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How to Get Rid of Demand–Supply–Equilibrium for Good

Egmont Kakarot-Handtke*

Abstract

The present paper provides a substantial re-conceptualization of the serial clearing of the product market on the basis of structural axioms. This change of premises is required simply because from the accustomed premises only the accustomed conclusions can be derived and these are known to be inapplicable in the real world. This holds in particular for the still popular idea that the working of a market can be described in terms of the triad demand function–supply function–equilibrium. Structural axiomatization provides the complete and consistent picture of interrelated product market events.

JEL D00, E00, E30

Keywords new framework of concepts; structure-centric; axiom set; time; randomness; paradigm; price setting; market clearing; inventory cycle; quantity of money; profit

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> In other words, the main developments in economics of the twentieth century . . . had been more a matter of form than of substance. . . . Little new of any great significance has been learned about the workings of markets since Adam Smith and, . . . , Smith added much less to the discussion than most economists have commonly supposed. (Nelson, 2006, p. 298)

To get over the intellectual stagnation of standard economics, the present paper provides a substantial re-conceptualization of the serial clearing of the product market on the basis of structural axioms. This change of premises is required simply because from the accustomed premises only the accustomed conclusions can be derived and these are known, all refinements notwithstanding, to be inapplicable in the real world. This holds in particular for the still popular idea that the working of a market can be described in terms of the triad demand function–supply function–equilibrium, a conceptualization that has been thoroughly refuted (Lee and Keen, 2004). Therefore, the set of behavioral axioms of standard economics is replaced by a set of structural axioms. The methodological rationale has been discussed at length in (2013b, Sec. 7).

In Section 1 the set of structural axioms is introduced and elucidated. In Section 2 the price setter's task in an environment with ongoing random shocks is formally defined. It is the interaction of price setting and deviations from a target stock of products that keeps the inventory cycle and the complementary flexible price adaptations going. This adaptations also determine the changes of the quantity of money which are dealt with in Section 3. Concurrent with the interrelated movements of output, sales and price varies profit. Total profit is composed of monetary and non-monetary profit. This distinction is introduced in Section 4. Monetary profit is determined by the expenditure ratio and the distributed profit ratio, non-monetary profit is determined by inventory changes. Section 5 concludes.

1 Where to start

> A scientific deductive system ("scientific theory") is a set of propositions in which each proposition is either one of a set of initial propositions . . . or a deduced proposition . . . in which some (or all) of the propositions of the system are propositions exclusively about observable concepts (properties or relations) and are directly testable against experience. (Braithwaite, 1959, p. 429)

The formal foundations of theoretical economics must be nonbehavioral and epitomize the interdependence of real and nominal variables that constitutes the monetary economy (for details see 2013b).

The first three axioms relate to income, production, and expenditures in a period of arbitrary length. For the remainder of this inquiry the period length is conveniently assumed to be the calendar year. Simplicity demands that we have at first one world economy, one firm, and one product. Quantitative and qualitative differentiation is obviously the next logical step.

Total income of the household sector Y in period t is the sum of wage income, i.e. the product of wage rate W and total working hours L, and distributed profit, i.e. the product of dividend D and the number of shares N.

$$Y = WL + DN \quad |t \tag{1}$$

Output of the business sector O is the product of productivity R and working hours.

$$O = RL \quad |t \tag{2}$$

The productivity R depends on the underlying production process. The 2nd axiom should therefore not be misinterpreted as a linear production function.

Consumption expenditures C of the household sector is the product of price P and quantity bought X.

$$C = PX \quad |t \tag{3}$$

A set of axioms is a *tentative* formal starting point. The assessment comes on the next stage with the interpretation of the logical implications of the formal world and the comparison with selected data and phenomena of the real world. Axioms should have an intuitive economic interpretation (von Neumann and Morgenstern, 2007, p. 25). The economic meaning is rather obvious for the set of structural axioms. What deserves mention is that total income in (1) is the sum of wage income and *distributed profit* and not of wage income and profit. Profit and distributed profit have to be thoroughly kept apart.

By choosing *objective* structural relationships as axioms behavioral hypotheses are not ruled out. The structural axiom set is open to *any* behavioral assumption and not restricted to the standard optimization calculus (for details see 2011b). The analysis of behavioral interaction is, for compelling methodological reasons, moved from the center of the domain to the periphery.

Definitions are supplemented by connecting variables on the right-hand side of the identity sign that have already been introduced by the axioms. With (4) wage income Y_W and distributed profit income Y_D is defined:

$$Y_W \equiv WL \qquad Y_D \equiv DN \quad |t. \tag{4}$$

With (5) the expenditure ratio ρ_E, the sales ratio ρ_X, the distributed profit ratio ρ_D, and the factor cost ratio ρ_F is defined:

$$\rho_E \equiv \frac{C}{Y} \qquad \rho_X \equiv \frac{X}{O} \qquad \rho_D \equiv \frac{Y_D}{Y_W} \qquad \rho_F \equiv \frac{W}{PR} \quad |t. \tag{5}$$

The axioms and definitions are consolidated to one single equation:

$$\rho_F \, \frac{\rho_E}{\rho_X} \, (1+\rho_D) = 1 \quad |t. \tag{6}$$

The period core (6) as absolute formal minimum determines the interdependencies of the measurable key ratios for each period. The factor cost ratio ρ_F summarizes the internal conditions of the firm. A value of $\rho_F < 1$ signifies that the real wage $\frac{W}{P}$ is lower than the productivity R or, in other words, that unit wage costs $\frac{W}{R}$ are lower than the price P or, in still other words, that the value of output per hour PR exceeds the value of input W. In this case the profit per unit is positive. Then we have the conditions in the product market. An expenditure ratio $\rho_E = 1$ indicates that consumption expenditures C are equal to income Y, in other words, that the household sector's budget is balanced. A value of $\rho_X = 1$ of the sales ratio means that the quantities produced O and sold X are equal in period t or, in other words, that the product market is cleared. In the special case $\rho_E = 1$ *and* $\rho_X = 1$ with budget balancing and market clearing the factor cost ratio ρ_F and with it the profit per unit is determined solely by the distributed profit ratio ρ_D. The period core (6) covers the key ratios about the firm, the market, and the income distribution and determines their interdependencies. The period core represents the pure consumption economy, that is, no investment expenditures, no foreign trade, and no government.

