# Normality of demand in a two-goods setting ☆

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## Abstract

We study the testable implications of normal demand in a two-goods setting. For a finite dataset on prices and quantities, we present the revealed preference conditions for normality of one or both goods. Our characterization provides an intuitive extension of the well-known Weak Axiom of Revealed Preference, and is easy to use in practice. We illustrate the empirical relevance of our theoretical results through an application to an experimental dataset. We also briefly discuss extensions of our conditions to a setting with more than two goods.

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## 1. Introduction

Focusing on a two-goods setting, Chambers et al. (2010, 2011) derived the necessary and sufficient revealed preference conditions for behavioral complementarity and gross substitutes in

demand. The current paper complements these earlier papers by establishing the revealed preference conditions for normal demand in situations with two goods. Our conditions are easy to verify and do not depend on the feasibility of a set of linear inequalities as is usual in revealed preference analysis. As we will discuss in more detail below, our conditions bear specific relationships to the ones of Chambers et al. (2010, 2011).

*Normal goods*    A good is normal if its consumption increases with income, keeping prices fixed. Normality is often a convenient assumption because it avoids pathological situations that violate the law of demand, which means that a good's consumption increases with its price (i.e. Giffen goods). Normality of goods imposes restrictions on how demand changes when budgets (prices and income) change, which implies specific testable implications.

For sufficiently rich datasets, normality of goods can be examined by estimating Engel curves and, subsequently, verifying whether they have a positive slope. Typically, such a test requires cross sectional data with fixed good prices; see, for example, Blundell et al. (2007). A second approach looks at the theoretical restrictions on consumer preferences that guarantee (local) normality of demand. Leroux (1987) provides a set of sufficient conditions involving first and second order derivatives of the utility function. Alarie and Bronsard (1990) extend these results by providing both necessary and sufficient conditions regarding the shape of utility functions. Bilancini and Boncinelli (2010) offer equivalent conditions that are easier to verify. Finally, Fisher (1990) relates normality of demand to the second order derivatives of expenditure functions.

*Two-goods case*    Following Chambers et al. (2010, 2011), our main focus is on a demand setting with two goods and a finite set of observations on prices and demanded quantities. For this setting we derive necessary and sufficient conditions for rational demand behavior in terms of normal goods. However, in Section 4, we also present a natural generalization of our conditions to a setting with more than two goods. These conditions provide a set of necessary (but not sufficient) conditions for consistency of observed demand behavior with normality.

If there are only two goods, a relative price increase of one good necessarily implies a relative price decrease of the other good. As such, in two good settings relative price changes are unambiguous. In addition, when there are only two goods, they are necessarily Hicksian substitutes. Thus, for any price change, we can determine the direction of the substitution effect, which will be a key factor in the characterization that we develop below. By contrast, as soon as there are three or more goods, there may be Hicksian complements, which makes the substitution effect ambiguous. In such a case, the change in the quantity of a certain good due to a relative price change will depend on both the intensity of the complementarity or substitutability with the other goods, as well as on the magnitude of the relative price change.

Admittedly, the focus on a two-goods setting may seem somewhat restrictive. Importantly, however, a multi-goods setting can often be reduced to a two-goods setting. First, one can use Hicksian aggregation for dimensionality reduction. A set of goods can be represented by a Hicksian aggregate if the goods' relative prices remain fixed over observations. Thus, it suffices to verify the empirical validity of constant relative prices, to check whether the demand for multiple goods can be studied in terms of two Hicksian aggregates. Alternatively, one can assume that preferences are weakly separable. Specifically, for $x_i$ the demanded quantity of good $i$ and $u$ the consumer's utility function, we have

$$u(x_1, \ldots, x_n) = v(w(x_1, x_2), x_3, \ldots, x_n)),$$