

A MATHEMATICAL DEMONSTRATION OF WHY NEOCLASSICAL THEORY IS WRONG

Gerson P. LIMA¹

"Personal belief is immaterial to the status of a theory". Archibald (1971, page 14).

1. INTRODUCTION

This paper analyses the neoclassical approach to supply behavior, stressing its shortcomings and demonstrating that it is impossible to elaborate a theory of supply behavior based upon the neoclassical principle of differential calculus for profit maximization. It is a remarkable fact that, despite proposing to explain price and production by the interaction of supply and demand, neoclassical theory defines the supply curve only under the restrictive hypothesis of perfect competition. In contrast, modern literature on industrial organization proposes a generalization of the neoclassical notion of supply curve. This proposition is here developed, leading to a comprehensive supply-and-demand model which may deal with any intensity of competition, or lack of competition, between producers.

The basic idea is that the principle of profit maximization through differential calculus brings about, as the first-order condition, an equation which links price and production, and this equation may be identified with the supply curve because it contains all, and only, the equilibrium points which maximize profit. Additionally, a conjectural variation parameter stemming from competition, and an expected price derived under a rational expectations hypothesis have been appropriately considered. Aiming at supporting the theoretical proposition, an empirical analysis is presented, in which the estimates of the short run neoclassical supply curve and the long run supply curve are obtained. Neoclassical theory is then critically appreciated in the light of these enhanced theoretical and empirical basis, and always in theoretical grounds; the potential lack of realism of neoclassical theory is not emphasized.

What the paper stresses is, firstly, that the method of differential calculus is neither necessary nor sufficient to define the supply curve: the long run supply curve may be obtained independently of the profit maximization principle. Secondly, some implications of the neoclassical notion of short run are analyzed, and the conclusion is that in fact the first-order condition for maximization is not a short run supply curve as initially supposed, even if under the hypothesis of perfect competition.

Thirdly, the paper points out that differential calculus leads directly to a relation between price and production, without any dynamic decision-making model. Dynamics is thus reported to time-series analysis, whose models are independent of neoclassical theory and may thus carry out results which are not anticipated by it. Finally, it is observed that neoclassical theory must take actual competition into account. However, in so doing the neoclassical paradigm can no longer be isolated and identified. The main conclusion is that neoclassical theory cannot explain supply behavior. Even if it could give support to the hypothesis that producers maximize its profits, there would remain a complex pattern of competitive behavior for which neoclassical theory has no explanation. It is important to stress that, more than a critique of neoclassical theory, this paper is intended to carry a positive contribution to the reconstruction of the economic theory.

Organization is as follows: section 2 develops the neoclassical principle of profit maximization into a comprehensive supply-and-demand market model, and section 3 contains the empirical analysis which supports the theory. Section 4 is dedicated to the

¹ This paper was originally prepared in the summer of 1991 as a condensed version of the Author's doctoral thesis, presented at the University of Paris in 1992: "Une Analyse Critique des Fondements Théoriques et Empiriques de la Courbe d'Offre". This text is a revised version of August 2011 which attempted to preserve the original exposition but added few lines to the conclusion section. In the last 20 years nothing appeared in the neoclassical literature to contest the results herein presented.

critical analysis of neoclassical theory and finally section 5 presents some main conclusions.

2. GENERALIZATION OF THE NEOCLASSICAL SUPPLY CURVE

The neoclassical approach to the supply curve has recently been revised and generalized. Comprehensive treatments of the subject may be found in BRESNAHAN (1989) and in SCHMALENSEE (1988). This section develops the profit maximization principle towards the supply curve in order to later stress the weaknesses and inconsistencies of the neoclassical paradigm. To start with, suppose a market where demand may be described by a linear equation such as:

$$D_t = a_0 - a_1 P_t + a_2 F_t \quad (1)$$

where D is consumption, P is price, and F is a shift parameter composed of all other demand-related variables, such as consumer income. The condition of linearity is actually not indispensable; it has been proposed here for the sake of simplicity in the mathematical treatment. What really matters is that the derivative of the demand curve cannot vary autonomously, as if it were an exogenous variable; it depends on consumers' behavior which is supposed to be rather stable. However, the derivative a_1 may vary in accordance with some exogenous variable, such as consumer income, presenting thus a "scale effect". Considering that this scale effect can be eliminated by taking the logarithms of all variables, the condition of linearity is not restrictive for the purpose of deducing a general neoclassical supply curve. Given the industrial plant, the input prices and the restriction of a conjectural variation parameter, the first-order condition for profit maximization, which is an individual concern, is expressed by:

$$P_t + \lambda_i (\partial P / \partial D) Q_{it} - c_1(Q_{it}) = 0 \quad (2)$$

where λ_i is an index associated with the conjectures of the firm i about the behavior of its competitors, $(\partial P / \partial D)$ is the slope of the inverse demand function, and c_1 is the marginal cost which depends upon individual production Q_i . Given the conditions of the problem, equation (2) represents a line that connects all, and only, the points which maximize profit. Equation (2) contains all equilibrium solutions which, under the neoclassical approach, are desired by the profit maximizing firms. Despite its being surprisingly simple, equation (2) may therefore be defined as the individual supply curve. A supply curve is a relation between price and production which is described in mathematical terms by an equation stating that the production is a function of the price (or vice versa) and a set of exogenous variables. No other endogenous variable may be include in the equation of the supply curve. Curiously, BRESNAHAN (1989) avoids the term "curve", adopting instead the name "relation". In turn, SCHMALENSEE (1988) decided to call it "quasi-supply", with the inverted commas.

Equation (2) is also a fairly general expression which may be seen as a "natural way to parameterize various oligopoly solution concepts" (GEROSKI, PHILIPS & ULPH, 1985, page 378). Accordingly, it has been taken as the point of departure in many theoretical and empirical studies in industrial organization. "The λ_i are conjectural variations that are best interpreted as reduced form parameters that summarize the intensity of rivalry that emerges from what may be a complex pattern of behavior" (SCHMALENSEE, 1988, p. 650). The value of the exogenous parameter λ_i ranges from zero, which corresponds to the neoclassical notion of perfect competition, to unity, which identifies a monopoly and the solution proposed by COURNOT (1838, chapter VII)² for a competitive producer.

Imagine a Cournotian simultaneous equations system composed of:

² Note added to the 2011 revision: besides this famous solution, Cournot was also the pioneer on the creation of the perfect competition notion, which he named concurrence indéfinie (COURNOT, 1838, chapter VIII), but neoclassical literature does not mention him on the matter.

- a) the demand equation (1);
- b) n profit-maximizing equations (2), one for each firm;
- c) the equilibrium condition stating that total production and total consumption match.