2 Quantities, price, and time in the product market

A cursory run over the pages of economic textbooks convinces us that households and firms are normally price takers and quantity adapters in a regime of perfect competition. This is the theoretical benchmark case. A cursory glance at economic reality brings home the intuition that all firms are price setters, wage (co-)setters, employment setters, dividend and number of shares setters, and that all households set their expenditure ratio, that is, they decide in any given period about consumption expenditures and saving/dissaving. Economists, of course, know that price taking is a provisional assumption that has been introduced to simplify the analysis. Unintentionally it has gained a life of its own and first assumed the role of an acceptable approximation and then of a paradigm. This is to turn the relation of theory and reality on its head.

> Such thinkers do not reflect that the idea, being a result of abstraction, ought to conform to the facts, and cannot make the facts conform to it. (Mill, 2006, p. 751), see also (Kline, 1982, p. 48)

As analytical limiting case, price taking is an acceptable behavioral assumption. However, a general theory cannot be based on this premise. The general premise is that the agents autonomously set all the independent variables they can get hold of in their respective spheres. This methodological rule is now applied to the pure consumption economy, that is, for the most elementary economic configuration. For a start, this economy is undifferentiated, that is, the horizontal interdependence of many product markets on the one side and many labor markets on the other is left out of the picture (for details about differentiation see 2013a). We have one product and one labor market and their vertical interdependence.

2.1 The sales ratio gives way

In the small and well-arranged world of (6) all variables are either set by the household or the business sector, except the sales ratio ρ_X which resides in the no man's land between the sectors. Accordingly, we treat it as the dependent variable and have now:

$$\rho_X = \frac{W}{R}(1+\rho_D)\frac{\rho_E}{P} \qquad |t. \tag{7}$$

This equation confronts the business sector with three possible outcomes. The sales ratio is $\rho_X < 1$, that is, the quantity bought by the household sector is less than the quantity produced by the business sector. As a consequence the stock of unsold products increases. Vice versa if $\rho_X > 1$. What we would like to see is, of course, market clearing $\rho_X = 1$ because this is our preconceived idea of how efficient markets operate. From this idea, however, does not follow that the product market has to be cleared in the period under consideration, but, loosely speaking, in the course of time (Mirowski, 2004, p. 347). It does not follow either that market clearing happens in some fictional state called simultaneous equilibrium.

The sales ratio ρ_X depends on unit wage costs $\frac{W}{R}$, on the income distribution ρ_D, on effective demand as defined by the expenditure ratio ρ_E, and finally on the price P. We first focus on the interdependency between demand and price and how they interact in the process of market clearing. By blanking out the rest of the consumption economy the formal representation simplifies to:

$$\begin{gathered}\rho_X = \Theta\frac{\rho_E}{P} \\ \text{with} \quad \Theta \equiv \frac{W}{R}\left(1+\frac{DN}{WL}\right) \quad \text{constant} \quad |\text{t}.\end{gathered} \tag{8}$$

There are two ways to keep the factor Θ constant. Either each single variable remains fix or the respective proportions of the variables remain unaltered while the variables themselves change. If, for example, the wage rate W moves in tandem with the productivity R, unit wage costs remain fix over time. For the beginning each variable of Θ is kept constant. This implies that labor input is fixed, say at full employment, and by consequence the firm's output too. Real supply stays put.

It is assumed now that the expenditure ratio fluctuates randomly around unity, such that over a longer time span there is no bias or permanent deviation in one direction or the other, i.e.

$$\frac{1}{n}\sum_{t=1}^{n}\rho_{Et} \sim 1. \tag{9}$$

The households alternately save, i.e. $\rho_E < 1$, and dissave, i.e. $\rho_E > 1$, in an irregular sequence and after n periods it is open whether cumulated consumption expenditures are greater, less or equal to cumulated income, i.e. the symmetric variations of the expenditure ratio do not necessarily lead to cumulated budget balancing, i.e.

$$\sum_{t=1}^{n} C_t \lesseqqgtr \sum_{t=1}^{n} Y_t. \tag{10}$$

Logic demands that budget balancing must occur at some date before the end of time. How this happens can be left open here (for details see 2011a). From (10) follows that, whenever budget balancing occurs in the interim, the weighted expenditure ratio over all periods must be unity. Budget balancing is a temporal indeterminate logical necessity. At some date in the future cumulated consumption expenditures must be equal to cumulated income or, in other words, cumulated saving and dissaving must be zero.

