NEOCLASSICAL MICROECONOMIC THEORY: SHOULD HETERODOX ECONOMISTS SHOW IT ANY RESPECT?

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Before starting, it is necessary to make clear the critique's target since many heterodox economists seem to be unsure what the core elements of NCMT are while others think that NCMT is an imprecise concept. In this article NCMT is defined in terms of its theoretical tools and the theoretical models (either formal-mathematical and/or literary) that utilize the tools; and the discourse that links together the tool-based models constitutes the neoclassical microeconomic theory that is delineated in the textbooks assigned in introductory, intermediate, and graduate courses. In particular, Table 1 lists the tools and models included in such textbooks for the last sixty years. These twenty-nine topics represent what is taught to every heterodox (and mainstream) economist in their core graduate microeconomic theory courses as well as what they learned in their undergraduate microeconomic theory courses. Moreover these core tools and models and associated discourse underpin virtually every book, article, and model that utilizes NCMT. Thus they constitute the minimum standards of what the profession expects every new Ph.D. economist to know.[1] And they are also the foundation of neoclassical economic theory, for if the tools and models are incoherent and/or dismissed for empirical or theoretical reasons, then the associated discourse would be unintelligible. Hence there would be no neoclassical theory, micro or otherwise.[2] Consequently these tools and models will be the subject of our critique.

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[1] See Krueger (1991), Hansen (1991), Kasper (1991), and Klamer and Colander (1990). The list of the eighty-two textbooks examined is found in the appendix to the Bibliography. All the textbooks were or are widely used in the classroom, as can be gathered from the acknowledgments in the texts. Moreover, top ranking graduate programs in economics (2001), such as Massachusetts Institute of Technology, Harvard University, Princeton University, Yale University, University of Wisconsin-Madison, and University of California-Los Angeles assign Mas-Colell, Whinston, and Green (1995), Varian (1992), and Kreps (1990) as primary texts in their graduate microeconomic theory courses. The difference in material covered (as represented by the twenty-nine topics in Table 1) between these texts and the other seventy-nine texts in the sample is near zero (an average of 24.67 topics covered by the three texts versus 25.37 topics covered by the other seventy-nine texts). Thus, the same core theoretical tools and models of NCMT are taught to undergraduate and graduate students alike.

[2] It is claimed by some (for example Mandler, 1999) that not all of the topics are necessarily part of the theoretical core of NCMT and references are then made to the irrelevant topics, such as differentiable

Table 1

Neoclassical Microeconomic Theory as Represented in Textbooks, 1941 - 2002

Tools and Models	
Economics defined as the allocation of scarce resources	68 (83)
Scarcity, scarce factor inputs	61 (74)
Production possibility frontier	52 (63)
Opportunity costs	57 (70)
Equilibrium	82 (100)
Demand Side	
Utility/diminishing marginal utility	77 (94)
Maximize utility	79 (96)
Utility functions, indifference curves, marginal rate of substitution	72 (88)
Income/substitution effects	71 (87)
Individual consumer/market demand curve	82 (100)
Price elasticity of demand	82 (100)
Production and Costs	
Production function	62 (76)
Single input variation, marginal products	78 (95)
Law of diminishing returns	77 (94)
Proportional input variation, returns to scale	55 (67)
Isoquants, marginal rate of technical substitution	55 (67)
Marginal costs: MC = Px/MPx	80 (98)
Firm/market supply curve	80 (98)
Markets	
Perfect or pure competition	82 (100)
Profit maximization	82 (100)
Marginal cost = price	82 (100)
Imperfect/monopolistic competition	79 (96)

production functions. Whatever the merits of the technical claim, the topics listed are necessary, as Mandler points out, if the broad explanatory and predictive discourse of NCMT is to be sustained.

Firm demand curve	79 (96)
Marginal revenue = marginal costs (or equivalent)	82 (100)
Oligopoly with firm demand curve	62 (77)
Distribution and General Equilibrium	
Marginal productivity principle	64 (78)
Wage rate = MP_L x Price, Profit = MP_K x Price	76 (93)
General Equilibrium	51 (62)
Pareto-efficiency/optimality	46 (56)
Total Number of Textbooks	82

(the entry in parentheses gives the percentage of textbooks that included the topic)

Our critique of the tools and models of NCMT will in general not include novel arguments or claims, but rather will bring together many longstanding critical expositions combined with drawing out their theoretical implications. In some cases, the form of the argument will be external theoretical analysis directed at the sensibility of the neoclassical tools and models, while a second form of argument will be an internal theoretical criticism. The third form will utilize empirical evidence to question the empirical support a particular tool or model but more generally to complement and support the other forms of argument. What we will not argue is that NCMT should be dismissed because its tools and models lack realism or because it utilizes abstruse mathematical language. In the case of the former, it is not a question of the degree of realism but whether they exist at all. As for the latter, we take the position that mathematical language is neutral with respect to theoretical tools and models; and besides that heterodox economists also utilize abstruse mathematical language, such as indecomposable semi-positive square matrix and eigenvalue: we will not be a kettle calling the pot black.

There are many critiques of the tools and models of neoclassical microeconomics, far more than we can utilized given the word-page constraints of the article: so much incoherence, so few words. Hence only a portion of the critiques will be used, while the others will be cited in footnotes as

supporting critiques.[3] It should also be noted that our critique is not intended to change the minds of neoclassical economists—for paraphrasing Joan Robinson: convinced against their will, they are neoclassical economists of the same opinion still. Rather as stated above, our article is directed primarily at heterodox economists who believe that NCMT has some usefulness and secondarily at heterodox economists who would also want a reasonable summary of the incoherence of neoclassical microeconomics along with a list of supporting citations that would be useful to them for their research and teaching.