This simultaneous equations system will give the solutions for price, production and consumption; equations (1) and (2) play thus the role of the law of supply and demand. Combining all the supply schedules of individual producers in the industry, i. e., summing up all individual production at each price level, a composed relation will be brought about:

$$P_t + \lambda Q_t (1/ \alpha_1) - c_2(Q_t) = 0 \quad (3)$$

$$P_t + (\lambda / \alpha_1) Q_t - c_2(Q_t) = 0 \quad (3)$$

where Q is the total industry production, α_1 is the slope of the demand curve (1), and c_2 depends on all individual marginal cost curves. The parameter λ may be seen as resulting from a complex simultaneous dynamic oligopolistic game of all companies in a branch; it must somehow be a composition of the λ_i of the n individual firms, varying as n varies. The value of λ may range from zero (maximum rivalry between partners) to the unity (maximum cooperation) passing through the solution proposed by COURNOT (1838, chapter VII). In the Cournot's model, when all companies produce the same quantity λ is equal to $1/n$.

Incidentally, it must be pointed out that viewed ex post this relation does not allow for the identification of any individual behavior. Moreover, despite the fact that λ will here be supposed to be constant at each branch and during a period of time sufficient for a successful econometric analysis, it may in reality be variable. The crucial hypothesis is that it does not vary autonomously, without any clear reason. Any variation in λ must be explained by a variation in another variable, either endogenous or exogenous. λ reflects the behavior of decision-makers and for any economic theory to exist this behavior must be supposed to be consistent: identical exogenous conditions will correspond to identical decision patterns represented by λ . Admitting that the marginal cost is independent of the price level, equation (3) may thus be seen as a general formula of the neoclassical industry supply curve whose slope is given by:

$$\partial Q_t / \partial P_t = b_1 = - \alpha_1 / \lambda \quad (4)$$

This expression shows that the supply slope b_1 is a function of λ , and that it may consequently range from a perfect competition schedule to a perfect monopoly situation, providing then a general relation suited for econometric application. Despite the fact that all elements in the supply slope may be variable, thus giving to it a "scale effect", for the sake of mathematical simplicity the slope will here be supposed to be constant.

On the other hand, the neoclassical supply curve has until here been defined in association with the neoclassical notion of short run, in which production capacity is given. From now on, in order to develop a long run neoclassical supply curve the production capacity K will be taken explicitly into account, and this is done by considering K as an explanatory variable in the industry supply curve which, given these features, can be expressed by:

$$Q_t = \beta_0 + \beta_1 P_t - \beta_2 W_t + \beta_3 K_t \quad (5)$$

where W represents the set of exogenous input prices which shifts the supply curve either to the left when increasing, or to the right when it diminishes. In general, any supply shifting variable other than K which would occasionally be considered relevant, such as concentration, sales promotion, advertising, risk aversion, and so on may, like K, be included as an explanatory variable in the supply curve. Actually, econometric estimates of an equation designed to explain any economic variable Y must, in order to match the ceteris paribus clause, include all possible exogenous shifter variable X. This procedure is

a necessary condition to, ex post, give theoretical support to the hypothesis that X is constant at any assumed level.

In neoclassical theory investment in production capacity, and consequently the value of K at each moment in time, has been tied to the question of entry of new firms into the branch. This means that any increase in production capacity depends upon the arrival of a new company. To entry in the market, the new firm will invest in a new plant and increase the production capacity of the branch. The decision of investing in production capacity denotes a competitive behavior, which is a notion opposite to profit maximization. The idea of new firms to increase competition and lower prices is a seriously restrictive hypothesis which will not be considered here; instead, capital embodied in K will be supposed to be free to enter without necessarily modifying the number n of competitors. Therefore, assuming that in the neoclassical approach the demand for production capacity is a function of the profit rate M and the set Z of prices of goods and services associated with the investment, K will be expressed by:

$$K_t = \gamma_0 + \gamma_1 M_t - \gamma_2 Z_t \quad (6)$$

Considering in addition that K takes a long time to mature, it will be justifiable to suppose that it is also a function of the expected future profit rate M^* :

$$K_t = \gamma_0 + \gamma_{11} M_t + \gamma_{12} M_t^* - \gamma_2 Z_t \quad (7)$$

where M^* is a rational expectation for profit with arguments on present and past values of the exogenous variables, defined as satisfying:

$$M_t^* = E \{ M_t \mid W_{t-\xi}, F_{t-\nu} \} + u_t \quad (8)$$

where W and F are the exogenous variables of the model and u is a white noise. The base for expectation formation is represented by the indefinite lag structure implicit in ξ and ν and will be determined by econometrics. "Thus the rational expectations are given as linear combinations of the predictions of the exogenous variables, and the relevant information on which to base these is the set of past values" (WALLIS, 1980, page 332) of the exogenous variables. Collecting equations, a neoclassical general market model which takes into account any degree of competition or cooperation between companies may be described by the following simultaneous equations system:

$$\text{demand: } D_t = \alpha_0 - \alpha_1 P_t + \alpha_2 F_t$$

$$\text{short run supply curve: } Q_t = \beta_0 + \beta_1 P_t - \beta_2 W_t + \beta_3 K_t$$

$$\text{investment in capacity: } K_t = \gamma_0 + \gamma_{11} M_t + \gamma_{12} M_t^* - \gamma_2 Z_t$$

$$\text{equilibrium condition: } D_t = Q_t$$

$$\text{profit margin: } M_t = P_t - W_t \quad \text{and} \quad M_t^* = P_t^* - W_t$$

The model has thus five equations to solve for five endogenous variables: consumption D, price P, production Q, profit margin M and capacity K. Exogenous variables are cost-related W and Z, and demand shifter F. Given the short run behavior, the long run supply curve may be brought about by replacing capacity K in the short run supply:

$$Q_t = \beta_0 + \beta_1 P_t - \beta_2 W_t + \beta_3 [\gamma_0 + \gamma_{11} M_t + \gamma_{12} M_t^* - \gamma_2 Z_t]$$

Simplification and replacement of M and M^* by their definitions lead ultimately to the long run supply curve:

$$Q_t = \varphi_0 + \varphi_{11} P_t + \varphi_{12} P_t^* - \varphi_{21} W_t - \varphi_{22} Z_t \quad (9)$$

where φ represents linear combinations of the parameters β and γ of the short run behavioral equations, and P_t^* is a rationally expected price. This expression shows the relation between price and production which stems exclusively from the behavior of

producers, and this relation refers to the long run because it is valid for any production capacity.