In order to clear the market in period t the firm must set the price in (8) such that $\rho_X = 1$. Analytically this is no problem. We take market clearing as a condition and get the market clearing price $P^{\star}$ as:

$$P^{\star} = \Theta\rho_E \quad \text{if} \quad \rho_X = 1 \quad |t. \tag{11}$$

The market clearing price moves in parallel with the random changes of the expenditure ratio or, in loose terms, with demand. All exogenous demand shocks are absorbed by the price, the rest of the system is not affected. There is no split of an expansive or contractive effect between price and output. The price setting has to be carried out at the beginning of period t because the axioms refer to a period of a suitably defined length. It almost goes without saying that the firm does not know at period beginning what ρ_E is going be. There is no foreknowledge of a random event. Hence $P \neq P^{\star}$ in (8) and therefore $\rho_X \neq 1$. The product market is never cleared because the price setter has no way to divine the market clearing price. What applies to the current period applies *a fortiori* to future periods.

The crucial methodological point is: what can easily be done within a well-defined formal frame cannot be done by real human beings. It is therefore illegitimate to take market clearing as a premise – except for analytical purposes. The accustomed consensus

> Wherever economics is used or thought about, equilibrium is a central organising idea. (Hahn, quoted in Boland, 2003, p. 99)

is indefensible and ultimately counterproductive as the evident failure of General Equilibrium Theory testifies (Ackerman and Nadal, 2004). A theory that assumes the fact $X \neq O$ away is of no value whatsoever. Simplification, abstraction, as-if reasoning, or idealization can in this case not be accepted as a justification.

> The idea that the economy is essentially in an equilibrium state or on an equilibrium path from which it is sometimes perturbed seems simply to be the wrong departure point. (Kirman, 2010, p. 511)

Because there is no such thing as an equilibrium the notion of disequilibrium lacks a reference and also vanishes from the economist's vocabulary. All that can be said without regress to misplaced physical analogies is that the market evolves.

2.2 The stock of products

The change of the stock of products in period t is defined as the excess between output O and the quantity bought X by the households:

$$\Delta\bar{O} \equiv O - X \equiv O\,(1-\rho_X) \quad |t. \tag{12}$$

The stock at the end of an arbitrary number of periods $\bar{t}$ is given by definition as the numerical integral of all previous stock changes plus the initial endowment:

$$\bar{O}_t \equiv \sum_{t=1}^{t} \Delta\bar{O}_t + \bar{O}_0 \tag{13}$$

The resulting interrelation between the sales ratio and the stock is given by

$$\bar{O}_t \equiv \sum_{t=1}^{t} O_t\,(1-\rho_{Xt}) \quad \text{if} \quad \bar{O}_0 = 0 \tag{14}$$

From this in combination with (8) follows that the stock of products ultimately depends on the development of ρ_E and P.

Seen from the firm's perspective, the stock at the end of period $\bar{t}$ is either too large, too small, or just right. This depends on the firm's target stock which is denoted by $\bar{O}_t^{\theta}$. The firm's objective is not to clear the market in the period under consideration, that is, to sell exactly the current output O, but to bring the actual stock as close as possible to the target stock, i.e.

$$\bar{O}_t - \bar{O}_t^{\theta} \rightarrow 0. \tag{15}$$

Only if the actual stock is exactly equal to the target stock the task in the subsequent periods reduces to market clearing in the narrow sense, i.e. to

$$O - X = 0. \tag{16}$$

When economists paint demand and supply schedules the underlying formalism says (16) while the accompanying story of equilibrating market forces is a verbalization of (15). This double talk explodes in General Equilibrium Theory with the incompatibility of existence and stability of equilibrium (Ingrao and Israel, 1990, p. 359).

2.3 Price setting

The price is not determined by anonymous market forces but set by a person with a name and a telephone number.

> An intellectually respectable answer should consist of something more than tired clichés; observable economic events derive ultimately not from unspecified coordinating mechanisms, whether invisible hands, price systems, or neowalrasian "auctioneers", but … from definable actions of real people. (Clower, 1994, p. 806)

We cannot read the mind of a price setter but we need at least a rule of thumb of price setting for our theoretical purposes. This rule is inspired by systemic necessities. We have two basically different alternatives: stochastic and deterministic price setting.

The period values of the variables are connected formally by the familiar growth equation, which is added to the structural set as the 4th axiom:

$$Z_t = Z_{t-1}\,(1 + \dddot{Z}) \tag{17}$$

The path of the representative variable Z_t is then determined by the initial value Z_0 and the rates of change $\dddot{Z}_t$ for each period:

$$Z_t = Z_0\,(1+\dddot{Z}_1)\,(1+\dddot{Z}_2)\ldots(1+\dddot{Z}_t) = Z_0\prod_{t=1}^{t}(1+\dddot{Z}_t) \tag{18}$$

Equation (18) describes the path of a variable with the *rates of change* as unknowns. These unknowns are in need of determination and explanation. This has a straightforward methodological consequence:

> The simplest hypothesis is that variation is random until the contrary is shown, the onus of the proof resting on the advocate of the more complicated hypothesis ... (Kreuzenkamp and McAleer, 1995, p. 12)

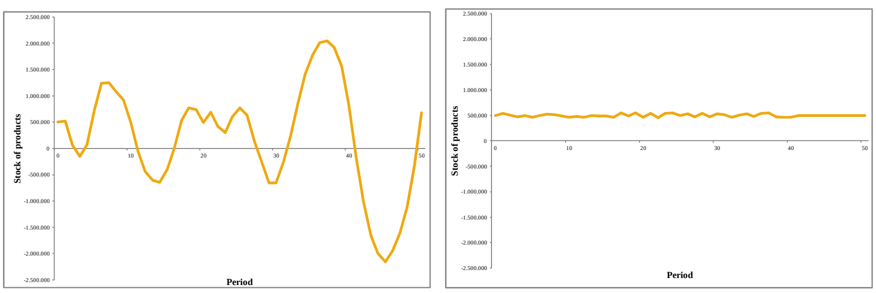
The stochastic price change consists of two elements: (a) direction, which depends on the deviation of the actual stock of products from its target value, and (b), magnitude, which depends on a plausible set of discrete random rates of change. For our simulations the rates of change are taken from the worksheet random number generator. The price change in period t is accordingly given by:

$$\ddot{P} = \underbrace{\{-1,0,1\}}_{\text{direction}} \underbrace{Pr(\{0 \leq \ddot{P} \leq x\%\})}_{\text{magnitude}} \quad |t. \tag{19}$$

