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A Stronger Criterion for the Weak Weak Axiom

by

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(Final version)

Abstract: The Weak Weak Axiom (WWA) is a milder version of the Weak Axiom of Revealed Preference (WA) and is equivalent to pseudomonotonicity of the excess demand function. Since the WWA guarantees uniqueness of the equilibrium in a broad class of general equilibrium models, it is important to have criteria to check when the WWA holds. In this paper a new and more general characterization of pseudomonotonicity for C^1 maps is provided. Using this result we obtain a stronger criterion for the WWA than those available in the literature. A complete characterization of the WA for excess demand functions is also offered and other important existing results are obtained in a straightforward fashion.

1. Introduction

The Weak Axiom of Revealed Preference (WA) has been introduced by Samuelson (1938) as a consistency requirement of consumer behaviour. The restrictions it places on demand, and specifically on the response to compensated price changes, are quite similar to those derived from standard consumer theory. However, the WA is a milder rationality requirement as compared to the hypothesis of utility maximization and, as shown by Kim and Richter (1986), it characterizes the behaviour of a consumer with not necessarily transitive preferences.[1]

The WA is not only a more general and realistic modeling assumption for consumer behaviour, but it is also a good property for the whole consumption sector in general equilibrium models. As it is well known, if the WA holds at the aggregate level the equilibrium set is convex and, as long as the number of equilibria is finite, the equilibrium price vector is unique (up to normalization).

This paper deals with a milder version of the WA which yields similarly nice results and is known as the Weak Weak Axiom (WWA). In an n-good competitive economy the WWA is defined in terms of the excess demand function $Z: \mathbb{R}_{++}^n \to \mathbb{R}^n$ which is homogeneous of degree zero, i.e. $Z(\lambda p) = Z(p)$ for all $\lambda > 0$ and satisfies Walras'Law, i.e. $p \cdot Z(p) = 0$.

Definition 1. *The excess demand function Z satisfies the Weak Weak Axiom (WWA) if for any pair of price vectors, p and q,*

$$q \cdot Z(p) \leq 0 \qquad implies \qquad p \cdot Z(q) \geq 0.$$

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[1] On rationalizations of demand behaviour obeying the WA or milder versions of it see also the recent work of John (2000b, 2000c) and Quah (2000).

Using Walras' Law, the WWA is easily seen to be equivalent to a notion of generalized monotonicity introduced by Karamardian (1976) and known as pseudomonotonicity.

Definition 2. *A function F of a set $D \subseteq \mathbb{R}^n$ into $\mathbb{R}^n$ is said to be pseudomonotone (PM) if, for all $x, y \in D$*

$$(y - x) \cdot F(x) \leq 0 \qquad implies \qquad (y - x) \cdot F(y) \leq 0$$

An interesting property of continuous pseudomonotone functions with an open convex domain is the convexity of the set of zeroes. Therefore, if the excess demand of a pure exchange economy satisfies the WWA, the set of equilibrium prices is convex. This result also extends to some classes of productive economies such as those with a convex, constant returns to scale technology [see Jerison (1999, Proposition 1)]. Moreover the WWA can be used indirectly in productive economies that can be reduced to exchange models in the factors of production. Clearly, if the 'reduced' excess demand function satisfies the WWA then the equilibrium set of the original productive economy is convex.

Checking whether aggregate demand or excess demand satisfy useful properties such as the WA or the WWA can be quite a difficult task if only the bare definitions are available. When differentiability is assumed, however, the analysis can be carried out more conveniently in terms of the derivatives, since local conditions are usually easier to check than global ones.

Differential characterizations of the weak axioms lend themselves to a variety of applications. They have been used in many analyses of aggregate demand including Hildenbrand (1983, 1994), Freixas and Mas-Colell (1987), Marhuenda (1995), Quah (1997) and Jerison (1999). In some cases they have led to the formulation of new economically interpretable conditions ensuring determinateness of equilibrium in

general competitive analysis. For example, Hildenbrand (1994) and Jerison (1999) were able to show that the weak axioms hold in the aggregate provided that the consumption patterns of the population display a certain tendency toward increasing dispersion.

Casting properties of demand in differential terms has also led to some progress in empirical analysis. New testable hypotheses have been proposed and econometric analyses have been carried out with cross-section data on household expenditures which shed new light on consumption as, for example, in Hildenbrand and Hildenbrand (1986), Härdle, Hildenbrand and Jerison (1991) and Hildenbrand and Kneip (1993).

To sum up, differential criteria for the WA and the WWA seem valuable tools for both theoretical and empirical analysis.

