, is also that  
 32 in which the individual acts independently of the mass of his competi-  
 33 tors and often works against them, whereby the dependence of one  
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 36 16. “No matter what may be the way in which prices are regulated, the result always is the  
 37 following: 1) The law of value dominates the movements of prices, . . . 2) The average profit  
 38 which determines the prices of production must always be approximately equal to that quan-  
 39 tity of surplus-value, which falls to the share of a certain individual capital in its capacity as  
 an aliquot part of the total social capital” (II.X.17–18). (All references to *Capital* give part  
 number, chapter number, paragraph number.)

upon the other is impressed upon them, while the stronger side always acts more or less unitedly against its antagonist. If the demand for this particular kind of commodities is larger than the supply, *then one buyer outbids another*, within certain limits, and thereby raises the price of the commodity for all of them above the market-price, while on the other hand *the sellers unite in trying to sell at a high price*. If, vice versa, the supply exceeds the demand, some one *begins to dispose of his goods at a cheaper rate* and the others must follow, while the buyers *unite in their efforts to depress the market-price as much as possible below the market-value*. The common interest is appreciated only so long as each gains more by it than without it. And common action ceases, as soon as this or that side becomes the weaker, when each one tries to get out of it by his own devices with as little loss as possible. (emphasis added)

Here we find a clear echo of the argument used by the young Marx in *Wage-Labour and Capital*. It is also clear that the price is *not* unique at each moment of time: on the contrary, there is a constellation of prices at each moment of time. This fact supports our claims that the process needs to be analyzed under the assumption that buyers and sellers follow mixed strategies instead of pure strategies.

#### 4. Classical Competition and Bertrand Competition

In the previous sections we outlined the classical notion of competition with particular concern for market price determination. In this section we try to answer the following question: Has the classical notion of competition percolated into modern theory? A positive answer to such a question would allow us to make use of some recent results in order to extend the analysis of market competition within classical economics.

As is well known, in 1883 the mathematician Joseph Louis François Bertrand wrote a review of Léon Walras's *Théorie mathématique de la richesse sociale* (1883) and Augustin Cournot's *Recherches sur les principes mathématiques de la théorie des richesses* (1838).<sup>17</sup> Bertrand was highly skeptical of the then recent blossoming of mathematical economics. In particular, he poured scorn on Cournot's book:

17. An English translation of Bertrand's text, originally in *Journal des Savants* volume 48, pages 499–508, is provided in the appendix of Maignan de Bornier 1992.

1 [Cournot's] formulae, written only in letters, bristle with unknown  
 2 functions; [Cournot] would consider it outside his field if he were to be  
 3 more specific. Practical economists must feel that it would be of little  
 4 value to study such formulae, be they true or false, so they escape from  
 5 this study by merely closing the book. If Cournot's theory of wealth . . .  
 6 has failed to attract any serious attention over the past century, it is  
 7 because the ideas are lost under the profusion of algebraic signs. (quoted  
 8 in Magnan de Bornier 1992, 647)

9  
 10 As concerns Cournot's duopoly model, Bertrand claimed that, pace  
 11 Cournot, it admitted "no solution under this assumption" (647), that is,  
 12 under the assumption that each duopolist tries to undercut the rival in  
 13 order to attract buyers and stops doing that only when he or she has nothing  
 14 more to gain from reducing his or her prices. (Note that for Bertrand  
 15 it is Cournot himself who assumed price competition between the two  
 16 sellers.) In short, the gist of Bertrand's criticism is that Cournot failed to  
 17 acknowledge that the envisaged downward movement of prices was limited  
 18 only by the marginal cost.<sup>18</sup> A somewhat similar charge of indeterminacy  
 19 was raised sixteen years later by a distinguished economist, Francis  
 20 Ysidro Edgeworth, in a paper originally published in Italian in 1897 and  
 21 translated with some modifications into English in 1925. Edgeworth went  
 22 beyond Bertrand insofar as he claimed that the duopoly model admits a  
 23 continuous price cycle in the presence of diminishing returns:

24 [The case of two identical articles] is treated by Cournot as the first step  
 25 in the transition from monopoly to perfect competition. He concludes  
 26 that a determinate proposition of equilibrium defined by certain quantities  
 27 of the articles will be reached. Cournot's conclusion has been  
 28 shown to be erroneous by Bertrand for the case in which there is no cost  
 29 of production; by Professor Marshall for the case in which the cost follows  
 30 the law of increasing returns; and by the present writer for the case  
 31 in which the cost follows the law of diminishing returns. *In the last  
 32 case there will be an indeterminate tract through which the index of  
 33 value will oscillate, or rather will vibrate irregularly for an indefinite  
 34 length of time.* (Edgeworth 1925, 117–18; emphasis added)

35  
 36 18. In Bertrand's wording "without limits," but this is only because in Cournot's original  
 37 example the marginal cost is zero. This is not the place to discuss whether Bertrand's interpretation  
 38 of Cournot is well grounded or whether Cournot actually used prices instead of quantities  
 39 as strategic variables: see Magnan de Bornier 1992 and 2001, Dimand and Dore 1999, Morrison  
 1998 and 2001.