The direction of the price change depends on the difference between the actual stock of products and the target value as given by (15). If the sign of the difference is positive then the sign of the price change is negative, and vice versa. This is not an immutable law but a plausible assumption.

$$-1_t = sgn_P\left(sgn\left(\bar{O}_{t-1} - \bar{O}^{\theta}_{t-1}\right)\right) \tag{20}$$

Eqs. (19) and (20) deliver the price change which is fed into (8). Figure 1a shows the resulting inventory cycle. The initial stock is equal to the target stock which remains constant over the whole time span of observation. It is worth remembering that all variables are fixed except the expenditure ratio which hoovers randomly around unity. These exogenous shocks to the consumption economy together with the price setting rule produce the trajectory of the stock of products as given by (14) and shown in Figure 1a.



(a) Directed stochastic price setting **(b)** Delayed deterministic price setting

Figure 1: Inventory cycles in dependence of different price setting rules

The simple stochastic feedback works with a minimum of assumptions but is not very efficient. Obvious shortcoming are wide swings that may transit negative territory which is impossible in reality. Depending on the random rates of change the cycles may build up and shrink over time. And finally, once the cycle is set in motion it does not stop when the exogenous shocks cease. Obviously, there is plenty of room for refinements and no upper limit for the introduction of additional assumptions. However, here we are interested in the weakest assumption that is necessary and sufficient for market clearing over time in a random environment. As a matter of principle stochastic feedback prevents explosion and implosion and keeps the system going. This is sufficient for a start.

Deterministic price setting uses more information. The market clearing price cannot be calculated for the current period but, with the help of (11), retroactive for the previous period:

$$P_t = P^{\star}_{t-1} = \Theta \rho_{Et-1} \quad \text{if} \quad \rho_{Xt-1} = 1. \tag{21}$$

This price is inserted in (8) and from (14) then follows the development of the stock of products which is displayed in Figure 1b. This one-period delayed tracking of the market clearing price keeps the inventory rather close to the target level. Note that the random changes of ρ_E are suspended in period$_{40}$ and that the stock then swings back to the target level. The system becomes stationary. The deterministic price setting rule involves a bit more calculation than directed random feedback but is certainly more efficient. It solves the task of market clearing in a rather down-to-earth fashion without the invocation of occult market forces or superhuman faculties.

$$\rho_X = \overset{B\,\downarrow}{\Theta}\,\frac{\rho_E \leftarrow A}{P}$$

$$\overbrace{\underbrace{\bar{O} - \bar{O}^{\theta}}_{\to 0}} \leftarrow C$$

Figure 2: The price setter's task in the structural-axiomatic environment with random shocks

The situation of the price setter is summarized in Figure 2. The person in charge faces the exogenous random changes A to C. The household sector's randomly varying demand is denoted by A. The factor B has here been neutralized and shall be dealt with later. Expectations, too, vary in the first approximation at random but can only have an effect on target variables, here on $\bar{O}^{\theta}$. If, for example, the price setter expects an increasing demand in the future he will raise the target stock. Eq. (20) of the stochastic price setting rule then makes that the price starts to rise. In the first round the exogenous variations B and C have been switched off. This reduces the task of the price setter to the compensation of the random changes of the expenditure ratio, such that actual inventory is kept as close as possible in the vicinity of the fixated target level.

2.4 All together now

As the next logical step on our way to full generality we lift the simplifying assumption of a fixed employment and other restrictions, but keep the resulting factor Θ unchanged. Eq. (7) turns to:

$$\begin{aligned} \rho_X &= \frac{W}{R}\left(1+\rho_V\rho_N\right)\frac{\rho_E}{P} \\ \text{with}\quad \rho_V &\equiv \frac{D}{W}, \quad \rho_N \equiv \frac{N}{L} \quad |t. \end{aligned} \tag{22}$$

The factor Θ remains constant if, first, the wage rate W moves in step with the productivity R. This keeps unit wage costs stable. Second, the dividend D is assumed to follow the wage rate W, hence ρ_V is a constant. Finally, the number of shares N follows employment L, hence ρ_N is also a constant. Both conditions taken together make that the income distribution does not change while the economy either grows or shrinks because $\rho_D \equiv \rho_V\rho_N$. Distribution is a separate issue that has been dealt with elsewhere (for details see 2012). While all constituent parts of the factor Θ change, they do it in such a way that the factor itself remains constant.

Since the wage rate has, according to the inner logic of the system, been given the task of compensating random productivity variations in order to keep the price stable it cannot be used for the coordination of the labor market. It is assumed here that employment L follows demand or, more precisely, the expenditure ratio. If $\rho_E > 1$ then L grows with a random rate of change $\ddot{L}$ and vice versa if demand decreases. This implies that additional labor is hired at the going wage rate W. Changes of the wage rate depend ultimately on productivity variations and not on the accustomed conception of demand/supply in the labor market (see Section 2.5).