The most general differential characterizations of pseudomonotonicity have been recently provided by Crouzeix and Ferland (1996) and John (1995, 2000a). They have shown that, for C^1 functions on an open and convex domain, PM is equivalent to the following two conditions:

(A) *For all $x \in D$ and $v \in \mathbb{R}^n$*

$$v \cdot F(x) = 0 \qquad implies \qquad v \cdot \partial F(x)v \leq 0$$

(B) *If $F(x) = 0$ and $v \cdot \partial F(x)v = 0$, then for all $\bar{t} > 0$ there exists $t \in (0, \bar{t})$ such that $v \cdot F(x + tv) \leq 0$*

Condition (A) requires that the Jacobian matrix $\partial F(x)$ be negative semidefinite on the orthogonal space to $F(x)$. At a zero, thus, the Jacobian matrix has to be negative semidefinite. Condition (A) can be checked by studying either the signs of the principal minors of a bordered matrix or the signs of the eigenvalues of a suitable transformation of the Jacobian matrix.

Condition (B) implies that, at any zeroes of F, the one-variable function $v \cdot F(x + tv)$ cannot take strictly positive values for all t in an open interval $(0, \varepsilon)$, $\varepsilon > 0$. Specifically, if $t = 0$ is a critical point of $v \cdot F(x + tv)$, i.e. $v \cdot \partial F(x)v = 0$, in order to check for condition (B) one has to make sure that there is no open interval $(0, \varepsilon)$ such that the graph of the one-variable function lies strictly above the horizontal axis. It is worth noticing that $t = 0$ can be a critical point even if the Jacobian matrix is not singular. This might be the case, for example, when $\partial F(x)$ is a skew-symmetric matrix. In such a case, one has to make sure that for all $v \in \mathbb{R}^n$ the corresponding one-variable function does not remain strictly positive in some interval $(0, \varepsilon)$.

This paper provides a stronger criterion for pseudomonotonicity by showing that condition (B) can be relaxed in a significant way. We obtain a more general differential characterization of pseudomonotonicity and, in particular, of the WWA for excess demand functions. Other interesting results available in the literature are also derived as straightforward corollaries. In addition, we provide a complete differential characterization of the WA which extends a previous result by Zhou (1995) to the case of excess demand functions.

In the next section we prove the main mathematical result concerning general C^1 functions. In Section 3 the above result is applied to the case of excess demand functions in order to obtain differential characterizations of the WWA. In the last section a complete characterization of the WA is provided and other related results are discussed.

2. A mathematical result

In this and the next sections we shall confine to the case of C^1 functions on an open and convex domain. Let us introduce the following condition:

(C) *If $F(x) = 0$ and $v^T \partial F(x) = 0$, then for all $\bar{t} > 0$ there exists $t \in (0, \bar{t})$ such that $v \cdot F(x + tv) \leq 0$*

Condition (C) is significantly weaker than (B). For example, if the Jacobian matrix at a zero is skew-symmetric but not singular, condition (C) is trivially satisfied whereas (B) needs checking for all $v \in \mathbb{R}^n$, as we have already noticed. The following result improves upon the characterization of continuously differentiable pseudomonotone maps obtained by Crouzeix and Ferland (1996) and John (2000a).

Theorem 1. *Let $F \colon D \to \mathbb{R}^n$ be a C^1 function on the open convex set $D \subseteq \mathbb{R}^n$. The following statements are equivalent:*

i) F is pseudomonotone.

ii) F satisfies conditions (A) and (C).

iii) F satisfies conditions (A) and (B).

Proof.

The implication from (i) to (ii) is quite standard. Let $v \cdot F(x) = 0$ and set $y = x + tv$ for any $t > 0$ close to zero. Since $(y - x) \cdot F(x) = tv \cdot F(x) = 0$, by PM we have $0 \geq (y - x) \cdot F(y) = tv \cdot F(x + tv)$ and $(1/t)v \cdot [F(x + tv) - F(x)] \leq 0$ for all t close to zero. Taking the limit we obtain $v \cdot \partial F(x)v \leq 0$, hence (A) holds. Finally, PM trivially implies (C).

(ii) implies (iii). Let us assume that (A) and (C) hold but (B) is violated, i.e. $F(x) = 0$, $u^T = v^T \partial F(x) \neq 0$ and there exists $\bar{t} > 0$ such that $v \cdot F(x + tv) > 0$ for all $t \in (0, \bar{t}]$. Since $u \cdot u > 0$, by continuity of the Jacobian there exists an open ball centered at x, B_x, such that $v^T \partial F(z) \cdot u > 0$ for all $z \in B_x$. Let us define the function

$$f(s, t) = v \cdot F(x + su + tv)$$

in a sufficiently small neighborhood of the origin of $\mathbb{R}^2$, so that all the vectors $x + su + tv$ are in B_x. By assumption, f is C^1 and its partial derivatives are

respectively

$$f_s(s,t) = v \cdot \partial F(x + su + tv)\, u$$

$$f_t(s,t) = v \cdot \partial F(x + su + tv)\, v$$

Since $x + su + tv \in B_x$, the partial derivative $f_s(s,t)$ must always be strictly positive. We shall show that the last statement does not hold, so that the contradiction establishes our result.