The article is written like a sequence of chapters in a continuous story centered on specific set of tools and models, while the references and footnotes both ground the story as well as extending its implications beyond its narrow, restrictive scope. More specifically, the article will concentrate on what is considered the theoretical and explanatory core of NCMT, the supply and demand explanation of the price mechanism and its application to competitive markets. Thus, our critique starts by examining the choices, preferences, utility functions, and demand curves, followed by examining production, costs, factor input demand functions and partial equilibrium, and ending with perfect competition and the supply curve. In the conclusion, the implications of the results will be extended to the firm and imperfectly competitive markets, and then the question whether general equilibrium theory or game theory can save NCMT is briefly addressed. What we hope to make clear by the end of the article is that both the tools and models that underlie the price mechanism as well as the general theoretical framework in which the price mechanism rests are incoherent and hence NCMT is without sense and sensibility.

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[3] Many of the critiques we shall utilize are found in Keen (2001) and at Keen's website: www.debunking-economic.com.

Preferences, Utility Functions, and Demand Curves

Open any introductory microeconomic textbook and you are quickly told about the price mechanism and the role of demand and supply curves. Moreover the emphasis is on the primacy of demand curves over supply curves because the ensuing discussion always starts with demand curves. Hence we shall start with demand theory; so in this section we shall deal with preferences, utility functions, and the consumer and market demand curves and their derivative properties.

Preferences and the Utility Function

Like neoclassical economists, we start with a consumer utility function of the general form:

(1) $U = \mu(\mathbf{y})$

where the vector of goods and services $\mathbf{y} = (y_1,\ldots, y_n) \geq 0$ and divisible. It is now assumed that the individual consumer has preferences regarding each y_i, but, in general, neoclassical economists are not concerned how the consumer acquires them. However, preferences have to come from somewhere, such as the consumer's family when s/he was a small child, since the consumer must have some social basis for identifying objects to have preferences about and socially derived reasons for preferring or not preferring y_i itself or relative to say y_j in the context of achieving a valued end. Consequently, an individual consumer outside of a social network wanting y_i as an acultural object for its own sake is simply unintelligible. This argument implies that objects which consumers have preferences for are socially understood and hence have social characteristics that cannot be derived from their 'technical' characteristics.[4] Since the socially embedded consumer must have social preferences in order to make choices among socially understood goods and services that would achieve a valued end such as the maximizing of utility, then those preferences must be intrinsically non-autonomous since they are

[4] There are also additional arguments that undermine Lancaster's new approach to consumer demand—see Watts and Gaston (1982-83).

socially constructed.[5] More significantly there is no reason not to suppose that they are in part constructed and altered by the same industrial and social processes which the goods and services are produced to meet the valued ends desired by the consumer—that is, preferences are also endogenous.[6] Such an outcome could also reproduce (as in Galbraith's revised sequence theory of demand) the consumer and her/his preferences that are the basis of making the choices. Hence, to initiate preference and demand theory by assuming that preferences are given relative to and independent of an array of given goods is to start the theory with nonsense.[7]

If preferences are socially constructed and articulated, then it is possible that the preference structure formation process or algorithm used by the consumer is also socially produced and the preference structure arising therefrom might not result in choices generating a unique utility maximizing outcome. To examine this point further, we shall assume, as is traditionally the case, the axiom of comparability that a consumer can decide whether s/he prefers the vector of goods and services $\mathbf{y}^i$ to $\mathbf{y}^j$ or is indifferent them.[8] For a consistent preference structure to exist that would permit maximization,

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[5] The socially embedded consumer with social preferences also has the capability of making interpersonal comparisons regarding consumption and other social activities (Peacock, 1996). This, in part, undermines the theoretical core of neoclassical welfare economics.

[6] More strongly, it is plausible to argue that the 'social characteristic' of a good is constructed simultaneously with preferences, which means that neither can stand independently of the other. Hence a change in either means a change in both and if the social characteristic of the good also becomes vested in its price, then a change in price could have the Veblenian outcome of a change in both preferences and the good. This of course would mean that there could be no consumer or market demand curves for such a good, no price elasticity of demand, no possibility to talk about optimality of market equilibrium, and no possibility of an unchanging consumer. And it can also be plausibly argued that the latter result can be generalized in that the activity of social consumption generates a consumer with continuously changing preferences. Without the fixity of preferences, neoclassical welfare/cost-benefit arguments cease to have any meaning or substance.

[7] This conclusion raises severe doubts about Pareto efficiency in that the market does not act to adopt the given scarce resources to meet given ends; rather it is possible the market creates the ends to which it then allocates scarce resources. This possible outcome also renders incoherent the neoclassical definition of economics that is about making choices regarding scarce resources relative to given ends.

[8] This assumption has a conceptual problem that can be called the "curse of dimensionality". For example, if it is assumed that there are thirty different goods and services and the quantity of each y_i can

the choice of vectors must be transitive or more generally acyclical so that it is not possible to have $\mathbf{y}^1$ P(referred to) $\mathbf{y}^2$, …, $\mathbf{y}^{n-1}$ P $\mathbf{y}^n$ and $\mathbf{y}^n$ P $\mathbf{y}^1$. There is no apparent reason or possibility to restrict the possible social influences upon the consumer's choice making decisions since social influences are intrinsic to choice making decisions and are non-autonomous. Hence, it is quite plausible to conclude that the consumer relies on multiple influences when making decisions. But multiple influences easily generate choices of vectors that are intransitive and/or cyclical as different influences are relevant when different vectors are compared; and without a single preference ranking of the vectors, the consumer's preference structure is inconsistent and therefore not a useful guide for utility maximization. Moreover, multiple influences combined with the "curse of dimensionality" implies that the consumer will rarely if ever attain a complete ordering of all the possible vectors of goods and services; and this also prevents the consumer's preference structure from being a useful guide for utility maximization.