3. AN EMPIRICAL ANALYSIS

3.1. Econometric Method

In order to take into account the simultaneous equations bias, two econometric methods are, amongst others, appropriate for dealing with the neoclassical supply and demand general model: the indirect least squares (ILS) and the two stage least squares (2SLS). The first stage of these methods is the estimation of the reduced model in which each endogenous variable is expressed as a function of all exogenous variables. Considering then that the margin expectation M^* is a function of the lagged exogenous variables set, it may provisionally be seen as an exogenous variable, under a mathematical point of view. An initial reduced model would thus be given by:

$$Y_{it} = A_{i0} + A_{i1} W_t + A_{i2} F_t + A_{i3} Z_t + M_t^* \quad (10)$$

where Y_i represents all endogenous variables and A_{ij} are combinations of the structural parameters α , β and γ . The rationally expected profit margin M^* defined in (8) may be econometrically estimated through the following equation:

$$M_t^* = A_{m0} + A_{m1}(L) W_t + A_{m2}(L) F_t + A_{m3}(L) Z_t + u_{mt} \quad (11)$$

where $A_{mj}(L)$ are lag operators in the exogenous variables W , F and Z , and u_m is a white noise. Replacing M^* given by (11) in the initial reduced model expressed by (10), the conclusion is that all the endogenous variables will be functions of the same lagged set of exogenous variables, in such a way that the final reduced model will be:

$$Y_{it} = A_{i0} + A_{i1}(L) W_t + A_{i2}(L) F_t + A_{i3}(L) Z_t + u_{it} \quad (12)$$

Every endogenous variable, and thus the model as a whole, will have a double behavior: the actual Y_t and the equilibrium Y_t^* value. The equilibrium level is just a theoretical implication of the model; it would be observable only in an imaginary situation when all exogenous variables had stopped varying. This approach to the econometric method differs from time-series analysis, in which equilibrium is defined by a relation connecting economic series. For example, WICKENS & BREUSCH (1988, page 189) propose a general autoregressive-distributive lag equation to describe any time series:

$$y_t = \sum_l^m \alpha_l y_{t-l} + \sum_o^n \beta_o x_{t-o} + e_t$$

where x represents the set of exogenous variables. Accordingly, they define a long-run multiplier by:

$$\varepsilon = \left[\sum_o^n \beta_o \right] / \left[1 - \sum_l^m \alpha_l \right]$$

This long-run multiplier is the parameter of the particular (equilibrium) solution of the general time-series equation above, which is a difference equation. They could have developed this equilibrium solution a step further, proposing additionally to compute equilibrium values through the expression:

$$y_t^* = \varepsilon x_t$$

Transposing terminology and splitting the exogenous variables set x into W , F and Z , and inserting the constant parameter, the equilibrium solution would be expressed by:

$$Y_{it}^* = A_{i0} + \varepsilon_{i1} W_t + \varepsilon_{i2} F_t + \varepsilon_{i3} Z_t \quad (13)$$

where the asterisk indicates equilibrium values and the ϵ_{ij} are obtained by summing up the respective coefficients which are significant in the estimation of (12). For each equation the choice of the lag structure may be based on the statistical performance of the whole equation: possible combinations of simultaneous lags may be proposed exhaustively, searching for the best set of results of statistical tests, especially the absence of autocorrelation in the residuals. The idea is that, if W , F and Z are given, after some time has elapsed the dynamic effect of exogenous shocks, represented by u in expression (12), will vanish.

In other words, the spread u between actual and equilibrium values is the time component which may be eliminated because after several random exogenous shocks it will show no systematic behavior. Moreover, u cannot be an explanatory variable; economic contents of the endogenous variable stem from the set of exogenous variables and not from the time-dependent residual. This procedure is in accordance with both the ILS and the 2SLS methods, which purposely eliminate the residual u when passing from the first to the second stage of estimation.

In the second stage the structural relations of the market model may be estimated either via an ILS or a 2SLS procedure, depending on whether the structural equation is, respectively, just or over-identified. This procedure compares favorably to the method of cointegration/error correction proposed by ENGLE & GRANGER (1987): their proposal is first to estimate the equilibrium parameters of cointegrated series, using them in a second step to describe the time-behavior of the series. Considering, however, that the trend u towards equilibrium is a stationary series with zero mean, the method proposed here is purposely intended to first eliminate the random time-behavior u of the endogenous variables, and then estimate the structural relations of the market model.

Finally, it is important to observe that the reduced equations of present and expected profit margins are identical, what means that the econometric treatment of the model will make it impossible to distinguish their coefficients from each other. This stems from the fact that "expectations, since they are informed predictions of the future events, are essentially the same as the predictions of the relevant economic theory" (MUTH, 1961, p. 316). As a corollary, MUTH (1960, p. 324) states that unless relevant expectations data are available it is not possible to distinguish γ_{11} from γ_{12} in equation (7): econometric analysis can only bring about the composed parameter γ_1 in equation (6), provided that K and M refer to equilibrium values K^* and M^* . Identically, it is not feasible to estimate parameters ϕ_{11} and ϕ_{12} in the long run supply curve (9) but only a combined coefficient for price. Therefore, the long run supply curve may more appropriately be expressed by:

$$Q_t^* = \phi_0 + \phi_1 P_t^* - \phi_2 W_t \quad (14)$$

where the Z set of prices associated with the cost of investment is included in W . The slope of the long run supply curve will thus not be so simple, as defined by b_1 in expression (4); it will become:

$$dQ_t/dP_t = \phi_1 = (\partial Q_t/\partial P_t) + [(\partial Q_t/\partial K_t) \times (\partial K_t/\partial P_t)] \quad (15)$$

where the first term in brackets $(\partial Q_t/\partial P_t)$ may, if somebody wants, be associated with the hypothetical short run maximizing behavior of producers and the second term (in square brackets) has two components: one is the marginal productivity of capital $(\partial Q_t/\partial K_t)$, which is a physical property, and the other is the propensity to invest $(\partial K_t/\partial P_t)$, which comes from the investment in production capacity equation. The first term represents the firms' objective of maximizing profit. On the opposed direction, the second terms stems from the competitive behavior of producers.

To sum up, the method proposed is as follows: the first step is performed to estimate the reduced equations; then, retaining only significant parameters in (12), equilibrium parameters are computed, leading to (13), and consequently the residual u is eliminated. In the second step these theoretical equilibrium series or parameters are used to compute

the coefficients of the behavioral equations of the structural short run market model and the long run supply curve (14).