Since $f(0,0) = v \cdot F(x) = 0$ and $f_s(0,0) = v \cdot \partial F(x)u = u \cdot u > 0$, the equation $f(s,t) = 0$ defines an implicit function, i.e. there exists $\varepsilon > 0$ and a function $s(t)$ defined in the open interval $(-\varepsilon, \varepsilon)$, such that $s(0) = 0$ and $f(s(t), t) = 0$ for all t. The implicit function is differentiable and

$$s'(t) = -\frac{f_t(s(t), t)}{f_s(s(t), t)}$$

Since $v \cdot F(x + s(t)u + tv) = 0$ for all $t \in (-\varepsilon, \varepsilon)$, condition (A) requires that

$$0 \geq v \cdot \partial F(x + s(t)u + tv)v = f_t(s(t), t).$$

Moreover, $f_s(s(t), t) > 0$ and we obtain $s'(t) \geq 0$ for all t. Therefore $s(t)$ is non negative and non decreasing in the interval $[0, \varepsilon)$.

Now, let us take $0 < t^* < \min\{\bar{t}, \varepsilon\}$. From the violation of condition (B) we have

$$f(0, t^*) = v \cdot F(x + t^* v) > 0$$

and by the definition of implicit function,

$$0 = f(s(t^*), t^*) = v \cdot F(x + t^* v + s(t^*)u).$$

Thus $s(t^*) \neq 0$ and since $s(t) \geq 0$, it must be $s^* = s(t^*) > 0$. By the Mean Value Theorem there exists $0 < \tilde{s} < s^*$ such that

$$0 > f(s^*, t^*) - f(0, t^*) = f_s(\tilde{s}, t^*)s^*$$

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therefore, $f_s(\tilde{s}, t^*) < 0$ and this contradiction completes the proof.

(iii) implies (i). This result was proved in different ways by Crouzeix and Ferland (1996) and by John (2000a).

<div align="right">Q.E.D.</div>

As an immediate corollary, Theorem 1 provides a first-order characterization of pseudomonotonicity for *regular* functions. Recall that a C^1 function is regular if the Jacobian matrix at zeroes is not singular, i.e. $F(x) = 0$ implies $\det \partial F(x) \neq 0$. Therefore, at zeroes, $v^T \partial F(x) \neq 0$ for all $v \neq 0$ and condition (C) trivially holds. The following result is due to John (1995, 2000a).

Corollary 1. *Let $F: D \to \mathbb{R}^n$ be a regular C^1 function on the open convex set $D \subseteq \mathbb{R}^n$. Then F is pseudomonotone if and only if condition (A) holds.*

3. Characterizations of the WWA

The characterization of pseudomonotonicity obtained in the previous section directly applies to the case of excess demand functions and offers a first-order characterization of the WWA. In this section we show that, owing to the properties of Z, the criteria for pseudomonotonicity of the excess demand functions can be further strengthened by asking conditions (A) and (C) to hold only for vectors $v \in \mathbb{R}^n$ laying on the orthogonal space to p.

Theorem 2. *Let Z be a C^1 excess demand function. Then Z satisfies the WWA if and only if, for all $p \in \mathbb{R}^n_{++}$ and $v \in \mathbb{R}^n$, the following conditions hold:*

(A') $v \cdot p = 0$ and $v \cdot Z(p) = 0$ imply $v \cdot \partial Z(p)v \leq 0$.

(C') If $Z(p) = 0$, $v \cdot p = 0$ and $v^T \partial Z(p) = 0$, then for all $\bar{t} > 0$ there exists $t \in (0, \bar{t})$ such that $v \cdot Z(p + tv) \leq 0$.

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Proof. Given Theorem 1 we only need to show that (A') and (C') imply (A) and (C). Let $v \cdot Z(p) = 0$ and notice that v can be written as $v = u + \alpha p$ with $\alpha = v \cdot p / p \cdot p$. Clearly, the vector u is orthogonal to both p and $Z(p)$. By Walras' Law $p^T \partial Z(p) = -Z(p)^T$ and by homogeneity $\partial Z(p) p = 0$. Hence

$$v \cdot \partial Z(p) v = (u + \alpha p) \cdot \partial Z(p)(u + \alpha p) = u \cdot \partial Z(p) u,$$

and (A') implies (A).

Next we show that (C') implies (C). Let $Z(p) = 0$ and $v^T \partial Z(p) = 0$. The vector v can be written as $v = u + \alpha p$ with $\alpha = v \cdot p / p \cdot p$, where the vector u is orthogonal to p. Since α can be negative, let $t > 0$ be sufficiently small so that $(1 + \alpha t) > 0$. Then, by homogeneity

$$Z(p + tv) = Z(p + t(u + \alpha p)) = Z(p + su) \tag{1}$$

where $s = t/(1 + t\alpha)$. Using twice Walras' Law yields

$$p \cdot Z(p + tv) + tv \cdot Z(p + tv) = p \cdot Z(p + su) + su \cdot Z(p + su) \tag{2}$$

First notice that, by (1), $p \cdot Z(p + tv) = p \cdot Z(p + su)$. Thus, for $t > 0$ sufficiently small, also $s > 0$ is close to zero and, by (2), $v \cdot Z(p + tv)$ has the same sign as $u \cdot Z(p + su)$. Finally, since $0 = v^T \partial Z(p) = (u + \alpha p)^T \partial Z(p) = u^T \partial Z(p)$ we have that (C') implies (C) and this completes the proof.