Finally, since there are no restrictions on what the influences are, it is both plausible and possible that they

(1) produce a lexicographic preference structure that is transitive and acyclical and hence a consistent preference structure that is a guide for utility maximization; but such a preference structure violates the axiom of continuity and hence eliminates indifference curves;

(2) produce a fixed proportions (continuous or discreet) consumption patterns that are consistent

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vary from zero to ten (although in principle the upper bound is unrestricted), the number of different $\mathbf{y}^i$ would be 11^{30}. If each comparison of $\mathbf{y}^i$ and $\mathbf{y}^j$ took the consumer 1 billionth of a second, it would take her/him 5.53^{13} years to make all of them; and that period of time is not only longer than the life span of the consumer, it is also much longer than the known age of the universe. This example is rather crude relative to a more realistic example of a consumer making comparisons of goods and services vectors in a typical supermarket that has over 1000 different items; and in this case even if the quantities under consideration are zero or one, the time required to undertake all the comparisons would be even greater than the crude example. Hence, the axiom of comparability is simply incoherent, without any sense. It should be noted that the curse of dimensionality is distinct from radical uncertainty in that the latter rejects the possibility of comparisons because the consumer simply does not know about all goods and services that could be included in $\mathbf{y}^i$ or all of the vectors of goods and services to be compared. Thus, if

with utility maximization but do not permit the derivation of the marginal utility of the individual goods involved; or

(3) result in the consumer adopting a frugal/green/non-materialist attitude that restricts consumption to a particular satisfactory or ecologically sustainable level or cultural/ethical/moral attitudes that affect choice decisions and consumption patterns independently of any utility consideration, hence resulting in decisions that are inconsistent with and/or not based on utility, utility maximization, and/or the axiom of nonsatiation.

In short, because the domain of influences is unrestricted and the curses of dimensionality and radical uncertainty ever present, the consumer can quite plausibly not be excluded from having a preference structure that is incomplete, is without a single preference ranking, is in part lexicographic, contains fixed proportions consumption patterns, and is based on satiated, non-maximization choice decisions. Such a preference structure is inconsistent with a utility function that permits utility maximization, generates marginal utility (whether diminishing or not), and has indifference curves (whether strictly convex or not). In fact, it is plausible to suppose that such a preference structure is inconsistent with the concept of a utility *per se*. Just because consumers choose, this does not allow one to conclude that their choice decisions are consistent with utility functions *per se*, a utility maximizing function, or a strictly quasi-concave utility function which is generally assumed in textbooks when constructing consumer demand curves.[9] [Steedman, 1980; Rizvi, 2001; Baker, 1988a and 1988b; Petrick and Sheehan, 2002; Katzner, 2002; and Lane, et. al., 1996]

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radical uncertainty also exists, the axiom of comparability simply ceases to be at all.

[9] This conclusion undermines bounded rationality because rationality as defined in NCMT is incoherent; and without rationality of NCMT there is no *bounded* rationality for there is nothing to be bounded.

Consumer and Market Demand Curves

Without an appropriate structure of preferences underlying, for example, a strictly quasi-concave utility function, it is not possible to derive a consumer demand curve and any of its derivative properties. That is, as is generally done in graduate textbooks, let us assume a strictly quasi-concave utility function. Now assuming utility maximization subject to a budget constraint, the Lagrangian function is:

(2) $L = \mu(\mathbf{y}) + \lambda(M - \mathbf{py})$

where the vector of prices $\mathbf{p} = (p_1, \ldots, p_n)$.

The first order conditions for utility maximization are:

$$L_1 = \frac{\partial \mu(\mathbf{y})}{\partial y_1} - \lambda p_1 = \mu_1 - \lambda p_1 = 0$$

(3) .....

$$L_n = \frac{\partial \mu(\mathbf{y})}{\partial y_n} - \lambda p_n = \mu_n - \lambda p_n = 0$$

$$L_\lambda = M - \mathbf{py} = 0.$$

Rearranging the first order conditions, we find that $-\mu_i/\mu_j = -p_i/p_j = MRS_{ji}$ and $M = \mathbf{py}$ or the conditions for consumer equilibrium that maximizes utility. To see if a utility maximization position has in fact been reached, the second order conditions are needed:

$L_{11} = \mu_{11}; \ldots; L_{1n} = \mu_{1n}; L_{1\lambda} = -p_1$
.....
$L_{n1} = \mu_{n1}; \ldots; L_{nn} = \mu_{nn}; L_{n\lambda} = -p_n$
$L_{\lambda 1} = -p_1; \ldots; L_{\lambda n} = -p_n; L_{\lambda\lambda} = 0.$

Putting this into a bordered Hessian matrix and taking its determinant, we have:

$$\begin{vmatrix} \mu_{11} & \ldots & \mu_{1n} & -p_1 \\ \ldots & \ldots & \ldots & \ldots \\ \mu_{n1} & \ldots & \mu_{nn} & -p_n \\ -p_1 & \ldots & -p_n & 0 \end{vmatrix} > 0.$$

This result emerges because of the axiom of strictly quasi-concave utility function ensures that the determinant of the bordered Hessian is negative definite. Consequently, the consumer equilibrium

position is a local maximum as well as a global maximum. Finally, solving the first order conditions, we get the equilibrium demand functions for $y_1, \ldots, y_n$:

$$(4) \qquad \begin{aligned} y_1^e &= f_1(\mathbf{p}, M) \\ &\cdots\cdots\cdots\cdots \\ y_n^e &= f_2(\mathbf{p}, M). \end{aligned}$$