3.2. An Empirical Example

The practical example presented here is part of the empirical study on the Brazilian cement industry presented in the Author's doctoral thesis (commented in the footnote on the first page). Cement data source is the National Syndicate of the Cement Industry, except for price which was provided by a monthly independent magazine on building costs (Pini Editors). Exogenous variables are the National Gross Fixed Capital Formation F and the direct cost of production W , which is also used as a proxy for the cost of investment Z . Given that the industrial capacity in the nineteen-seventies was constrained, it became necessary to include a dummy variable $D1$ in both quantity equations. The estimated equations of the reduced model are presented below (t statistics in brackets):

REDUCED MODEL

CONSUMPTION:

$$D_t = 9.896 - 0.312 W_t + 30.234 F_{t-1} - 2.958 D1$$

$$(5.17) \quad (-2.91) \quad (13.07) \quad (-3.76)$$

$$R^2 = 0.98 \quad DW = 1.90 \quad F(3,12) = 162.48$$

PRICE:

$$P_t = 16.791 + 1.102 W_{t-2} + 11.967 F_{t-1}$$

$$(6.33) \quad (6.04) \quad (2.32)$$

$$R^2 = 0.87 \quad DW = 2.24 \quad F(2,12) = 40.64$$

PRODUCTION:

$$Q_t = 9.362 - 0.304 W_t + 31.048 F_{t-1} - 2.960 D1$$

$$(4.69) \quad (-2.72) \quad (12.87) \quad (-3.60)$$

$$R^2 = 0.98 \quad DW = 1.94 \quad F(3,12) = 158.10$$

PRODUCTION CAPACITY:

$$K_t = 9.643 - 61.032 F_{t-4} + 102.359 F_{t-4}$$

$$(3.65) \quad (-4.82) \quad (9.37)$$

$$R^2 = 0.96 \quad DW = 1.65 \quad F(2,10) = 106.68$$

PROFIT MARGIN:

$$M_t = 8.910 + 0.908 W_{t-2} + 16.337 F_t - 13.970 F_{t-2}$$

$$(2.62) \quad (4.21) \quad (2.17) \quad (-2.08)$$

$$R^2 = 0.71 \quad DW = 2.24 \quad F(3,11) = 9.16$$

The lag structure is especially complex in the reduced equation of the demand for production capacity because K takes time to mature. Moreover, considering the special financial conditions then offered by government for investment, this has not been influenced by cost considerations: the cost parameter in the reduced equation for K is not significant. In the original study data was also fitted using the logarithm of all variables. Results then obtained are statistically not different from those presented above. Given this lag structure, and taking the dummy variable as being always zero, the reduced equilibrium model is obtained by adding up the respective significant coefficients of each exogenous variable:

REDUCED EQUILIBRIUM MODEL

consumption: $D_t^* = 9.896 - 0.312 W_t + 30.234 F_t$

price: $P_t^* = 16.791 + 1.102 W_t + 11.967 F_t$

production: $Q_t^* = 9.362 - 0.304 W_t + 31.048 F_t$

profit margin: $M_t^* = 8.910 + 0.908 W_t + 2.367 F_t$

production capacity: $K_t^* = 9.643 + 41.327 F_t$

where asterisks refer to equilibrium values. The random term has consequently been eliminated and the equilibrium reduced model is the basis for the second stage. Considering that not all structural equations are just-identified, the 2SLS method was adopted in the second step, therefore bringing about the following estimates of the equations in the market model (t statistics in brackets):

DEMAND CURVE:

$$D_t^* = 14.649 - 0.283 P_t^* + 33.620 F_t$$

(7241) (-4258) (13284)

R2 = 1.00 DW = 1.97 F (2,12) > 10000

SHORT RUN SUPPLY CURVE:

$$Q_t^* = 1.284 + 0.060 P_t^* - 0.369 W_t + 0.734 K_t^*$$

(43.95) (28.89) (-161.4) (1254)

R2 = 1.00 DW = 2.24 F (3,9) > 10000

INVESTMENT IN CAPACITY:

$$K_t^* = -48.658 + 3.469 M_t^* - 0.356 W_t$$

(-150.4) (264.8) (-77.8)

R2 = 0.99 DW = 2.57 F (2,10) > 10000

The short run supply curve is intended to describe the supply behavior for a given production capacity K. In the long run the product demand may increase, inducing therefore an expectation of larger profits, thus leading to a higher demand of investment in capacity and consequently to a shift of the short run supply curve. Following a kind of an ILS procedure, K^* may be replaced in the short run supply curve, therefore leading to the long run supply curve:

$$Q_t^* = -34.431 + 2.606 P_t^* - 3.176 W_t \quad (16)$$

whose slope (2.606) is as defined by expression (15). It is important to stress that the long run supply curve may alternatively be obtained independently of this intermediate step given by the investment in capacity. In fact, the long run supply curve may be derived directly from the reduced equilibrium model through an ILS or a 2SLS procedure. For example, adopting the latter method it was obtained the following alternative estimate of the long run supply curve:

$$Q_t^* = -34.722 + 2.628 P_t^* - 3.218 W_t \quad (17)$$

(-55.1) (90.3) (-82.2)

R2 = 0.99 DW = 2.63 F (2,12) = 4206.7

Parameters of expression (17), which corresponds to the supply curve theoretically proposed by (14), are not statistically different from parameters in (16). The mechanics leading to the long run supply curve as expressed by (16) is analogous to an ILS procedure. The idea is that, as shown by the reduced model, given a certain level of the cost W the demand-shifter F simultaneously determines the equilibrium values of

production Q and price P. Taking differentials of the reduced equilibrium equations for production and price, one has:

$$\text{production variation: } dQ_t^* = -0.304 dW_t + 31.048 dF_t$$

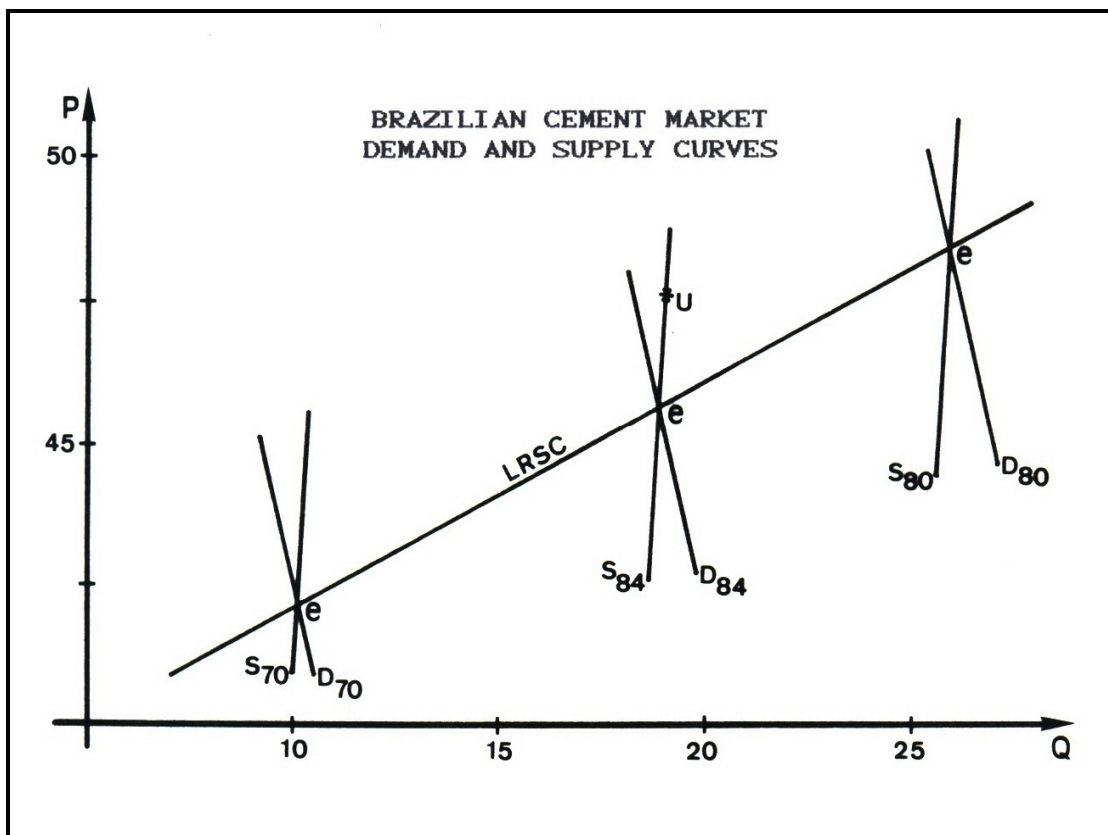
$$\text{price variation: } dP_t^* = 1.102 dW_t + 11.967 dF_t$$