<div align="right">Q.E.D.</div>

As a straightforward corollary we have an interesting result for 'regular' excess demand functions. Recall that an excess demand function is said to be *regular* if its Jacobian matrix has maximal rank at all zeroes, i.e. if $Z(p) = 0$ then $\mathrm{rank}\, \partial Z(p) = n - 1$. For a regular excess demand function, condition (C') of Theorem 2 trivially holds. Indeed, if $Z(p) = 0$ and $v^T \partial Z(p) = 0$, regularity and Walras' Law imply

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$v = \lambda p$, $\lambda \in \mathbb{R}$, thus $v \cdot p = 0$ yields $v = 0$. The following result has been proved by John (1995, 2000a).

Corollary 2. *A regular C^1 excess demand function satisfies the WWA if and only if condition (A') holds.*

Without the assumption of regularity, condition (A') is not sufficient for the WWA. This has been shown by means of a counterexample in Hildenbrand and Jerison (1989) (see also Example 3 in the Appendix). Therefore, it seems unlikely that a stronger criterion for the WWA than the one contained in Theorem 2 could be obtained.

4. Characterization of the WA and final remarks

This section provides a new differential characterization of the WA and discusses some related results available in the literature.

Definition 3. *The excess demand function Z satisfies the Weak Axiom of Revealed Preference (WA) if $(q - p) \cdot Z(p) \leq 0$ and $(q - p) \cdot Z(q) \geq 0$ imply $Z(p) = Z(q)$.*

The following example shows that the WA is actually a stronger property than the WWA.

Example 1. Let the excess demand $Z: \mathbb{R}_{++}^3 \to \mathbb{R}^3$ be defined by $Z(p) = (1/p_1) M p$ where M is the skew-symmetric matrix

$$M = \begin{bmatrix} 0 & -1 & 1 \\ 1 & 0 & -1 \\ -1 & 1 & 0 \end{bmatrix}$$

with rank 2. The Jacobian matrix of $Z(p)$ is

$$\partial Z(p) = -(1/p_1) Z(p) e^T + (1/p_1) M$$

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where $e = (1, 0, 0)$. It is easy to see that $p^* = (1, 1, 1)$ is the unique equilibrium (up to normalization) and that Z is regular. Moreover, condition (A') holds, since from $v \cdot Z(p) = 0$ we have $v \cdot \partial Z(p)v = (1/p_1)v \cdot Mv = 0$. Therefore, by Corollary 2, the excess demand function satisfies the WWA. To show that the WA does not hold, take any q not collinear to p^*. Thus $Z(q) \neq Z(p^*)$ and $(q - p^*) \cdot Z(p^*) = 0$, but

$$(q - p^*) \cdot Z(q) = -\frac{(q_3 - q_2) + (q_1 - q_3) + (q_2 - q_1)}{q_1} = 0$$

and the WA is violated. An analogous example for the case of demand functions was given by Kihlstrom, Mas-Colell and Sonnenschein (1976).

A differential characterization of the WA has been provided by Zhou (1995) in the case of individual demand functions. An individual demand is a C^1 function $f: \mathbb{R}_{++}^n \times \mathbb{R}_{++} \to \mathbb{R}^n$ satisfying budget identity, i.e. $p \cdot f(p, w) = w$, and homogeneity of zero degree in prices p and income w. Homogeneity allows us to normalize income to 1 and restrict the analysis to the function $F: \mathbb{R}_{++}^n \to \mathbb{R}^n$ defined by $F(p) = f(p, 1)$. The WA for F is formally defined as in Definition 3. Zhou (1995) has shown that the WA is completely characterized by (A) and the following condition:

(LZ) Let $v = q - p$. If $v \cdot F(p) = 0$ and $F(p) \neq F(q)$, then there exists $t \in [0, 1)$ such that $v \cdot \partial F(p + tv)v < 0$.

Zhou (1995) leaves open the question of whether the above result also applies to the case of excess demand functions.[2] By using Theorem 2, we derive a complete characterization of the WA for excess demand and then we show that Zhou's question has a negative answer.

Theorem 3. Let Z be a C^1 excess demand function. The following statements are equivalent:

[2] I am indebted to Reinhard John for drawing my attention to Zhou (1995)'s paper and for suggesting this application of Theorem 2.

i) Z satisfies the WA.

ii) Z satisfies the WWA and condition (LZ).

iii) Z satisfies conditions (A'), (C') and

(LZ') Let $v = q - p$. If $v \cdot p = 0$, $v \cdot Z(p) = 0$ and $Z(p) \neq Z(q)$, then there exists $t \in [0, 1)$ such that $v \cdot \partial Z(p + tv)v < 0$.