However, if, as is quite possible, the utility function does not exist or exists but with properties noted above, then there would be no basis for utility maximization, marginal rate of substitution, and the utility maximizing consumer demand curve since the first and second order conditions depend on the existence of the marginal utility of individual goods and services. Moreover, since the *Slutsky equation* the concepts of the *substitution effect* and the *income effect* are also based on marginal utility, bordered Hessian matrix, and indifference curves, they would not exist or have any meaning.[10] Without both

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[10] As is well known, the substitution effect is the slope of the compensated demand curve. To derive the curve, we first specify a Lagrangian function in which expenditure is minimized subject to achieving a given level of total utility: $L = \mathbf{py} + \varphi[U^0 - \mu(\mathbf{y})]$. First order conditions are:

$$L_1 = p_1 - \varphi\frac{\partial\mu(\mathbf{y})}{\partial y_1} = 0$$

$$\cdots\cdots\cdots\cdots$$

$$L_n = p_n - \varphi\frac{\partial\mu(\mathbf{y})}{\partial y_n} = 0$$

$$L_\varphi = U^0 - \mu(\mathbf{y}) = 0$$

Since the utility function is strictly quasi-concave, the equilibrium position derived from the first order conditions is a minimum equilibrium position. Solving the first order conditions, we get compensated demand functions:

$$y_1^u = f_1^u(\mathbf{p}, U^0)$$

$$\cdots\cdots\cdots\cdots$$

$$y_n^u = f_n^u(\mathbf{p}, U^0)$$

effects, it is not possible to establish any connection between y_i and its price (thus leaving the quantity demanded unexplained) which implies there is no functional relationship (whether it be negative or positive) between y_i and its price—thus there is no "law of demand" whatever that law might be. That is, from the neoclassical perspective, the non-existence of the consumer demand curve arises because, after considering multiple influences the consumer's choice decisions in face of a budget constraint minimizes the influence of or is made independent of prices. The absence of the substitution and income effects, the consumer demand curve has the further consequence of undermining the concept of *price elasticity of demand.*[11]

In most textbooks, the market demand curve is derived by aggregating across consumer demand curves and it is assumed to have the same properties as the individual consumer demand curve.[12] However, the conditions for exact linear (or representational) aggregation are strict: that each consumer has a homothetic utility function (which generates linear Engel curves) and that the homothetic utility function for each consumer is the same. If these conditions (which produce consumer demand curves with all the right properties) do not hold, then the aggregate market demand curve that is derived has,

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However, in the absence of indifference curves, marginal utility, and bordered Hessian matrix, there are no first order conditions, minimum equilibrium position, and hence no compensated demand curve and by implication no substitution effect.

[11] The absence of the utility function, marginal utility, utility maximization, and the consumer demand curve also means that the concepts of *Giffen good, income elasticity of demand, cross-price elasticity of demand, consumer surplus*, and *duality* are meaningless; that the *homogeneity and budget constraint/adding-up properties* of the demand curve are irrelevant; that the problems of the incompatibility of *Giffen goods* and market-determined prices and of *integrability* are non-problems; and that *revealed preference theory* cannot be logically linked to utility functions and consumer demand curves derived therefrom. It should also be noted that revealed preference theory is methodologically incoherent in its own right (Wong, 1978) and without empirical support (Sippel, 1997).

[12] Consistent aggregation requires that all consumers have perfect knowledge so that the prices in their demand functions are the same. However, if uncertainty exists and some prices vary among the consumers, then consistent aggregation is not possible. The issue of uncertainty and failed expectations also affects the budget constraint when the consumer's income is a function of the expected prices of its endowments, which means that the derivation of the consumer's demand curve is problematical. [Katzner, 1991]

aside from continuity and homogeneity, none of the properties of a consumer demand curve. In particular, there is no functional relationship between y_i and its price (so no law of market demand); and no aggregate (or market) versions of the substitution and income effects, price elasticity of demand, cross-price elasticity of demand, or the strong axiom of revealed preference theory. Consequently, some neoclassical economists have attempted to avoid this outcome by assuming a "representative consumer" or just assuming that all consumers have the same homothetic utility function. But such assumptions are unjustified because they restrict what in principle cannot be restricted, which are the array of possible social influences upon consumer's choice making. Others have sought to reject aggregation and simply base the market demand curve on market price-quantity data. This implies, however, that neoclassical consumer preference and demand theory is irrelevant for understanding market activity. These responses are themselves dead ends if there are no utility functions (homothetic or not) or consumer demand curves (since with respect to the latter argument there would be no reason to presume any functional relationship between y_i and its price). In short, the conclusion must be that there is no basis for the existence of a market demand curve *per se*. [Rizvi, 1994 and 1998; Katzner, 1991; Varian, 1992; Mas-Colell, Whinston, and Green, 1995; and Deaton and Muellbauer, 1999]

Production and Cost Theory

Relative to demand, the supply side of NCMT is more complex because of the pre-conditions that need to be specified before any analysis of production and costs take place; and the latter has to occur before discussion about supply curves take place, and that discussion requires the introduction of an additional set of assumptions. Therefore, in this section attention will be focus on production and costs and in the following section perfect competition and the supply curve will be examined.