For any given level of W (dW equal to zero), if F increases as a consequence, for example, of a higher consumer income, what means that the demand curve shifted to the right, then dF will be different from zero and, dividing the former expression by the latter, the long run supply slope will be brought about:

$$dQ_t^*/dP_t^* = 2.594$$

This value is statistically the same as presented above. Therefore, "We can imagine that we move along the supply curve by means of successive increases of demand" (ROBINSON, 1933, page 85). In other words, if W is constant then variations of F create a series of all possible equilibrium points. These equilibrium points necessarily stem from the producers' decision-making process. Consequently, on connecting them one obtains the outline of the long run supply curve. The conclusion is that the general neoclassical approach to short run supply curve as proposed by BRESNAHAN (1989) may be extended to the long run by the introduction of the demand for investment in production capacity, combined with a rational expectations schedule as proposed by MUTH (1960). These extension and improvement suggest that the neoclassical theory may be improved and create a comprehensive general supply and demand model.

This model has been supported by empirical data from the Brazilian cement market: all parameters and equations are significant and all the signs in the estimated model are theoretically coherent. The graphical representation below condenses all these results for a constant value of W (as for 1984) and three successive levels of the demand (as for 1970, 1980 and 1984).



The long run supply curve (LRSC) is obtained by connecting the equilibrium points defined by the intersection of the three demand curves (D₇₀, D₈₄ and D₈₀) with the

corresponding three short run supply curves (S_{70} , S_{84} and S_{80}). It is a remarkable fact that the long run supply curve (LRSC) may be derived directly from the reduced equilibrium model, without passing through the intermediate step of the short run supply curve. The estimation of the long run supply curve may be done without concern about the short run behavioral decision-making model.

4. A CRITICAL APPRECIATION OF THE NEOCLASSICAL PARADIGM

The neoclassical paradigm of profit maximization through differential calculus calls for "well-behaved" curves of demand and, especially, cost. In contrast, independently of their being or not being twice differentiable, JOHNSTON (1960) gives evidence that cost curves may not have the form which suits neoclassical theory. Nonetheless, potential problems associated with costs will not be stressed in this paper, as already assumed in relation to the puzzling restriction imposed on capital mobility by the question of the number n of firms in a branch. Furthermore, despite the detailed empirical application presented in the previous section, in what follows the realism or lack of realism of neoclassical theory will not be considered. The discussion here is concentrated on the implications of the neoclassical paradigm from a theoretical perspective.

4.1. The Uselessness of Differential Calculus

As a simplifying convention, in this text "profit maximization" as a neoclassical paradigm is synonymous with "profit maximization through differential calculus". The main subject is thus the method by which profit is maximized: mathematical differential calculus. Other possible methods of maximizing profits than the neoclassical one are outside the scope of this article. The first logical implication of neoclassical theory on supply behavior may be transformed into

statement one: profit maximization is not a necessary condition for defining a supply curve.

In fact, the supply curve may be proposed directly, as is seen for example in equation (14), in which all variables may moreover be taken either by their natural values or by some kind of transformation, such as their logarithms in order to linearize the relation. Incidentally, this direct assumption is the procedure followed in relation to the demand curve: when dealing with market analysis no neoclassical analyst makes reference to the consumers' behavior which would lead to the demand curve as proposed. Whether consumers maximize utility or not, since COURNOT (1838) the demand curve has been formalized as a relation between price and consumption with negative slope. This relation may be shifted, like expression (1) for example, by some exogenous variables such as consumer income or competitor's sales. A demand curve is by itself incapable of giving evidence that it necessarily stems from a utility maximizing procedure.

All the same, a supply curve like (14) contains no information indicating that it necessarily comes from a profit maximizing procedure. A sufficient condition for deriving a supply curve with a general positive slope would for example be: if demand rises then producers increase price and production. It is unnecessary that profit, either before or after demand rise, be the maximum allowed by prevailing exogenous conditions. The hypothesis that firms increase profit when demand conditions make it possible is more general than the hypothesis that firms always get the maximum profit.

If producers are consistent when making their decisions on price and production, making the same decision for identical exogenous conditions, then a certain relation between price and production will be observed ex post. This relation stems from the behavior of producers being thus the supply curve which is independent of the hypothesis that they maximize profits. The absence of maximization does not imply absence of consistency in the decision-making process. In theoretical terms, the absence of

maximization does not imply economic chaos. This relation may incidentally not be brought about immediately after an exogenous variation; a certain period of adjustment will almost ever be necessary. In passing, neoclassical theory has no explanation for the adjustment period and this has not been considered a serious handicap for price and production determination.

Expression (14) does not necessarily stem from the principle of profit maximization; it may be derived from a different producers' decision-making behavior, such as that proposed in LIMA (1991)³. On the other hand, in the previous section it is demonstrated that expression (14) is sufficient to build up the supply side in a supply-and-demand analysis; as a corollary, the profit maximization principle is, theoretically speaking, unnecessary. It is possible that firms maximize, and the hypothesis that they really do so should scientifically be submitted to an empirical test, as discussed in the remainder of this section. As a complement, the second logical implication of neoclassical theory on supply behavior may be transformed into

statement two: profit maximization is not a sufficient condition for defining a supply curve.