Proof. *(i) implies (ii).* The WA trivially implies the WWA. Next, let $(q - p) \cdot Z(p) = 0$ and $Z(p) \neq Z(q)$. By the WA we have $(q - p) \cdot Z(q) < 0$. Set $g(t) = v \cdot Z(p + tv)$ with $v = q - p$ so that $g(0) = 0$ and $g(1) < 0$. By the Mean Value Theorem there exists $t \in (0, 1)$ such that $0 > g'(t) = v \cdot \partial Z(p + tv)v$ and (LZ) holds.

(ii) implies (iii). By Theorem 2, the WWA implies conditions (A') and (C'). (LZ) trivially implies (LZ').

(iii) implies (i). Let us assume that the WA is violated and conditions (A'), (C') and (LZ') hold. By Theorem 2, Z satisfies the WWA, therefore the only way the WA can be violated is when $(q - p) \cdot Z(p) = (q - p) \cdot Z(q) = 0$ and $Z(p) \neq Z(q)$. Set $q' = (p \cdot p/p \cdot q)q$ and $v = q' - p$, so that $v \cdot p = 0$. By homogeneity and Walras' Law we have $v \cdot Z(p) = v \cdot Z(q') = 0$ and $Z(p) \neq Z(q')$. Define the function $g(t)$ as above and notice that, by pseudomonotonicity of Z, also g is PM.[3] Since the set of zeroes of a PM function is convex and $g(1) = g(0) = 0$, the function g is constant on $[0, 1]$ and (LZ') cannot hold. This contradiction completes the proof.

Q.E.D.

Remark 1. Theorem 3 improves upon a characterization of the WA provided by Zhu (1999) which, essentially, amounts to the equivalence between (i) and (ii).

Remark 2. As a straightforward implication of Theorem 3 and Corollary 2 we

[3] Indeed, let $0 \geq (s - t)g(t) = [(p + sv) - (p + tv)] \cdot Z(p + tv)$. Since Z is PM we have $0 \geq [(p + sv) - (p + tv)] \cdot Z(p + sv) = (s - t)g(s)$ and g is PM.

see that conditions (A') and (LZ') characterize the WA for *regular* excess demand. In general, however, one cannot dispense with condition (C'). In other words, conditions (A) and (LZ) characterize the WA for demand functions, but not for excess demand functions. The following example justifies this claim.

Example 2. Let $f: \mathbb{R} \to \mathbb{R}$ be defined by $f(x) = x^3[2 + \sin(1/x)]$ and $f(0) = 0$. The function f is C^1 and is not pseudomonotone, since its graph crosses the horizontal axis from below. However, f satisfies conditions (A) and (LZ). Indeed, $f(x) = 0$ only when $x = 0$ and since $f'(0) = 0$, condition (A) holds. To show that (LZ) is also satisfied notice first that, for $x \neq 0$, $(y - x)f(x) = 0$ only when $y = x$. Therefore we only need to consider the case $x = 0$. For all $y \neq 0$ we have $f(y) \neq f(0)$ and one can easily check that $f'(y) < 0$ for any $y = 1/2\pi k$ and for any $y = -1/(2k+1)\pi$, where k is any positive integer. Therefore, in any neighbourhood of zero the derivative of f takes on negative values so that we can conclude that the function f satisfies also condition (LZ). A similar example can be constructed for an excess demand function in the two dimensional case. Example 3 in the Appendix shows an excess demand function which satisfies conditions (A') and (LZ') but violates the WA.

The different characterizations of the WA for demand and excess demand are explained by pseudomonotonicity criteria. Since demand never vanishes in its domain, condition (C) trivially holds so that (A) is all we need to ensure pseudomonotonicity of F. On the other hand, Example 2 and 3 clearly show that condition (LZ) plays no role in the characterization of pseudomonotonicity, so that in the case of excess demand condition (C) must also be required.

Remark 3. A sufficient condition for the WA is that condition (A') holds with a strict inequality [see, for example, Mas-Colell (1985, Sec. 5.7) or Hildenbrand and Jerison (1989)]. This result is a straightforward implication of Theorem 3 since, in

that case, (C') and (LZ') are trivially satisfied.

Two final remarks deal with a differential condition closely related to the weak axioms.