Technology and the Production Function

As in the textbooks, we start with a firm production function of the general form:

(5) $y = f(\mathbf{x})$

where y is the output and the vector of factor inputs $\mathbf{x} = (x_1, \ldots, x_n) > 0$ and divisible. The production function also has three additional definitional properties: it consists only of technology that ensures for any technique of production represented by the factor input combination $\mathbf{x}^i$, y is maximized; it and its technology is considered exogenous datum and fixed; and the factor inputs, x_i, are scarce factor inputs. However, these definitional properties generate three problems. The first concerns the technology itself in that the technology creators draw upon technological, economic, and social influences (all of which are external to the production function and hence cannot be restricted) to create technology for a specific valued end which the influences also define. Consequently, the range (which may be great or small) of technology that the firm can choose to include in its production function can have fixed production coefficients where the increase in a single input is necessary but not sufficient for an increase in output, variable production coefficients where the increase in a single input is both necessary and sufficient for an increase in output, or a combination of both. And since the valued end can be the maximization of output given inputs or something else, there can be only one or quite many $\mathbf{x}^i$ that produce the same y.[13]

Given the array of technologies and corresponding techniques of production available to the firm, the second problem arises over the choice of technology and techniques to be included in its production function. Assuming that the firm prefers technology that maximizes output given inputs, the firm's choice algorithm, as in consumer choice theory, can include many influences concerning the

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[13] For neoclassical economists, the objectives of the technology creators at this level of analysis are outside of consideration and investigation. Hence it is possible and even plausible that the technology available to the firm is consciously engineered to not maximize output from given inputs. It is also possible that the technologists do not separate technology from valued end output objective; thus $\mathbf{x}^i \rightarrow$ y can be based on objectives completely outside $\mathbf{x}^i \rightarrow$ maximum y. Finally, there is no reason not to suppose that technological, economic, and social influences on the technology creators are constructed and altered through the use of the technology to produce goods and services—that is, technology can change through usage, hence making it endogenous. These possibilities render incoherent the assumption that technology is fundamental datum and the definition of neoclassical economics that

nature and usage of the factor inputs relative to what is meant by maximizing output. Consequently, choices of $\mathbf{x}^i$ (and its technology) can be cyclical and hence cannot arrive at a single $\mathbf{x}^i$ that maximizes y; the firm can have a cyclical interpretation of maximum y relative to $\mathbf{x}^i$ hence also making its choice of $\mathbf{x}^i$ indeterminate; or the factor inputs in different $\mathbf{x}^i$ are different thus making it impossible for the firm to compare and chose between the different technologies relative to a given y. Moreover, the choice of technology combined with the "curse of dimensionality" implies that the firm may not be able to choose a range of technology for its production function that is complete, singled valued in that for any $\mathbf{x}^i$ there is a single y, and for any given $\mathbf{x}^i$ the resulting y is maximized; and these specific shortcomings render the conception of a production function incoherent as well as preventing it from being a useful guide and tool for cost minimization.

However, assuming that the firm does choose technology for its production function and given its choice algorithm, the resulting production function, in conjunction with the issues raised in the first problem, could plausibly have the following properties:

(1) each of the techniques of production has fixed production coefficients which implies that y is not a monotonic in x_i, the marginal product of x_i and the *marginal* rate of technical substitution do not exist, and there is no distinction between fixed and variable inputs;

(2) there is a single technique of production with fixed production coefficients which has all the implications of (1) above as well as no technical substitution at all;

(3) scale dependent inputs linked with output such that for any y there is a single $\mathbf{x}^i$ (with fixed production coefficients) and for y + 1 there is a single $\mathbf{x}^j$ (with fixed production coefficients) where $\mathbf{x}^i \neq \mathbf{x}^j$ in that there is at least one input in $\mathbf{x}^j$ that is not in $\mathbf{x}^i$; such a production schema violates continuity and convexity and eliminates proportional changes in inputs and outputs,

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requires the technology to be separate from the ends.

which means there are no isoquants especially convex isoquants, marginal rate of technical, and laws of returns to scale; and

(4) variable production coefficients that are constant or decline until the fixed factor input is fully utilized and ceases to take on any more of the variable inputs, which means that marginal products do not decline.

Since the influences on the creation and choice of technology is unrestricted, the resulting "production function" created by the firm may have none of the usual properties and characteristics associated with strictly quasi-concave production function (differentiable or not, homogeneous or homothetic) with strictly convex technology.[14] In short, incoherent, useless as a guide and tool for cost minimization, and lacking traditional production properties, the neoclassical production function is neither a sensible or sustainable delineation of production.

The third problem concerns scarcity as a definitional property of the production function. Given the lack of restrictions on the technology available to the firm and the firm's choice of technology, it is possible that its production function contains inputs that are produced by other firms and does not include constraints on production such as declining marginal products or decreasing returns to scale. In addition, the produced input connection between firms, when taken across all firms, could generate a system of production where all firms use produced and non-produced inputs in production. Thus, the production of produced inputs can be represented, as is overwhelming empirically the case, in terms of an input-output model with circular production and one or more non-produced inputs. With the lack of production constraints combined with producibility, reproducibility, and circular production, the produced inputs in the production function cease to have the properties of a scarce factor input;[15] and

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[14] The empirical evidence does support this possibility—see Lee (1986).