The new price setting rule that is applied for simulation says that the very price is taken as an anchor in period t that would have sold current output plus the excess inventory in period $t-1$ given the consumption expenditures in period $t-1$. The precisely calculated price is then slightly modified by a symmetric random disturbance to account for all kinds of errors or frictions. Hence this rule of thumb lies somewhere in between a stochastic and a deterministic rule.

$$\begin{aligned} P_t &= P_{t-1}\left(1+Pr\left(\{-x\% \leq \ddot{P} \leq x\%\}\right)\right) \\ \text{with}\quad P_{t-1} &= \frac{C_{t-1}}{\left(\bar{O}_{t-1}-\bar{O}^{\theta}_{t-1}\right)+O_{t-1}} \end{aligned} \tag{23}$$

Figure 3 summarizes the resulting development in the product market. While the quantities produced and sold grow over the time span of observation with employment, the inventory keeps close to its target level. The price reacts in each period and irons out all exogenous random variations. However, the flexible price remains roughly constant over the whole time span. Whether the market is cleared at the end of an arbitrary period $\bar{t}$ or not can be read off the stock of products. Figure 3 shows the three market dimensions quantity, price, and time. It fully replaces the 'totem of the micro' (Leijonhufvud). There is no such thing as a simultaneous demand–supply–equilibrium.

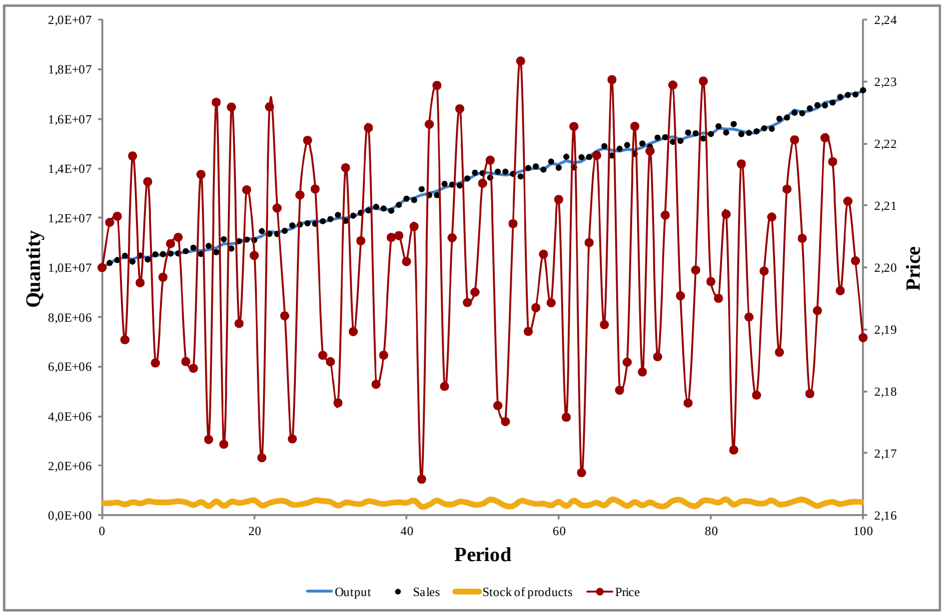


Figure 3: The structural-axiomatic account of the development of output, sales, price, inventory and their interdependence

The price stability over the time span of observation is, of course, due to our assumptions. In the general case it follows from (22) under the condition of market clearing:

$$P^{\star} = \frac{W}{R}\left(1+\rho_V\rho_N\right)\rho_E \quad \text{if} \quad \rho_X = 1 \quad |t. \tag{24}$$

If the wage rate rises faster than productivity, if the dividend rises faster than the wage rate, if the number of shares rises faster than employment and if the expenditure ratio is greater than unity, then the market clearing price $P^{\star}$ rises. Eq. (24) captures the structural-axiomatic theory of inflation. Three elements are crucial: unit wage costs, distribution expressed by the distributed profit ratio, and demand expressed by the expenditure ratio. In the case of price inflation the endpoint of the price curve on the right hand side of Figure 3 is higher than the starting point. Note that the quantity of money (32) is not among the price determinants of (24). This amounts to a repudiation of the quantity theory.

The erratic price movements of Figure 3, which roughly cancel out during the time span of observation, invite two ideas. First, the business sector could keep the price constant in the hope that the random changes of inventory cancel out over time. Second, arbitrageurs could try to buy when the price seems to be at the lower turning point and sell when the price seems to be at the upper turning point. We do not follow this ideas further here.

2.5 Employment as dependent variable

The period core (6) is neutral with regard to the direction of dependency and the physical notion of causality has no meaning in the structural-axiomatic context. This physical analogy is simply misleading. Dependency is an add-on assumption that has to be justified independently of the axiom set on its own merits. For analytical purposes we now change the direction of dependency. The crucial alteration in comparison to (7) consists in making employment L the dependent variable and imposing market clearing. The firm does not react with the price to random changes of the expenditure ratio but with an adaptation of employment. This implies that there is no practical hindrance to the flexible adaptation of total working hours. This is an idealization. We now have:

$$L = \frac{DN}{\dfrac{PR}{\rho_E} - W} \quad \text{if} \quad \rho_X = 1 \quad |t. \tag{25}$$

Under the condition of market clearing, employment in the pure consumption economy is dependent on the expenditure ratio, price, productivity and the wage rate. Rather unsurprisingly, employment moves in step with demand, expressed by the expenditure ratio. What runs against the accustomed idea of market clearing in the labor market is that wage rate and employment also move in step, that is, cutting the wage rate is not conductive to higher employment according to (25), just the contrary. The application of the demand–supply–equilibrium scheme to the labor market is therefore utterly misleading because it ignores the interdependence with the product market. The point to take home is: all other variables in (25) fixed, an increase of the wage rate *increases* overall employment. It is therefore impossible to pull an economy out of a recession with overall wage cuts. The standard advice of standard economics can only send the economy from bad to worse.