(D) There exists a vector $e \in \mathbb{R}^n_+$, $e \neq 0$ such that, for all $p \in \mathbb{R}^n_{++}$ and $v \in \mathbb{R}^n$,

$$v \cdot e = 0 \qquad \text{implies} \qquad v \cdot \partial Z(p)v \leq 0$$

This condition has been used in the analysis of aggregate demand in a stronger form which implies the WA [see, for example, Mas-Colell (1985, Sec. 5.7), Mas-Colell (1991), Quah (1997)]. As shown by Hildenbrand and Kirman (1988, Lemma 6.1), condition (D) is equivalent to the monotonicity of Z with respect to the vector e, i.e. $(q - p) \cdot [Z(q) - Z(p)] \leq 0$ for all p and q such that $p \cdot e = q \cdot e$. By using the above condition it is easily seen that (D) implies the WWA.

Remark 4. Condition (D) is unnecessarily strong for the WWA. Figure 1.(c) in Mas-Colell (1991) provides an example of a function which violates (D) but that can be thought of as the excess demand of a rational consumer.[4] On the other hand, condition (D) is not strong enough, in the sense that it does not imply the WA. Indeed, it is easy to see that the excess demand in Example 1 satisfies (D) for the vector $e = (1, 0, 0)$.

Remark 5. From Theorem 3 it is easily seen that conditions (D) and (LZ') are sufficient for the WA. This result generalizes another well-known sufficient condition, which requires (D) to hold with a strict inequality [see, e.g. Mas-Colell (1985, Sec. 5.7)].

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[4] I thank Reinhard John for suggesting this example.

APPENDIX

Example 3. Let us consider the excess demand function $Z \colon \mathbb{R}^2_{++} \to \mathbb{R}^2$, defined by

$$Z(p) = \left(h\left(\frac{p_1}{p_2}\right), \ -p_1 \, h\left(\frac{p_1}{p_2}\right) \Big/ p_2 \right)$$

where $h(s) = f(s-1)$ and f is as in Example 2. At the unique equilibrium, $p^* = (1,1)$, the Jacobian matrix is the null matrix, therefore condition (A') in Theorem 2 is satisfied.

Next, consider condition (LZ') in Theorem 3. If $Z(p) \neq 0$ then (LZ') trivially holds since $v \cdot p = 0$ and $v \cdot Z(p) = 0$ yield $v = 0$. Let us consider then the equilibrium price vector p^* and any $v = q - p^*$ such that $v \cdot p^* = 0$. Excluding the trivial case $v = 0$, from the last equality we obtain $v_2 = -v_1$ and $v_1 \neq 0$. Therefore we have

$$g(t) = v \cdot Z(p^* + tv) = v_1 h(s(t))[1 + s(t)]$$

where $s(t) = (1 + tv_1)/(1 - tv_1)$ and $t \in [0,1]$. The derivative of g is

$$g'(t) = v_1 s'(t) \left[h'(s(t))(1 + s(t)) + h(s(t)) \right]$$

Since $v_1 s'(t) > 0$ for all $t \neq 0$ and any $v_1 \neq 0$, the sign of the derivative is equal to the sign of the expression in square brackets, which can be written as follows:

$$\left\{ 3(s(t)-1)^2 \left[2 + \sin\left(\frac{1}{s(t)-1}\right) \right] - (s(t)-1)\cos\left(\frac{1}{s(t)-1}\right) \right\} (s(t)+1) + $$
$$+ (s(t)-1)^3 \left[2 + \sin\left(\frac{1}{s(t)-1}\right) \right] \tag{A.1}$$

Let us suppose that $v_1 > 0$ and set $t = 1/[v_1(4\pi k + 1)]$ for some positive integer k sufficiently large so that $0 < t < 1$. Then $1/(s(t)-1) = 2\pi k$ and substituting t in (A.1) we obtain an expression with the same sign as

$$(6 - 2\pi k)(4\pi k + 1) + 2 \tag{A.2}$$

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Clearly, (A.2) is negative for any $k \geq 1$, therefore, we have shown that for $v_1 > 0$ there exists $t \in (0,1)$ such that $0 > g'(t) = v \cdot \partial Z(p^* + tv)v$. Similarly, if $v_1 < 0$ we can find $t \in (0,1)$ such that $1/(s(t)-1) = -(2k+1)\pi$ and show again that $g'(t) < 0$. Therefore, we conclude that the excess demand function satisfies condition (LZ').

Finally, to see that Z violates the WA (and also the WWA) simply take the price vectors $p^* = (1,1)$ and $q = (2,1)$. Thus, $(q - p^*) \cdot Z(p^*) = 0$ and $(q - p^*) \cdot Z(q) = h(2) = f(1) > 0$.

References

Crouzeix, J.P. and J.A. Ferland (1996) "Criteria for Differentiable Generalized Monotone Maps", *Mathematical Programming*, 75, 399-406.

Freixas, X. and A. Mas-Colell (1987) "Engel Curves Leading to the Weak Axiom in the Aggregate," *Econometrica*, 55, 515-531.

Härdle W., W. Hildenbrand and M. Jerison (1991) "Empirical Evidence of the Law of Demand," *Econometrica*, 59, 1525-1549.

Hildenbrand, W. (1983) "On the Law of Demand," *Econometrica*, 51, 997-1019.