[15] Neoclassical economists have tried to circumvent this problem by defining goods according to time periods. Thus, because they represent different time periods, an input is conceptually different from an

more significantly, so do the non-produced inputs, as will be elaborated on below.[16] With perhaps none of the inputs in the production function scarce, although with production still taking place, the production function is not only an incoherent concept, it also does not exist. So just because production takes place and output is related to inputs, this does not allow one to conclude that production functions exist or to insert faith in place of scientific inquiry. Yet, for the neoclassical faithful, it can be said that those who believe in production functions with all their will are Fergusonians still.[17] [Ferguson, 1972; Varian, 1992; Mas-Colell, Whinston, and Green, 1995; Lee, 1998; and Bortis, 1997]

Cost Curves, Demand for Factor Inputs, and Partial Equilibrium

Without a production function or even a production function with marginal products, proportional input variation, and convex technology, it is not possible to derive cost minimizing output demand functions, cost functions, and their derivative properties. That is, let us assume a strictly quasi-concave production function. Now assuming cost minimization subject to an output constraint, the Lagrangian function is:

(6) $L = \mathbf{px} + \lambda[y^o - f(\mathbf{x})]$

where the vector of input prices $\mathbf{p} = (p_1, \ldots, p_n)$.

The first order conditions are

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output even when they have the same technical characteristics. This converts all produced inputs into relatively scarce factor inputs (assuming demand for their usage is sufficient). But this intertemporal equilibrium approach to production discards long run methodology utilized in virtually all neoclassical textbooks. More significantly, this definitional-based distinction has no sense in that no substantial reason is given for why time will make technically identical goods different; and in the real world example of wheat being an input into its own production, this approach is simply nonsense.

[16] Since produced inputs and circular production presuppose the prior existence of social activities engaged in production, production is also fundamentally a social process where output is a result of common, complementary, and coordinated effort; and social production is incompatible with the notion of scarcity.

[17] There are those who still believe in aggregate production functions in spite of well-known aggregation problems because they "work in practice". But this has been shown not to be the case at all—see McCombie (1998, 2000-2001, and 2001) and Felipe and McCombie (2001).

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\begin{aligned}
(7)\qquad & L_1 = p_1 - \lambda \partial f(\mathbf{x})/\partial x_1 = p_1 - \lambda f_1 = 0 \\
& \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\
& L_n = p_n - \lambda \partial f(\mathbf{x})/\partial x_n = p_n - \lambda f_n = 0 \\
& L_\lambda = y^o - f(\mathbf{x}) = 0
\end{aligned}
$$

Rearranging the first order conditions, we find that $-f_i/f_j = -p_i/p_j = MRTS_{ji}$ and $y^o = f(\mathbf{x})$ or the cost minimizing equilibrium conditions for the firm. To see if a cost minimizing position has in fact been reached, the second order conditions are need:

$$
\begin{aligned}
& L_{11} = -\lambda f_{11}; \ldots, L_{1n} = -\lambda f_{1n}; L_{1\lambda} = -f_1 \\
& \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\
& L_{n1} = -\lambda f_{n1}; \ldots, L_{nn} = -\lambda f_{nn}; L_{n\lambda} = -f_n \\
& L_{\lambda 1} = -f_1; \ldots, L_{\lambda n} = -f_n; L_{\lambda\lambda} = 0
\end{aligned}
$$

Putting this into a bordered Hessian matrix and then taking its determinant, we have

$$
\begin{vmatrix}
-\lambda f_{11} & \ldots & -\lambda f_{1n} & -f_1 \\
\ldots\ldots & \ldots\ldots & \ldots\ldots & \ldots\ldots \\
-f_1 & \ldots\ldots & -f_n & 0
\end{vmatrix} < 0
$$

because the production function is strictly quasi-concave. Hence we have cost minimization. Solving the first order conditions, we get *(constant output) factor input demand functions*:

$$
\begin{aligned}
(8)\qquad & x_1^e = \psi_1(p_1, \ldots, p_n, y^o) \\
& \ldots\ldots\ldots\ldots\ldots\ldots\ldots \\
& x_n^e = \psi_n(p_1, \ldots, p_n, y^o).
\end{aligned}
$$

Next, substituting them into total costs, we get the *total cost function* $TC = \mathbf{px}^e = TC^*(\mathbf{p}, y^o)$ which gives the minimum costs for producing any given amount of output. Finally, from the total cost function, the standard short run and long run cost curves and their shapes are easily derived and delineated.

However, if, as is quite possible, the production function does not exist or exists but with properties noted above, then there would be no basis for cost minimization, isoquants, marginal rate of technical substitution, and total cost functions and the standard cost curves. Moreover, since both the short and long run marginal cost curves are based on marginal products and proportional input variation,

they would not exist (irrespective of their shape). Finally, without technology restricted to generating at some point declining marginal products and decreasing returns to scale, there would be no necessary reason for increasing short and long run marginal cost curves to exist at all.[18] In short, without a production function and its traditional properties, it is not possible to establish in neoclassical economics a functional relationship between output and costs.[19]

Turning to the *(constant output) factor input demand function* and working in the **long run** where traditionally the substitution of factor inputs is permitted and differentiating $x_i^e = \psi_i(p_1, \ldots, p_n, y^o)$ with respect to p_i, we get the following:

$$\begin{bmatrix} \lambda^e f_{11} & \cdots & -f_1 \\ \vdots & & \vdots \\ \lambda^e f_{i1} & \cdots & -f_i \\ \vdots & & \vdots \\ -f_1 & \cdots & -f_n \quad 0 \end{bmatrix} \begin{bmatrix} \partial x_1^e / \partial p_i \\ \vdots \\ \partial x_i^e / \partial p_i \\ \vdots \\ \partial \lambda^e / \partial p_i \end{bmatrix} \equiv \begin{bmatrix} 0 \\ \vdots \\ -1 \\ \vdots \\ 0 \end{bmatrix}$$

Solving for $\partial x_i^e / \partial p_i$, the shape of the factor input demand function, we get:

(9) $$\frac{\partial x_i^e}{\partial p_i} = \frac{(-1)D_{ii}}{D} < 0$$ since both D_{ii} and D are negative.