From (25) follows for the real wage:

$$\frac{W}{P} = \frac{R}{(1+\rho_D)\,\rho_E} \quad \text{if} \quad \rho_X = 1 \quad |t. \tag{26}$$

The real wage is determined by the productivity, the income distribution, and the expenditure ratio. It does not depend on some fictitious demand and supply schedules for the labor market.

Employment grows in Figure 3. Whether this leads to full employment depends on the concurrent growth of labor supply. We do not follow this thread further at this juncture.

3 The stock of money

If income is higher than consumption expenditures the household sector's stock of money increases. The change in period t is defined as:

$$\Delta\bar{\mathsf{M}}_{\mathbf{H}} \equiv^{m} Y - C \equiv^{m} Y\,(1-\rho_E) \quad |t. \tag{27}$$

The identity sign's superscript m indicates that the definition refers to the monetary sphere. There no change of stock if the expenditure ratio is unity.

The stock of money $\bar{\mathsf{M}}_{\mathbf{H}}$ at the end of an arbitrary number of periods $\bar{t}$ is defined as the numerical integral of the previous changes of the stock plus the initial endowment:

$$\bar{\mathsf{M}}_{\mathbf{H}t} \equiv \sum_{t=1}^{\bar{t}} \Delta\bar{\mathsf{M}}_{\mathbf{H}t} + \bar{\mathsf{M}}_{\mathbf{H}0}. \tag{28}$$

The interrelation between the expenditure ratio and the households sector's stock of money, is then given by:

$$\bar{\mathsf{M}}_{\mathbf{H}t} \equiv \sum_{t=1}^{\bar{t}} Y_t\,(1-\rho_{Et}) \quad \text{if} \quad \bar{\mathsf{M}}_{\mathbf{H}0} = 0. \tag{29}$$

The changes in the stock of money as seen from the business sector are symmetrical to those of the household sector:

$$\Delta\bar{\mathsf{M}}_{\mathbf{B}} \equiv^{m} C - Y \quad |t. \tag{30}$$

The business sector's stock of money at the end of an arbitrary number of periods is accordingly given by:

$$\bar{\mathsf{M}}_{\mathbf{B}t} \equiv \sum_{t=1}^{\bar{t}} \Delta\bar{\mathsf{M}}_{\mathbf{B}t} + \bar{\mathsf{M}}_{\mathbf{B}0}. \tag{31}$$

The development of the stock of money follows without further assumptions from the axioms and is determined by variations of the elementary variables P, X, W

and L. While the stock of money can be either positive or negative the quantity of money is always positive and given by:

$$\bar{\mathsf{M}}_t \equiv \left| \sum_{t=1}^{t} \Delta \bar{\mathsf{M}}_t \right| \quad \text{if} \quad \bar{\mathsf{M}}_0 = 0. \tag{32}$$

The quantity of money follows either from (29) or from (31).

In order to reduce the monetary phenomena to the essentials it is supposed that all financial transactions are carried out by the central bank (for details see 2011c). The stock of money then takes the form of current deposits or current overdrafts. Initial endowments are set to zero. Then, if the household sector owns current deposits according to (28) the current overdrafts of the business sector are of equal amount according to (31). Money and credit are perfectly symmetrical.

The development of the stock of products depends on ρ_X, and that of the stock of money on ρ_E. Both variables are connected via eq. (22). The development of the household sector's stock of money is depicted in Figure 4 which refers to Figure 3. The business sector's stock is symmetrical.

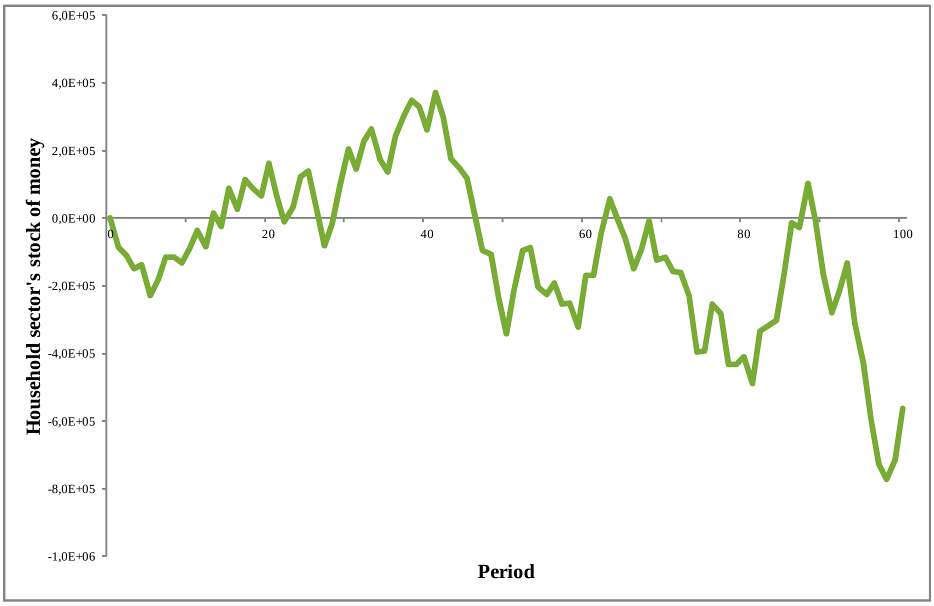


Figure 4: The variations of the expenditure ratio determine the development of the household sector's stock of money, i.e. of deposits respectively overdrafts (refers to Figure 3)

It is assumed here that the central bank's role is to support the autonomous transactions of the household and business sector and to passively accommodate credit and thereby the quantity of money. That is, money is perfectly neutral.