Hildenbrand, W. (1994) *Market Demand: Theory and Empirical Evidence.* Princeton, NJ: Princeton University Press.

Hildenbrand, K. and W. Hildenbrand (1986) "On the Mean Income Effect: A Data Analysis of the U.K. Family Expenditure Survey," *Contribution to Mathematical Economics in Honor of Gerard Debreu*, ed. by W. Hildenbrand and A. Mas-Colell. Amsterdam: North-Holland.

Hildenbrand, W. and M. Jerison (1989) "The Demand Theory of the Weak Axioms of Revealed Preferences", *Economics Letters*, 29, 209-213.

Hildenbrand, W. and A. Kirman (1988) *Equilibrium Analysis.* Amsterdam: North Holland.

Hildenbrand, W. and A. Kneip (1993) "Family Expenditure Data, Heteroschedasticity and the Law of Demand," *Ricerche Economiche*, 47, 137-165.

Jerison, M. (1999) "Dispersed Excess Demands, the Weak Axiom and Uniqueness of Equilibrium", *Journal of Mathematical Economics*, 31, 15-48.

John, R. (1995) "A First Order Characterization of Generalized Monotonicity", Bonn, Discussion Paper A-490.

John, R. (2000a) "A First Order Characterization of Generalized Monotonicity", (revised version), *Mathematical Programming*, 88, 147-155.

John, R. (2000b) "Quasimonotone Individual Demand", *Optimization*, 47, 201-209.

John, R. (2000c) "The Concave Nontransitive Consumer", *Journal of Global Optimization*, forthcoming.

15

Karamardian, S. (1976) "Complementarity Problems over Cones with Monotone and Pseudomonotone Maps", *Journal of Optimization Theory and Applications*, 18, 445-454.

Kihlstrom, R., Mas-Colell, A. and H. Sonnenschein (1976) "The Demand Theory of the Weak Axiom of Revealed Preference", *Econometrica*, 44, 971-978.

Kim, T. and M.K. Richter (1986) "Nontransitive-Nontotal Consumer Theory" *Journal of Economic Theory*, 38, 324-363.

Marhuenda, F. (1995) "Distribution of Income and Aggregation of Demand," *Econometrica*, 63, 647-666.

Mas-Colell, A. (1985) *The Theory of General Economic Equilibrium, A Differentiable Approach.* Cambridge: Cambridge University Press.

Mas-Colell, A. (1991) "On the Uniqueness of Equilibrium Once Again," *Equilibrium Theory and Applications*, ed. by W. Barnett, B. Cornet, C. D'Aspremont, J. Gabszewicz, and A. Mas-Colell. Cambridge: Cambridge University Press.

Quah, J. K.-H. (1997) "The Law of Demand when Income is Price Dependent," *Econometrica*, 65, 1421-1442.

Quah, J. K.-H. (2000) "Weak Axiomatic Demand Theory", mimeo, Oxford University.

Samuelson, P.A. (1938) "A Note on the Pure Theory of Consumer Behaviour," *Economica*, 5, 61-71.

Zhou, L. (1995) "A Characterization of Demand Functions that Satisfy the Weak Axiom of Revealed Preference," *Economics Letters*, 49, 403-406.

Zhu, D. (1999) "The Demand Functions that Satisfy the Weak Axiom of Revealed Preference and Generalized Monotonicity," mimeo, Université de Montréal.

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1. Maria Cristina Marcuzzo [1985] "Yoan Violet Robinson (1903-1983)", pp. 134

2. Sergio Lugaresi [1986] "Le imposte nelle teorie del sovrappiù", pp. 26

3. Massimo D'Angelillo e Leonardo Paggi [1986] "PCI e socialdemocrazie europee. Quale riformismo?", pp. 158

4. Gian Paolo Caselli e Gabriele Pastrello [1986] "Un suggerimento hobsoniano su terziario ed occupazione: il caso degli Stati Uniti 1960/1983", pp. 52

5. Paolo Bosi e Paolo Silvestri [1986] "La distribuzione per aree disciplinari dei fondi destinati ai Dipartimenti, Istituti e Centri dell'Università di Modena: una proposta di riforma", pp. 25

6. Marco Lippi [1986] "Aggregations and Dynamic in One-Equation Econometric Models", pp. 64

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11. Fernando Vianello [1986] "Labour Theory of Value", pp. 31

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15. Giovanni Bonifati [1986] "Saggio dell'interesse e domanda effettiva. Osservazioni sul cap. 17 della General Theory", pp. 42

16. Marina Murat [1986] "Betwin old and new classical macroeconomics: notes on Lejonhufvud's notion of full information equilibrium", pp. 20

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18. Mario Forni [1986] "Aggregazione ed esogeneità", pp. 13

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20. Fiorenzo Sperotto [1987] "L'immagine neopopulista di mercato debole nel primo dibattito sovietico sulla pianificazione", pp. 34