Hence the demand for factor input x_i^e is inversely related to its own price, that is the demand curve for a factor input slopes downward because, according to the above argument, changes in quantity demanded of the factor input is restricted to the original isoquant since output is constant. But, without a spectrum of techniques, marginal products, isoquants, and bordered Hessian matrix, cost minimizing factor input demand functions do not exist and there is no functional relationship between x_i^e and its own price—

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[18] Empirical evidence on short run "marginal cost curves" suggests that they are in general not upward sloping; and if they are upward sloping the explanation is not based on marginal products—see Lee (1986) and Blinder, et. al., (1998)

[19] The absence of an appropriate production function also implies that *cost elasticity*, *duality* between the production function and the total cost function, and the long run average total cost curve being an envelope of short run average total cost curves are meaningless concepts.

thus no law of demand for factor inputs.[20] However, the shape of the factor input demand function poses even more significant issues once produced inputs and circular and complementary production are considered. It was established, in the context of the capital controversies, that for a system of production in which circular production takes place and all inputs are reproducible except labor, a reduction in a factor's input price would not necessarily increase its demand nor result in its substitution for the relatively higher-price factor input. More detailed research has reinforced these results as well as extending them to include more than one non-produced factor input, which means that non-produced inputs are "acting" liked produced inputs.[21] The research also shows that the results emerge because an arbitrary change in an input price, p_i, in a system of produced inputs and circular production has collateral effects that are non-negligible, such as affecting other input prices that are presumed to be constant and putting other firms out of equilibrium hence requiring them to make adjustments (that also have collateral effects) to get back to equilibrium. The existence of collateral effects invalidates the *ceteris paribus*, partial equilibrium methodology underpinning the derivation of the slope of the factor input demand function, hence making it meaningless. Thus it calls into question **any** partial equilibrium analysis (short run or long run) that allows for some price and quantities changes and input substitutions and yet does not take into account their possible disequilibrium impact on other firms and their actions to regain equilibrium. Without partial equilibrium methodology, the traditional market analysis articulated in neoclassical textbooks is rendered incoherent—a point that will also be dealt with in the next section. [Ferguson, 1972; Pasinetti, 1977; and Steedman, 1985, 1988, and 2002]

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[20] For methodological, theoretical, and empirical evidence supporting the absence of the law of demand for factor inputs, see Fleetwood (2002), Michl (1987), and Bewley (1999).

[21] The research is carried out at the industry level, but it is equally applicable to the individual firm whose production function contains multiple technologies since the change in input price is arbitrary and in principle extends to all firms in the economy if the law of one price is to prevail.

Perfect Competition and the Supply Curve

There are numerous shortcomings of the perfect competition model. However, we are going to restrict our attention to its coherence in terms of its analytical tools and its use of partial equilibrium methodology. Starting with the demand side, as argued in the first section, there is no basis for the existence of a market demand curve; and hence by implication a firm demand curve.[22] With the absence of both demand curves there can be no firm or market supply and demand analysis. However, for the sake of continuing the analysis, we shall assume for the moment that the firm faces an exogenously given market price (in place of the horizontal firm demand curve). At this point it is generally assumed that the firm is a profit maximizer and proceeds by making production decisions that equate its marginal costs to the given market price. The general drawback to the argument is that, as noted above, the firm's choice algorithm for technology and for producing output (at given input prices) would not necessarily produce maximum profits even if its marginal cost is equated to the market price. Moreover these same influences may also inhibit a profit maximizing output choice from being made by the firm at all. Because the firm's mechanism for making choices and the choices it can chose among are socially constructed without constraints, the imposition of profit maximizing is an ad hoc and illegitimate restriction of the firm's choice decisions.[23] A more specific drawback concerns the shape of the firm's marginal cost curve. That is, profit maximization that is consistent with perfect competition requires that the firm marginal cost curve be increasing. But as noted above, there is no reason for the firm's production function should generate declining marginal products or decreasing returns to scale to produce the upward sloping curves; and without them, the profit maximizing firm will increase its

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[22] The usual rendition in textbooks is that the firm demand curve is perfectly horizontal at the market price, but no attempt is made to relate it to the market or consumer demand curve. Hence it is a theoretically groundless concept.

[23] For example, business histories and studies of business culture make it clear that the firm's decision-makers have non-profit maximizing objectives—see Godley and Westall (1996).

production and size so as to be incompatible with perfect competition. These results imply that the firm marginal cost curve need not be transformable into the firm supply curve where for each supply price the quantity supplied will maximize the firm's profits; and since the neoclassical firm supply curve exists only as an inverse transformation for the firm marginal cost curve, this implies that it need not exist.[24]

Market Supply Curve

The usual argument for the derivation of the short or long run market supply curve is that it consists of the horizontal aggregation of the individual firm supply curves. While virtually all textbooks assume that the conditions for consistent and representational aggregation are generally fulfilled for supply curves, this in fact may not be the case if the production functions underlying the various firms supply curve are different (non-homothetic) and the input prices for the same factor input are different. Even if a market supply curve is derived, it may yield perverse results (that is non-increasing in quantity supplied as the price increased) if the output is among its own factor inputs. More significantly, however, is that the upward sloping market supply curve generates non-negligible collateral effects by affecting the prices of factor inputs used in its own production as well as in closely related industries whose output and output prices can affect its market demand. This collateral impact is more generalized when production is carried out by produced means of production and circular production. Hence, these collateral effects violated the *ceteris paribus*, partial equilibrium methodology underpinning the derivation of both the short and long run market supply.[25] The same collateral effects also invalidate the