Profit maximization is an individual concern which requires the aggregation of the individual supply curves to obtain the industry supply curve, and this is not a simple problem. The aggregation is necessary because price is formed by the interaction of total demand and total supply; market price is not an individual but a collective concern. The neoclassical adding up process must take into account the fact that each producer has, besides the hypothetical individual profit maximizing behavior, an individual cost curve, an individual parameter of conjectural variation and an individual process of elaborating rational expectations. Consequently, additional hypotheses are necessary in the procedure of aggregation, stating how these behavioral features, conjectural variations and expectations are combined. Moreover, on the contrary direction, the industry supply curve cannot allow for identifying any individual supply curve.

The contribution of the notion of individual supply curve to economic theory seems to lack relevance. However, it becomes indispensable if the objective is to support the hypothesis that a producer maximizes his profit. In any case, the profit maximization principle is not sufficient to describe supply behavior; some other hypotheses must also be simultaneously considered, especially the pattern of interaction between producers, represented by the parameter λ_j . Therefore, if the hypothesis of profit maximization is neither necessary nor sufficient, differential calculus serves no theoretical purpose: market price and production may be determined through an econometrically workable model composed of the demand curve (1) and the supply curve (14), which do not necessarily stem from profit maximization.

4.2. The Absence of Demand for Investment Goods

In the neoclassical theory it is supposed, as in any other economic theory, that investment depends upon profits. In turn, the profit depends on price. Consequently, investment in production capacity K is at least partially a function of price P . On the other hand, more investment means more capacity and, normally, more production. Thus, in the long run production Q also depends on capacity K which is related to price P . Therefore, neoclassical theory should clearly state that Q is a composed function of P :

³ Note added to the 2011 revision: the Author's 1997 paper "Visible Hand" presents the Marshallian producers' decision making process and develops a comprehensive supply and demand theoretical model followed by an empirical application from the Brazilian cement market. In this model demand comes first and producers adjust price and production in such a way that it is mathematically feasible to deduce the supply curve. In this approach the supply curve is a reduced equation of the model and not a causal relation between price and production.

firstly as a direct consequence of the profit maximization principle, and secondly through K. However, despite its relying on a mathematical approach, neoclassical theory provides no clear formalization of the demand for investment in capacity when dealing with price formation. The link between short run and long run is loosely presented, in such a way that investment has always been considered, but seldom mathematically formalized. But what would happen if someone try to do so?

The neoclassical chain may be described as follows: interaction of supply and demand curves determines price which in turn influences profit which in turn motivates investment in capacity which in turn shifts the short run supply curve. Consequently, K is an endogenous variable in the problem of price determination and production setting, even under the hypothesis of perfect competition. Theoretically speaking, an endogenous variable cannot be supposed constant while other endogenous variables vary; this phenomenon may happen sometimes but never as a theoretical rule. As clearly shown by the reduced model, both production and capacity are functions of the exogenous variables. This means that, for one of them to vary it is required an exogenous variation to happen. Then, given any exogenous variation both production and capacity will vary together with all other endogenous variables. In other words, if consumer's income rise then not only the production will rise, but also the investment in production capacity. It is theoretically wrong to suppose that K may be given while demand varies⁴.

The omission of a variable X in a relation does not mean that this relation has been traced out for a given value of X, but for all values of X. So, in stating that maximization is associated with a given level of K, this variable K cannot be absent in the mathematical development of the neoclassical supply and demand model. It should be included in the individual equation (2) and in the industry equation (3):

$$P_t + \lambda_i (\partial P / \partial D) Q_{it} - c_2(Q_{it}) = 0 \quad (2)$$

$$P_t + (\lambda / \alpha_1) Q_t - c_2(Q_t) = 0 \quad (3)$$

This was done in equation (5):

$$Q_t = \beta_0 + \beta_1 P_t - \beta_2 W_t + \beta_3 K_t \quad (5)$$

thus creating a supply curve for the short run. Despite that, the pure neoclassical modeling would at best arrive at the equation (14):

$$Q_t^* = \varphi_0 + \varphi_1 P_t^* - \varphi_2 W_t \quad (14)$$

This equation does not mean that Q is a function of only P and W. Furthermore, it is widely known that Q depends on some others variables, among them K plays an important role. So, the relation between Q_t^* and P_t^* will in fact be traced for all values of K. In case K is absent, then the theorem of the omitted variable says that the estimate of the coefficient $\varphi_1 = \partial Q_t^* / \partial P_t^*$ will be biased and that the bias is such that the right value of the coefficient is that given by expression (15):

$$dQ_t / dP_t = \varphi_1 = (\partial Q_t / \partial P_t) + [(\partial Q_t / \partial K_t) \times (\partial K_t / \partial P_t)] \quad (15)$$

which stems from the complete neoclassical model. This means that, in order to identify the profit maximization effect, neoclassical theory must explicitly include K in its definition of supply curve. Otherwise, the supply slope would contain the propensity to invest, thus blurring the effect of profit maximization. Furthermore, neoclassical theory would be more clear if it could provide an equation to express demand for K as at least a partial function of profit. Once written in an explicit form, this equation would necessarily be considered in the model of price formation and production setting, as proposed in this study.

⁴ Note added to the 2011 revision: some neoclassical textbooks develop the question of the long run investment in production capacity without observing that profit maximization is no longer the only producer's motivation. They talk investment but do not recognize, and thus cannot advise the student, that "investment" is "competition" which contradicts profit maximization.

However, in so doing a new problem would arise: expression (5) would no longer be a supply curve. This stems from the fact that K , which is a shifter parameter in equation (5), is an endogenous variable. So, the short run supply curve (5) will be shifted as a consequence of any variation in the exogenous side. In particular, a variation in F means, besides a shift in the demand curve, that price, production and capacity change simultaneously. In other words, a shift in the demand curve leads to a shift in the neoclassical short run supply curve.

This means that in the figure above any point other than e , the point U for instance, is unattainable. So, any point other than e has no theoretical grounds. As a corollary, if (5) were a supply curve which ensured profit maximization, then every point in the plane $P \times Q$ would be a profit maximizing point. In this case the neoclassical paradigm would once again be useless, because any pair (price \times production) would naturally be a maximum point. Accordingly, the supply curve can be defined only in the long run, and its slope contains not only the hypothesis of profit maximization, if indeed it does contain it, but also the propensity to invest and compete.

This discussion of the demand for investment leads to the conclusion that the neoclassical notion of short run has no theoretical grounds. As a corollary, the neoclassical notion of the short run supply curve, including the special supply curve derived under the hypothesis of perfect competition, lacks theoretical support. It must here be remarked that this notion of short run is absorbing: industrial capacity seems to take a great deal of time to mature. But this is especially appropriate in individual terms: after deciding to invest in a new plant a particular company must normally wait a long period before new production takes over. However, taking the industry as a whole, a more general approach would state that at each moment in time a new industrial plant is being built by some competitor.