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22. Leonardo Paggi [1987] "Contemporary Europe and Modern America: Theories of Modernity in Comparative Perspective", pp. 38

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24. Fernando Vianello [1987] "Effective Demand and the Rate of Profits. Some Thoughts on Marx, Kalecki and Sraffa", pp. 41

25. Anna Maria Sala [1987] "Banche e territorio. Approccio ad un tema geografico-economico", pp. 40

26. Enzo Mingione e Giovanni Mottura [1987] "Fattori di trasformazione e nuovi profili sociali nell'agricoltura italiana: qualche elemento di discussione", pp. 36

27. Giovanna Procacci [1988] "The State and Social Control in Italy During the First World War", pp. 18

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29. Maria Cristina Marcuzzo (a cura di) [1988] "Richard F. Kahn. A discipline of Keynes", pp. 118

30. Paolo Bosi [1988] "MICROMOD. Un modello dell'economia italiana per la didattica della politica fiscale", pp. 34

31. Paolo Bosi [1988] "Indicatori della politica fiscale. Una rassegna e un confronto con l'aiuto di MICROMOD", pp. 25

32. Giovanna Procacci [1988] "Protesta popolare e agitazioni operaie in Italia 1915-1918", pp. 45

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36. Nerio Naldi [1988] "'Keynes' concept of capital", pp. 40

37. Andrea Ginzburg [1988] "locomotiva Italia?", pp. 30

38. Giovanni Mottura [1988] "La 'persistenza' secolare. Appunti su agricoltura contadina ed agricoltura familiare nelle società industriali", pp. 40

39. Giovanni Mottura [1988] "L'anticamera dell'esodo. I contadini italiani della 'restaurazione contrattuale' fascista alla riforma fondiaria", pp. 40

40. Leonardo Paggi [1988] "Americanismo e riformismo. La socialdemocrazia europea nell'economia mondiale aperta", pp. 120

41. Annamaria Simonazzi [1988] "Fenomeni di isteresi nella spiegazione degli alti tassi di interesse reale", pp. 44

42. Antonietta Bassetti [1989] "Analisi dell'andamento e della casualità della borsa valori", pp. 12

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44. Carlo Alberto Magni [1989] "Reputazione e credibilità di una minaccia in un gioco bargaining", pp. 56

45. Giovanni Mottura [1989] "Agricoltura familiare e sistema agroalimentare in Italia", pp. 84

46. Mario Forni [1989] "Trend, Cycle and 'Fortuitous cancellation': a Note on a Paper by Nelson and Plosser", pp. 4

47. Paolo Bosi , Roberto Golinelli , Anna Stagni [1989] "Le origini del debito pubblico e il costo della stabilizzazione", pp. 26

48. Roberto Golinelli [1989] "Note sulla struttura e sull'impiego dei modelli macroeconometrici", pp. 21

49. Marco Lippi [1989] "A Shorte Note on Cointegration and Aggregation", pp. 11

50. Gian Paolo Caselli e Gabriele Pastrello [1989] "The Linkage between Tertiary and Industrial Sector in the Italian Economy: 1951-1988. From an External Dependence to an International One", pp. 40

51. Gabriele Pastrello [1989] "Francois quesnay: dal Tableau Zig-zag al Tableau Formule: una ricostruzione", pp. 48

52. Paolo Silvestri [1989] "Il bilancio dello stato", pp. 34

53. Tim Mason [1990] "Tre seminari di storia sociale contemporanea", pp. 26

54. Michele Lalla [1990] "The Aggregate Escape Rate Analysed throught the Queueing Model", pp. 23

55. Paolo Silvestri [1990] "Sull'autonomia finanziaria dell'università", pp. 11

56. Paola Bertolini, Enrico Giovannetti [1990] "Uno studio di 'filiera' nell'agroindustria. Il caso del Parmigiano Reggiano", pp. 164

57. Paolo Bosi, Roberto Golinelli, Anna Stagni [1990] "Effetti macroeconomici, settoriali e distributivi dell'armonizzazione dell'IVA", pp. 24

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60. Andrea Giommi [1990] "La probabilità individuale di risposta nel trattamento dei dati mancanti", pp. 13

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65. Mario Forni [1990] "Misspecification in Dynamic Models", pp. 19

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68. Paola Bertolini [1990] "Sistema agro-alimentare in Emilia Romagna ed occupazione", pp. 65

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70. Margherita Russo [1990] "Cambiamento tecnico e distretto industriale: una verifica empirica", pp. 115

71. Margherita Russo [1990] "Distretti industriali in teoria e in pratica: una raccolta di saggi", pp. 119

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75. Enrico Giovannetti [1990] "Crisi e mercato del lavoro in un distretto industriale: il bacino delle ceramiche. Sez I", pp. 150

76. Enrico Giovannetti [1990] " Crisi e mercato del lavoro in un distretto industriale: il bacino delle ceramiche. Sez II", pp. 145

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