4 Profit

For the specification of profit the set of axioms is extended because additional variables have to be introduced. The 5th axiom states that total profit has a monetary and non-monetary component:

$$Q = Q_m + Q_n \tag{33}$$

4.1 Monetary profit

In the structural axiomatic context the business sector's monetary profit in period t is given with (34) as the difference between the sales revenues – for the economy as a whole identical with consumption expenditures C – and costs – here identical with wage income Y_W:

$$Q_m \equiv C - Y_W \quad |t. \tag{34}$$

In explicit form, after the substitution of (3) and (4), this definition is identical with that of the theory of the firm:

$$Q_m \equiv PX - WL \quad |t. \tag{35}$$

By applying the 1st axiom and the definitions (4) and (5) one arrives at:

$$Q_m \equiv C - Y + Y_D \quad \text{or} \quad Q_m \equiv \left(\rho_E - \frac{1}{1+\rho_D}\right) Y \quad |t. \tag{36}$$

Overall monetary profit is positive if the expenditure ratio ρ_E is > 1 or the distributed profit ratio ρ_D is > 0, or both. The determinants of profit look essentially different depending on the perspective. For the firm price P, quantity X, wage rate W, and employment L in (35) seem to be all important; under the broader perspective of (36), which is formally equivalent, these variables play no role at all. The profit definition provokes a cognitive dissonance between the micro and the macro view, but, of course, entails no logical contradiction.

4.2 Non-monetary profit

Non-monetary profit is defined as the difference between the valued increase of the stock of products in period t and the increase or decrease of the existing stock's value due to changes of quantities and valuation prices which is captured by $G_{\mathbf{B}}$:

$$Q_n \equiv P(O-X) + G_{\mathbf{B}} \quad |t. \tag{37}$$

If more goods are produced than sold in period t, i.e. $O > X$, the stock of products rises according to (12) and accumulates according to (13). It is, of course, possible that more units are sold than produced in a period, i.e. $O < X$. In this case the products are taken from the inventory. The period changes build up or take down the stock of products that therefore consists of different vintages. Initially, the valuation price of each vintage is P but it change over time. These changes come as appreciation or depreciation:

$$G_{\mathbf{B}} \equiv G_{\mathbf{B}}^{+} - G_{\mathbf{B}}^{-} \quad |t. \tag{38}$$

Changes of the inventory's value originate from the change of the quantity and the valuation price B of each hitherto unsold vintage. For the subset of items with a decrease in value taken together the depreciation is given by:

$$G_{\mathbf{B}}^{-} \equiv \sum_{h=1}^{l} \left(B_{ht}\bar{X}_{ht} - B_{ht-1}\bar{X}_{ht-1}\right) \quad \text{with} \quad B_{ht} < B_{ht-1} \quad |t. \tag{39}$$

For the subset of items with an increase of value taken together the appreciation is given by:

$$G_{\mathbf{B}}^{+} \equiv \sum_{h=1}^{l} \left(B_{ht}\bar{X}_{ht} - B_{ht-1}\bar{X}_{ht-1}\right) \quad \text{with} \quad B_{ht} \geq B_{ht-1} \quad |t. \tag{40}$$

The valuation price B is introduced as a new variable with the 5th axiom (33). The firm has some leeway in the valuation of its stock of products. So B usually differs from the market price P. Whether the firm's internal valuation prices are realistic or not remains to be seen until the respective vintage is brought to market.

In periods with an increase of the stock of products total profit (33) is higher than monetary profit and vice versa when the stock decreases. Summed over all periods non-monetary profits and losses are zero when the market is momentarily cleared in some period $\bar{t}$. In this case the *sum* of total profits is equal to the *sum* of monetary profits. Non-monetary profits cancel out. By the same token arbitrary valuations automatically cancel out over time and produce not much more than a time shift of non-monetary profits.

Taking (36) and (37) into account the profit axiom (33) in its explicit form finally reads:

$$Q = \underbrace{(C - Y + Y_D)}_{\text{monetary profit}} + \underbrace{P(O-X) + G_{\mathbf{B}}}_{\text{non-monetary profit}} \quad |t. \tag{41}$$

The equation summarizes the twofold process that generates the business sector's valued stock of products and the stock of money until period t. This boils down to the explicit form of the 5th axiom:

$$Q = PO - Y + Y_D + G_{\mathbf{B}} \quad |t. \tag{42}$$

Total profit is given as the difference of the valued output and total income, plus distributed profit, plus changes of the value of the stock of products. Value changes of inventory cancel out over time. If they are zero in a certain period total profit is given by:

$$Q = PO - Y_W \quad |t. \tag{43}$$

In the simplest case total profit is the difference between the market value of output and wage income. The development of total profit is shown in Figure 5.