To conclude, expression (5) is not a supply curve, even if the slope β_1 is such that the hypothesis of perfect competition prevails. The supply curve is that of expression (14) whose slope is given by (15) and contains not only β_1 but the effect of investment in capacity. Expression (5) may however be useful to test the hypothesis that in fact firms do maximize profit, and this is the last subject analyzed in this paper.

4.3. The Absence of Economic Dynamics

As a consequence of the process of differentiating to provide a maximum profit solution, the neoclassical producer has no rule of price decision. In fact, it is forbidden for neoclassical producers who is driven exclusively by the maximum profit to make decisions on production and price, in or outside the perfect competition castle. Instead, one neoclassical producer has only a supply relation connecting alternative sets of price and production which would always give him the same end result: the maximum profit. Because, perhaps, it would be incompatible with maximization, neoclassical theory elaborates no dynamic decision-making process: there is no neoclassical theory for explaining how an equilibrium point like e is reached. Accordingly, in neoclassical terms actual values are short run equilibrium points.

Despite postulating that producers invest after a shift in demand, the neoclassical theory assumes that both supply and demand come through instantaneous and simultaneously. Therefore, in order to match buyers and sellers intentions it is always required the intervention of an "auctioneer"⁵. The script is: producers communicate to the auctioneer their supply curves and he compares them with the informed consumers' schedules. Then he calculates the price which matches the market and send it to suppliers who therefore produce the exact quantity consumers will buy. Theoretically, the market

⁵ Note added to the 2011 revision: the auctioneer reminds the Adam Smith's "invisible hand", but neither this amazing resemblance nor the auctioneer's lack of scientific basis disturb the confidence of neoclassical people on their pretentious mathematical rigor. Footnote 3 (p. 11) refers to a supply and demand model in which producers can decide own price and production levels. Consequently, every point in the plane price \times production is a disequilibrium point. Equilibrium is there a mathematically deduced theoretical situation; the real life is supposed not to be in equilibrium.

always clear, it is in equilibrium forever. In the real life the dynamic process of adjustment from one point of equilibrium to another, which depends heavily on the propensity to invest, has been reported to time-dependent statistical analysis. Curiously, time-dependent econometrics treats data as disequilibrium values.

Time-dependent econometric model like time-series or any other seem thus not to be particularly appropriate for empirical work based on neoclassical theory. Time-series analysis is a statistical rather than an economic method, for it stresses time-based regularities occasionally observed in the behavior of endogenous variables. Time, nevertheless, cannot be an explanatory economic variable: economic equilibrium is not real life but a theoretical abstraction. As the reduced model shows, equilibrium values of endogenous variables are determined by levels of all exogenous variables properly lagged, independently of the time then elapsed. If some time-regularity has been detected in an economic endogenous variable, then it must be explained by some regularity in the time-behavior of a least one of the exogenous economic variables.

The notion of equilibrium proposed by time-series analysis may be extended to defining equilibrium values (expression 13). This means that time-series analysis could bring about theoretical equilibrium relations and values as mathematical consequences of the statistical treatment of the economic series. No previous equilibrium values of parameters and endogenous variables are required for time-series analysis to be carried out. To conclude, results obtained by time-dependent analysis, which is the econometric method⁶ more frequently adopted in association with neoclassical theory, will almost certainly be inconsistent with what neoclassical theorists would like to anticipated, such as the value of the supply slope.

4.4. The Absence of Theoretical Support

Despite the problems discussed above, let us consider that the hypothesis that producers follow the neoclassical maximization principle may be scientifically tested, and that differential calculus might be an appropriate method for this test. If the neoclassical paradigm could explain producers' behavior, leading thus to the supply curve, then it would be possible to anticipate the value of the supply slope given by the individual profit maximization expression (2):

$$P_t + \lambda_i (\partial P / \partial D) Q_{it} - c_3(Q_{it}) = 0 \quad (2)$$

where $(\partial P / \partial D)$ is the inverse of the always negative demand slope and λ_i is the individual conjectural variations parameter which depends also on the propensity to invest. The derivative of the price in relation to the individual firm's production in expression (2), or the inverse of the individual supply slope, is defined by:

$$B_i = \partial P_t / \partial Q_{it} = - \lambda_i (\partial P / \partial D) \quad (18)$$

Adding up all firms it was previously obtained the expression (3):

$$P_t + (\lambda / \alpha_1) Q_t - c_2(Q_t) = 0 \quad (3)$$

where α_1 is the demand slope $(\partial D / \partial P)$. Despite the fact that (3) is not the industry short run supply curve as supposed initially, it is appropriate for estimating the combined parameter (λ / α_1) using a three equations simultaneous model composed of expression (3), the demand equation (1) and the equilibrium condition. Supposing then some particularly favorable circumstances related to costs and the process of disaggregation, one could possibly use the estimate of (λ / α_1) to reach an estimate of B_i in (18). Alternatively, B_i could possibly be obtained directly, if data were available at the

⁶ Note added to the 2011 revision: up to 2011 some new developments in time-dependent econometrics appeared, but the misleading use of time to "explain" what only economics can actually explain still remains.

individual firm level. Let us therefore suppose that, with more or less difficulty, an estimate of the slope B_i has been brought about.

What then happens is that, even in the most favorable situation one could imagine, all that can actually be identified through econometric analysis is the composed parameter B_i . Given B_i , it is not valid to assume that the firm maximizes its profits and use the expression (18) to deduct the value of λ_i . In more simple terms: given an estimate in which the inverted individual supply slope B_i is equal to twelve and the inverted demand slope ($\partial P/\partial D$) is equal to minus three, it is not scientifically valid to deduct that λ_i is four. B_i may be independent both of the demand slope and the profit maximization assumption.

The demonstration that producers follow the maximization principle requires λ_i to be identifiable from an independent source. It would be necessary a kind of a "competimeter" to give a series of observed values of the intensity of the competition between producers. It would be not a surprise if the competimeter were part of the neoclassical assumptions. If such a series could be given, then a procedure analogous to that adopted in the case of capacity K could bring about an estimate of the parameter λ_i . Considering that such a device does not exist, and given an estimate of the slope of the equation (2), it will as always be impossible to confirm that it is a consequence of the profit maximization principle. Identically, given an estimate of the long run supply slope it is impossible to confirm that it is a consequence of the neoclassical paradigm.

There are three theoretical situations in which the maximization principle could be identified. The first is the monopoly solution in which there is only one λ_i and it is equal to one; the second is the Cournot solution in which all λ_i are equal to one⁷, and the third is perfect competition in which every λ_i is equal to zero. Stating this point in the natural order of a formal test of hypothesis: given an estimate of B_i such that λ_i is statistically not different from one (monopoly or Cournot), or from zero (perfect competition), then the hypothesis that the producer maximizes profit cannot be rejected. Otherwise the hypothesis must be rejected.