To defend this claim, Edgeworth produced a numerical example in which two firms compete on prices, but they have capacity constraints. Edgeworth showed there is no (pure strategy) equilibrium in his example and formulated a sort of dynamic solution: firms undercut each other until the price becomes so low that it is convenient for a firm to quote a high price and sell only to the residual demand instead of undercutting the price quoted by the rival. As Edgeworth wrote:

At every stage in the fall of price, and before it has reached its limiting value . . . , it is competent to each monopolist to deliberate whether it will pay him better to lower the price against his rival as already described, *or rather to raise it to a higher, perhaps the initial*, level for that remainder of customers of which he cannot be deprived by his rival (owing to the latter's limitation of supply). Long before the lowest point has been reached, that alternative will have become more advantageous than the course first described. (120)

With the development of game theory and its application to oligopoly models, the so-called Bertrand-Edgeworth competition, explicitly based on price undercutting, became a fruitful and extensively studied alternative to the price-taking competition embodied in the standard perfect competition model (see Baye and Kovenock 2008). Yet the contemporary Bertrand competition model is somewhat different from the original formulation and from the classical notion of competition. First, it is a one-shot game with a mixed strategy equilibrium and not a dynamic process of price undercutting. This feature magnifies the relevance of two missing elements in Smith's and Marx's writings. First is the problem of firms quoting the same price: in the case of a tie the firms fixing the lowest prices must share total demand in one way or another. This requires the introduction of a specific assumption in this regard. Second is the problem of how demand is rationed when a firm's quantity demanded exceeds its capacity. The introduction of a demand rationing scheme is another assumption lacking in the classical authors.

However, a comparison between modern Bertrand competition and Smith's notion of competition, and even more the story told by Marx in *Wage-Labour and Capital*, magnifies some deficiencies of the former. First, in the former there is a multitude of atomistic buyers described through a demand curve confronted with a given number of sellers, each defined by their costs (generally marginal costs are constant and uniform) and capacity. On the contrary, in Marx we find a sort of symmetry between

1 sellers and buyers. It is certainly not difficult to extend the Bertrand com-  
 2 petition model to investigate the case in which there is a multitude of  
 3 atomistic sellers described through a supply curve confronted with a given  
 4 number of buyers, each defined by their reservation price (possibly con-  
 5 stant and uniform) and purchasing power. Generalization to a symmetrical  
 6 case in which a number of sellers with their costs and selling capacities are  
 7 confronted with a number of buyers with their reservation prices and buy-  
 8 ing capacities is certainly less obvious. Second, Bertrand competition  
 9 theorists have analyzed quite extensively the case of duopoly with constant  
 10 marginal cost. Few contributions have investigated the oligopoly (see De  
 11 Francesco and Salvadori 2010 and the literature cited therein). When there  
 12 are more than two competing firms, many changes are needed. In the case  
 13 of two firms, any firm can either undercut the other or avoid doing so. In  
 14 the case of three or more firms, any firm can either undercut all other firms  
 15 or just some of the firms and not others, or none of them. For example, in  
 16 the case in which there are two (either equal or not) large firms and a  
 17 smaller firm, the latter can avoid high prices so that the two large firms are  
 18 not interested in undercutting it when they undercut each other at higher  
 19 prices. The small firm can take advantage of this protection from competi-  
 20 tion with larger firms (at high prices) to obtain a larger rate of profit (see  
 21 De Francesco and Salvadori 2010, theorem 1(c)). The analysis provided in  
 22 the appendix may give an idea of the problems involved.

## 24 5. Final Remarks

25  
 26 In this article we attempted to assess the classical notion of free competi-  
 27 tion in comparison with the Walrasian notion of perfect competition. We  
 28 showed that the latter is plagued with some logical difficulties that drasti-  
 29 cally reduce its explanatory power to equilibrium situations. Such difficul-  
 30 ties are absent in the classical notion of competition, which, contrary to  
 31 the Walrasian one, is not based on any kind of price-taking assumption.  
 32 Yet the former also displays some unsatisfactory aspects. In particular,  
 33 while the classical authors extensively investigated long-period, natural  
 34 values and gravitation, they were more sketchy on market price determi-  
 35 nation in situations of market disequilibrium. To fill this lacuna we ana-  
 36 lyzed Smith's and Marx's views on competition between buyers and sell-  
 37 ers. We claim that, taking inspiration from the modern theory of Bertrand  
 38 competition, it is possible both to render Smith's and Marx's hints for-  
 39 mally precise and to provide interesting new questions for modern Ber-  
 trand competition theorists.