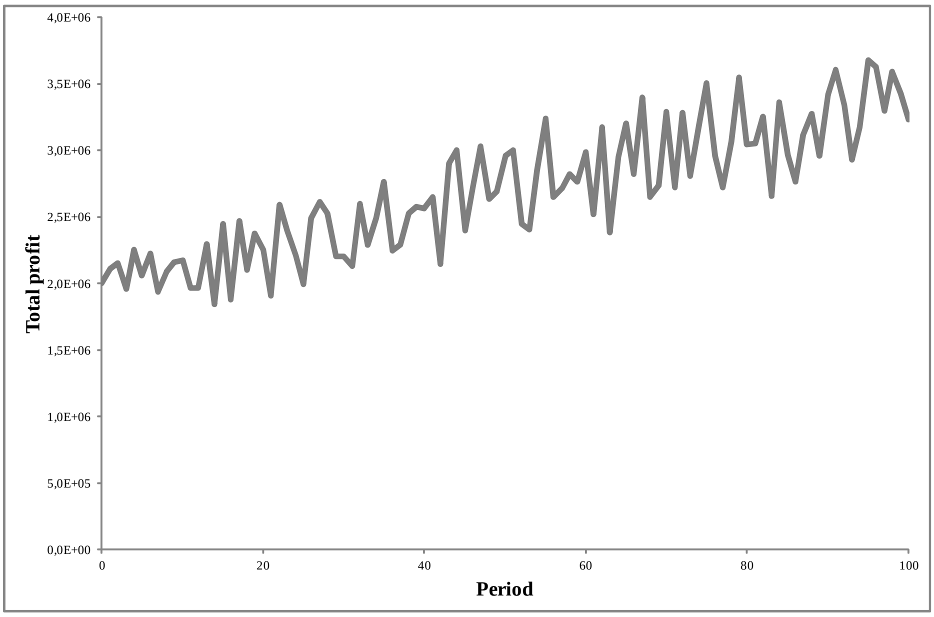


Figure 5: Development of total profit in the growing economy (refers to Figure 3)

With this, the picture of the product market is complete. It contains the – truncated – open development of employment, productivity, output, sales, inventory, quantity of money, the income distribution and total profit over time. This compares to the closed demand-supply-equilibrium scheme. The result is definite: the proper mathematical tool for the description of the product market as a constituent of the consumption economy is not a set of well-behaved demand and supply functions but a simulation. A simulation that is based on structural axioms can be verified *ex post*, that is, when the *ex ante* random rates of change are replaced by the actual rates.

5 Conclusion

We start from the widely shared observation:

> There is little or nothing in existing micro- or macroeconomics texts that is of value for understanding real markets. Economists have not understood how to model markets mathematically in an empirically correct way. (McCauley, 2006, p. 16)

From this follows the most urgent task of price theory: to conceive a formally consistent representation of the – open – market clearing process in the product market. First of all, a change of axioms is required. The misleading behavioral axioms of standard economics have to be replaced by structural axioms. From the structural-axiomatic analysis of the pure consumption economy then follows:

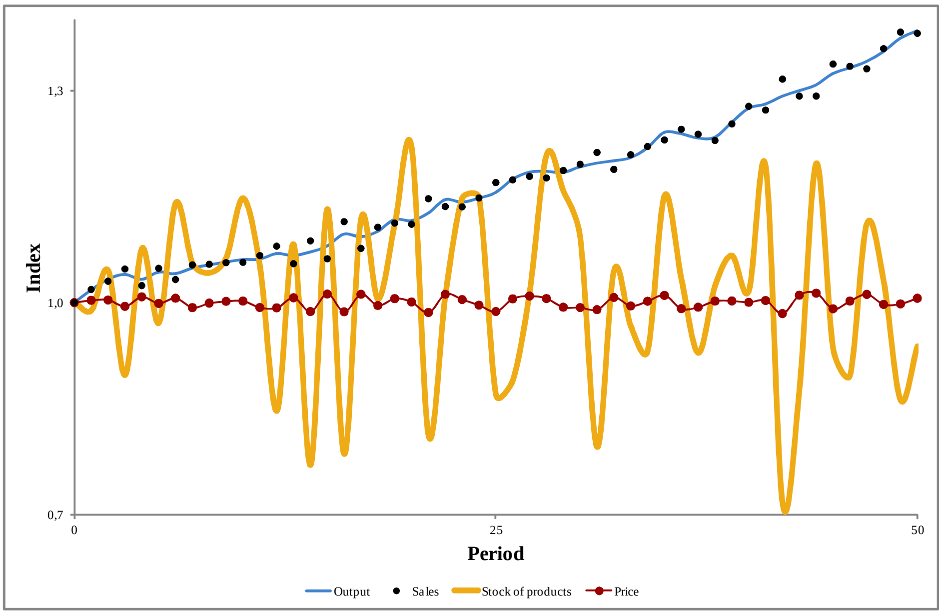


Figure 6: Quantities, price, and time in the product market (refers to Figure 3)

- The price setter's task is to set the price in a random environment, such that the actual stock of products remains in the vicinity of the target stock. This can be achieved in principle through directed stochastic feedback or through deterministic tracking of the market clearing price in the previous period. These exemplary price setting rules produce inventory cycles of different magnitudes. The deterministic rule is more efficient. An efficient price setting rule should be applicable under the condition of fixed or variable employment and under an alterable income distribution.

- Concurrent with the stock of products changes the stock of money because the expenditure ratio follows, for the beginning, a symmetric random path.
- The variations of the expenditure ratio and the distributed profit ratio in combination with changes of the value of the inventory determine total profit.

The complete structural-axiomatic picture of price setting and market clearing comprises the measurable variables employment, income, distributed profit, consumption expenditures, productivity, output, sales, price, inventory, money and profit, and their interaction over time. The obsolete demand–supply–equilibrium cross is replaced by Figure 6, which is comprehensive and actually open-ended.

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