However, independently of the possibility of occasionally finding these situations somewhere in the real world, they would always be special conditions, inappropriate for supporting a general theory of price formation and production (investment) decision. In theoretical terms, competition must be expected to be more general than those three special cases, resulting from an unpredictable composition of simultaneous cooperation, rivalry and the search for strategic production control through investment in capacity⁸.

The traditional method followed by neoclassical theory is based on the description of the static and dynamic environmental conditions, amongst them competition, under which profit would be maximized. This approach has been capable of providing no more than special models of price formation, but never a general price theory. Nonetheless, if the model were consistent, then the statistical regularity picked up through neoclassical

⁷ Note added to the 2011 revision: as Alfred Marshall once noted, Cournot's firms are monopolists; they make decisions independently of the competitor's decisions. This is coherent with Cournot's proposition of independence among firms. One may therefore conclude that monopoly, mutual independence and perfect competition are necessary conditions for differential calculus to be applied. It is then not a coincidence that Cournot analyzed these three theoretical situations in, respectively, chapters V, VII and VIII of his *Recherches*.

⁸ Note added to the 2011 revision: the Author's 1995 paper "Cartels, Cooperation and Rivalry" brings references to several studies which found that λ_i are between zero and one. The main purpose of that paper is the development of the supply and demand analysis of the Brazilian cement market (referred to in footnote 3 above) to demonstrate that the competition among firms is an unpredictable mix of cooperation and rivalry. Furthermore, this mix varies with the profit firms realized at any period of time.

time-series analysis should in principle be capable of bringing about an estimate of the model, without the need of anticipating the values of the parameters. In general, following any neoclassical method the best result obtained would be the long run supply curve as expressed by (14):

$$Q_t^* = \varphi_0 + \varphi_1 P_t^* - \varphi_2 W_t \quad (14)$$

This is a general equation which, for a given level of the cost W , will trace a positive slope line in a cartesian plane as demand shifts. No special values are expected for the coefficients φ_0 , φ_1 and φ_2 . The supply curve will always take the form of (14), plus some other particular exogenous variable relevant for some particular markets, no matter if firms maximize profits or not. On the other hand, it is also unfeasible to demonstrate that producers do not want to maximize profit. Moreover, it seems to make no sense to propose that firms do not try to maximize profit. The right phrase seems to be: firms try to maximize profits and it is possible that they succeed. There seems to be nothing necessarily wrong with profit maximization, but certainly there is no theoretical support for the method of differential calculus for price and production determination.

To conclude, in order to validate the maximization principle λ_i must be independently obtained, and this seems to be the main purpose of the neoclassical research program. However, the procedure of elaborating more complex "maximization problems", or replacing λ_i by an equivalent notion like game theory, can only cloud the question of identifying the neoclassical paradigm, whose simplest approach is given by a " λ_i -like" notion. If another argument is combined with λ_i , then the empirical demonstration of the maximization principle becomes still more difficult.

Although λ_i permits a clear vision of the problem, as Schmalensee states it results from "a complex pattern of behavior", in such a way that neoclassical theory allows at best for the description of particular situations associated with particular values of λ_i . Following the neoclassical research agenda it becomes impossible to reach a general theory of price formation and production (investment) decision. "A complex pattern of behavior" multiplied by the profit maximization principle cannot make the situation clearer, it will always be "a complex pattern of behavior". A (supposedly) known factor (maximization) multiplied by an unknown factor (λ_i) yields a result which is ... unknown. Neoclassical theory is incapable of explaining supply behavior: "trying to fit all types of situations into one system is obviously foredoomed to futility" (ROBINSON, 1953, page 590).

5. CONCLUSIONS

This paper stresses the shortcomings of neoclassical microeconomic theory in order to present some contribution to the reconstruction of economic theory. The study demonstrates that the neoclassical paradigm of profit maximization through differential calculus is neither a necessary nor a sufficient condition for defining the supply curve. It seems that the natural order has been subverted: neoclassical theory uses differential calculus to describe supply behavior instead of a method for testing the hypothesis that producers maximize their profits. Moreover, the process of profit maximization requires some restrictive environmental conditions and leads to restrictive consequences to economic dynamics.

Amongst those restrictive environmental conditions, the paper analyses the neoclassical notion of short run, which assumes production capacity to be given. This assumption corresponds to the statement that in the short run there is no demand for investment in capacity. However, in order to deal with the long run the demand for investment must be theoretically considered. Additionally, considering that the long run supply curve can explain the neoclassical short run equilibrium solution, the short run condition may be dispensed with. Consequently, for microeconomics the neoclassical notion of short run is an inconsistent and redundant hypothesis.

Profit maximization implies also that producers have no decision-making processes; instead, they have a relation connecting all their points of equilibrium. Therefore, as a restrictive consequence, the dynamics of adjustment between two points of equilibrium is reported to time-dependent econometric analysis which is a statistical method that considers time as an explanatory variable in economics. Curiously, time-dependent analysis potentially contains the equilibrium values of price and production which could be used to compute supply and demand curves, independently of any neoclassical microeconomic model.

One important observation permitted by the paper is that it is theoretically unfeasible to isolate the effect of the profit maximization principle on the supply performance, and hence on price and production formation. To reach the supply side neoclassical theory says dogmatically that you must multiply one faithful assumption - profit maximization - by another factor which is unpredictable - competitiveness. But in so doing you will obtain a result which is ... unknown. This means that differential calculus is useless to explain supply behavior: besides the hypothetical profit maximization there remains a complex pattern of competitive behavior which neoclassical theory cannot deal with. There is no theory to sustain the neoclassical approach of supply behavior.

The main conclusion of the paper is that the neoclassical research program cannot bring about a theory for the supply side of economics. In or outside the Cournotian-neoclassical world of perfect competition, the neoclassical paradigm implies the denial of the law of supply and demand. Two consequences stress the lack of scientific support to the neoclassical dogma of profit maximization. First, the best interpretation of the Cournot's theorems is that they demonstrate the inapplicability of differential calculus to describe suppliers' behavior and therefore to explain how price and production are formed. Second, talking or not talking supply and demand, it remains the fact that the neoclassical doctrine is unable to explain production and price formation. If it cannot do the job at the microeconomic level, less still it can do it at the macroeconomic level. This incompetence may be tailored, consciously or not, to give room for the monetary policy, which can therefore state that the price level is determined by the stock of money. In the neoclassical doctrine price and production levels, both at micro and macroeconomic stances, are not consequences of the human action. They fall from the sky and their ups and downs follow trends which are determined by the calendar. Neoclassical theory is not "science" but "dogma", a set of statements that may and has been manipulated at least for good and at most for evil.

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