



On the microeconomic foundations of linear demand for differentiated products [☆]

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Abstract

This paper provides a thorough exploration of the microeconomic foundations for the multi-variate linear demand function for differentiated products, which is widely used in industrial organization. The setting is the standard representative consumer with a quasi-linear utility function. A key finding is that strict concavity of the quadratic utility function is critical for the demand system to be well defined. Otherwise, the true demand function may be quite complex: Multi-valued, non-linear and income-dependent. We uncover failures of duality relationships between substitute products and complementary products, as well as the incompatibility between high levels of complementarity and concavity. The two-good case emerges as a special case with strong but non-robust properties. A key implication is that all conclusions derived in applied economic models via the use of linear demand that does not satisfy the Law of Demand ought to be regarded with some suspicion.

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1. Introduction

The emergence of the modern theory of industrial organization owes much to the development of game theory. Due to its privileged position as the area where novel game theoretic advances found their initial application in an applied setting, industrial organization then served as a further launching ground for these advances to spread to other areas of economics. Yet to explain the success of industrial organization in reaching public policy makers, antitrust practitioners, and undergraduate students, one must mention the role played by the fact that virtually all of the major advances in the theory have relied on an accessible illustration of the underlying analysis using the convenient framework of linear demand.

While this framework goes back all the way to [Bowley \(1924\)](#), it received its first well-known treatment in two visionary books that preceded the revival of modern industrial organization, and yet were quite precocious in predicting the intimate link between modern industrial organization and game theory: [Shubik \(1959\)](#) and [Shubik and Levitan \(1980\)](#). Then early on in the revival period, [Dixit \(1979\)](#), [Deneckere \(1983\)](#) and [Singh and Vives \(1984\)](#) were among the first users of the linear demand setting. Subsequently, this framework has become so widely invoked that virtually no author nowadays cites any of these early works when adopting this convenient setting.¹

Yet, despite this ubiquitous and long-standing reliance on linear demand, the present paper will argue that some important foundational and robustness aspects of this special demand function remain less than fully understood.² Often limiting consideration to the two-good case, the early literature on linear demand offered a number of clear-cut conclusions both on the structure of linear demand systems as well as on its potential to deliver unambiguous conclusions for some fundamental questions in oligopoly theory. Among the former, one can mention the duality features uncovered in the well known paper by [Singh and Vives \(1984\)](#), namely (i) the dual linear structure of inverse and direct demands (along with the use of roman and greek parameters), (ii) the duality between substitute and complementary products and the invariance of the associated cross-slope parameter range of length one for each, and (iii) the resulting dual structure of Cournot and Bertrand competition. In the way of important conclusions, [Singh and Vives \(1984\)](#) showed that, with linear demands, competition is always tougher under Bertrand than under Cournot. In addition, where the mode of competition to be endogenized in a natural way, both firms would always prefer to compete in a Cournot rather than in a Bertrand setting. ([Singh and Vives, 1984](#) inspired a rich literature still active today). Subsequently, [Häckner \(2000\)](#) showed that with three or more firms and unequal demand intercepts, the latter conclusion is not universally valid in that there are parameter ranges for which competition is tougher under a Cournot setting, and that consequently some firms might well prefer a Bertrand world (see also [Amir and Jin, 2001](#), for further qualifications of interest). [Hsu and Wang \(2005\)](#) show that consumer

¹ [Martin \(2002\)](#) provides an insightful overview of the history of the linear demand system, as well as a comparison between the Bowley and the Shubik specifications.

² One is tempted to attribute this oversight to the fact that industrial economists' strong interest in linear demand is not shared by general microeconomists (engaged either in theoretical or in empirical work), as evidenced by the fact that quadratic utility hardly ever shows up in basic consumer theory or in general equilibrium theory.

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