## Appendix 1

Let  $N$  be the number of buyers. Their reservation price is  $p_b$ . Let  $B_1 \geq B_2 \dots B_N$  be the different quantities of cotton they want to buy and let  $B = B_1 + B_2 + \dots + B_N$ . Similarly, let  $M$  be the number of sellers and  $c$  their reservation price. Let  $S_1 \geq S_2 \geq \dots \geq S_M$  be the different quantities of cotton they want to sell and  $S = S_1 + S_2 + \dots + S_M$ . Let us assume that  $c < p_b$  (the case in which  $c \geq p_b$  requires more accurate analysis) and that there are no buyers with a reservation price lower than  $p_b$  and no sellers with a reservation price higher than  $c$  (once again, a more accurate analysis would be required otherwise).

If  $S < B_2 + \dots + B_N$ , that is, if all buyers *but the largest one* are willing to buy *more* than the existing amount of cotton, buyer 1 could be excluded from the purchase and, as a consequence, any other buyer 2, 3, . . . ,  $N$  could be excluded too. Overbidding among buyers leads the price of cotton to rise to  $p_b$ . Therefore the best strategy for each buyer is to express a demand for cotton at her reservation price and the best strategy for each seller is to quote the price  $p_b$ . On the contrary, if  $B > S > B_2 + \dots + B_N$ , that is, if all buyers *but the largest one* are willing to buy *less* than the existing amount of cotton even if all buyers are willing to buy *more* than the existing amount of cotton, buyer 1 knows that she will certainly buy some cotton. In the limiting case in which all buyers 2, . . . ,  $N$  have purchased their desired amount of cotton, buyer 1 is a monopsonist in relation to the sellers who have not sold their cotton. Let  $p_m$  be this monopsony price. Obviously,  $p_m = c$ .<sup>19</sup> Clearly, if buyers 2, 3, . . . ,  $N$  quote price  $p_b$  for cotton, buyer 1 will quote price  $p_m < p_b$ . But if buyer 1 quotes price  $p_m$  for cotton, (some of) the other  $N - 1$  buyers will outbid her instead of quoting  $p_b$ . Therefore buyer 1 will overbid on them, instead of quoting  $p_m$ . And so on, until the price goes up so much that buyer 1 will prefer again to quote price  $p_m = c$  and buy only  $S - (B_2 + \dots + B_N)$  units of corn. And so on and so forth. In this situation, sellers cannot “stand opposed to the buyers like one man” and “fold their arms in philosophical contentment”: they must fight each other to sell at a higher price.

Similarly, if  $B < S_2 + \dots + S_M$ , undercutting among sellers leads the price of cotton to drop to  $c$ . Therefore, the best strategy for each seller is to quote her reservation price and the best strategy for each buyer is to express a demand for cotton at the price  $c$ . On the contrary, if  $S > B >$

19. Note that if buyers with a reservation price larger than  $c$  exist, the monopsony price is larger than  $c$ .



1  $S_2 + \dots + S_M$ , no equilibrium price exists. Nor can an equilibrium price  
 2 exist if  $S = B$ , since  $S > B_2 + \dots + B_N$  and  $B > S_2 + \dots + S_M$ : the larger seller  
 3 has a realistic possibility to sell part of her cotton at  $p_b$  and the larger buyer  
 4 has a realistic possibility to buy part of the desired amount of cotton at  $c$ .

5 As a consequence, if  $B + S_1 > S$  and  $S + B_1 > B$ , both armies, to use  
 6 Marx's metaphor, are engaged in infighting. The best strategies for both  
 7 buyers and sellers are not single (i.e., deterministic) prices but distribu-  
 8 tions of probability within a set of prices.

9 Determining such distributions of probability requires proper analysis,  
 10 which is beyond the scope of this article. Besides, to make such calcula-  
 11 tions we need to make further assumptions not stated by Marx. In particu-  
 12 lar, we need to know how the residual demand (supply) is determined for  
 13 sellers (buyers) quoting a price higher (lower) than that quoted by others  
 14 sellers (buyers) and what happens in the event of a tie. What is certain is  
 15 that buyer 1 will never quote a price lower than  $c$  (the monopsony price if  
 16 all other buyers are served) or a price higher than  $p_{Mb}$ , defined by the con-  
 17 dition that buyer 1 gets the same profit from buying  $\min\{S, B_1\}$  at price  
 18  $p_{Mb}$  and buying  $S - (B_2 + \dots + B_N)$  at price  $c$ . But, as a consequence, no  
 19 buyer will quote prices outside the range  $[c, p_{Mb}]$ . Similarly, seller 1 will  
 20 never quote a price higher than  $p_b$  (the monopoly price if all other sellers  
 21 are served) nor a price lower than  $p_{mS}$ , defined by the condition that seller 1  
 22 gets the same profit from selling  $B - (S_2 + \dots + S_M)$  at price  $p_b$  and selling  
 23  $\min\{B, S_1\}$  at price  $p_{mS}$ . However, as a consequence, no seller will quote  
 24 prices outside the range  $[p_{mS}, p_b]$ . Both arguments make sure that traders  
 25 can quote only prices that are in both ranges  $[c, p_{Mb}]$  and  $[p_{mS}, p_b]$ .

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