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[24] This implies that the *profit function* and its derivative relationships with the firm supply curve and factor input demand functions has no content. In any case, the concept of profit is so ill-defined by neoclassical economists that it is meaningless and devoid of coherent content. Hence the concept of a profit function or profit anything in NCMT is meaningless. [Salvadori and Steedman, 1985; Gram, 1985; and Naples and Aslanbeigui, 1996]

[25] It is sometimes argued that a long run market supply curve can be derived without violating the partial equilibrium methodology. However, such a supply curve consists of firms with production

ceteris paribus, partial equilibrium methodology underpinning the factor input demand functions that are necessary for the construction of the marginal cost curves that are the foundations of the market supply curves. Possible problems with consistent and representational aggregation, perverse outcomes, and violation of the partial equilibrium methodology clearly suggest that the market supply curve (both short and long run) is a unsustainable theoretical concept. [Katzner, 1991; Ozanne, 1996; Panico, 1991; Sraffa, 1925; and Aslanbeigui and Naples, 1997]

Conclusion

Without firm and market supply and demand curves and the concurrent violation of *ceteris paribus*, the partial equilibrium competitive market solutions delineated in the textbooks have no theoretical or explanatory substance whatsoever. But the negative implications extend beyond competitive markets. It is already known that the concept of the supply curve cannot be extended to non-competitive markets; and, as noted above, the problem with aggregating consumer demand curves means that market demand curves (and any firm demand curves derived from them) are also absence in non-competitive markets. In turn, this implies the absence of marginal revenue curves and the price elasticity of demand; and without them and, as noted above, cost minimizing cost functions, the argument that firms maximize profits by equating marginal cost to marginal revenue or considering the elasticity of demand is without meaning.[26] Consequently, the various neoclassical models of monopolistic competition, imperfect competition, oligopoly, and monopoly are also contentless.[27] On

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functions that generate the same minimum average total costs (which implies in this case the same technique of production) which produces a horizontal supply curve at the market price which is equal to the same minimum average total costs of each firm. A supply curve that cannot shift without altering its underlying production, that by itself "determines" the market price, and that does not have a role in determining market output, can hardly be called a supply curve at all.

[26] Even if demand and cost curves exist, it is still wrong that a firm maximizes profit by equating marginal cost and marginal revenue in multi-firm markets—see Keen, et. al. (2002).

[27] More specifically, all neoclassical pricing models, such as delineated in Scherer and Ross (1990), Blinder, et. al (1998), and in countless textbooks are incoherent and therefore cannot provide any

the factor input side, analogous to the lack of a supply curve for imperfectly competitive firms is the absence of factor input demand curves for firms who are not input price takers. More generally, the absence of marginal products and cost minimizing factor input demand functions results in the inability of firms to demand and pay factor inputs prices that equal the value of their marginal products, which in turn renders meaningless the marginal productivity principle.[28] Finally, without supply and demand curves (and all the concepts that underpin them), neoclassical welfare economics has no theoretical content.

With the apparent complete destruction and dismissal of NCMT at hand, can the Hickian cry to save it by adopting competitive general equilibrium theory or game theory succeed? Is this a get-away that is worth a try? The plausible existence of non-autonomous preferences, intransitive choices, and non-convexity in demand and production noted above makes the existence of competitive general equilibrium problematical; and its widely acknowledged that it is empirically vacuous and conceptually incoherent thus making it irrelevant for explaining the real world. Moreover, stability of equilibrium theorems do not exist so there is no account of how market forces generate a general equilibrium; uniqueness of equilibrium theorems can only be obtained on assumptions so restrictive as to be unacceptable; and existence proofs of competitive general equilibrium models are predicated on assuming an unspecialized economy in which exchange is an afterthought (while existence proofs for imperfectly competitive general equilibrium models do not exist). Finally, because of the inability of obtaining well-behaved aggregate excess demand function, general equilibrium cannot provide the

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explanation for price determination or price stickiness. In addition, there exists virtually no empirical evidence that supports neoclassical pricing models—see Lee (1995 and 1998), Downward and Lee (2001), and Downward (2001-2002).

[28] The empirical evidence also suggests that firms do not base wages and demand for labor on marginal products—see Kaufman (1988 and 2002) and Bewley (1999).

micro-foundations for macroeconomics.[29] So it is evident that competitive general equilibrium cannot save NCMT much less save itself; but how about game theory. Game theory is also subject to criticisms such as model outcomes depend on arbitrary assumptions and detail, players have non-autonomous preferences and rules of games are socially constructed and hence not independent of the players, players have incomplete preference structures and make intransitive choices all of which prevent them from making utility maximizing choices, and players may have social-ethical preferences that prefer non-Nash equilibrium outcomes. So game theory cannot come to the rescue. [Clower, 1994 and 1995; Ingrao and Israel, 1990; and Rizvi, 1991 and 1994]

The theoretical incoherence, empirical emptiness, and absence of empirical support lies at the basis of the dismissal of NCMT. However, it is not only the theory that is being dismissed, it is also a way of thinking, theorizing, and seeing the economy. The above arguments dismisses maximization and equilibrium as theoretical organizing tools; dismisses relative scarcity which means that prices cannot be indexes of scarcity and economics is not the allocation of scarce resources among competing ends; and dismisses the price mechanism as a 'visual' mechanistic metaphor of the way economic activity is coordinated and directed. Without sense, sensibility, and coherent vision of how the economy works, NCMT has nothing to offer heterodox economists. So should NCMT be shown any respect? The Sraffian clarion call of yesteryear is clearly the appropriate answer: No, the theory should be discarded and without a tear of remorse.

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[29] This failure enhances the importance of our critique since neoclassical economists will not resist the

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APPENDIX

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