HYSTERESIS IN POST-KEYNESIAN MONETARY THEORY

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Abstract

This paper focuses on research in Post-Keynesian economics of (non)equilibrium applied to monetary policy. The authors show by an amended New Consensus model that a case they call "Lavoie's" hysteresis is substantially different from Setterfield's (1998a) conception, despite some common features. The paper claims that in spite of presence of irreversibility and short-run and long-run path-dependence in both systems, there are some fundamental differences. Drawing upon the Kaldor - Setterfield's definition of determinate outcome, the authors argue that "Lavoie's" (2008) hysteresis in the natural rate is a locally-stable-multiple-equilibria case and they regard, in reference to Setterfield's concepts of deep endogeneity and adjustment asymmetries, "Lavoie's" hysteresis a conceptualization of historical time at a lower level than Setterfield's hysteresis. This paper states that Setterfield's (2008) references to his theory of hysteresis as a general theory, of which the traditional equilibrium is just a special case, might be applied to "Lavoie's" hysteresis only on the condition that differences between "Setterfield's" and "Lavoie's" thresholds were neglected. The final conclusion is drawn by the authors that presence of "Lavoie's" hysteresis is a sufficient condition for the limited long-run money neutrality to arise.

Introduction

Post-Keynesian (PK) economics is counted among heterodox schools of modern economics which opposes the neoclassical mainstream in several areas. One of these areas and a common denominator of all the others is a theory of equilibrium. Neoclassical economics of all streams - from Keynesians to New Keynesians to Monetarists to New Classical Macro to the eclectic New Consensus in Macroeconomics - is based on a more or less amended Walras' theory of general equilibrium. This theory may be

dynamicised, extended to cover an open economy, amended to meet the conditions of an imperfect-competitive environment, its essence staying the same, though: an assumption of existence of a unique and stable equilibrium state an un-intervened economic system converges towards automatically. Such an equilibrium state has to be determined exogenously, in effect. Consequently, it cannot be affected by changes in the values of nominal variables in the long run. Davidson (1993, p. 312) makes a critical reference to this assumption as to a "fundamental neoclassical article of faith", pointing out its irrational and arbitrary feature by this. Post-Keynesian economics has been running a research program since decades which approaches the alleged long-run equilibrium values of real (supposedly exogenously determined) variables as endogenous, especially depending on the past values of these variables - which phenomenon is called hysteresis or, in a more general sense, path-dependence.

The concept of hysteresis has been applied in many fields of economics for a long time, from the labor markets (e. g. Cross; Dalby; Ireland; Piscitelli, 1998) to foreign trade theory (e. g. Göcke, 1998) to theory of a firm and aggregate supply (e. g. Göcke, 2012) to monetary theory (e. g. Kienzler; Schmid, 2013). In the last field mentioned, an application of "non-equilibrium" concepts has a crucial impact not only on the design of the monetary theory in itself but, above all, on the design of the economic-political recommendations and the monetary policy. We are about to focus on the research in the area of hysteresis, primarily in its relation to the irreversibility phenomenon, and we will demonstrate the concerning conceptual questions by means of an amended three-equation New Consensus model. Marc Lavoie (2006, 2008) applies the theory of hysteresis exactly to this sphere, however, our standpoint is that recent developments of the general theory of hysteresis as done by Setterfield in the last decade (esp. 1998a, 2008) have hade a minimum effect to applications of Lavoie. Variant stresses in the perception of the essence of the notion of hysteresis are worth noticing, in our viewpoint. It should be pointed out at this moment that the term *"Lavoie's" hysteresis* which we introduce here is not to indicate an exclusive way of perception of hysteresis by Lavoie himself. This term is just an operative instrument for us and Lavoie indicates more than clearly that *"Lavoie's" hysteresis* - as used by us - covers only one of the hysteretic concepts discussed in Lavoie (2006, 2008).

Our ambition in this paper is to show that Setterfield's hysteresis and "Lavoie's" hysteresis are substantially different systems, despite a seeming similarity. We are going to prove this by means of the concept of (ir)reversibility we were dealing with in a previous paper (Chytil, Maslo, 2014), the concept of threshold effects (Setterfield, 2008; Lavoie, 2008), the concept of a determinate outcome as defined by Kaldor (1934) - Setterfield

(1995) and, finally, by means of Setterfield's (1998a, 2008) concepts of deep endogeneity and adjustment asymmetries.

(Ir)reversibility

Setterfield (2008) distinguishes four types of systems, according to the criterion of reversibility thereof: systems of traditional equilibrium, super-reversible systems, irreversible revocable systems and irreversible irrevocable systems. The characteristic feature of a system of traditional equilibrium is that after being moved out of its equilibrium, such a system restores its equilibrium position by itself. The equilibrium of such a system is unique and stable and works as a center of gravity, in practical terms, to which the system converges automatically (this process is called persistence[1] - see Setterfield, 2008, p. 30). An example can be

$$X_n = \alpha.X_{n-1} + Z_n, \quad \text{for} \quad |\alpha| < 1 \tag{1}$$

i. e.
$$X_n = \alpha^n.X_0 + Z.\sum_{i=1}^{n} \alpha^{i-1} \tag{2}$$

where
$$\lim_{n\to\infty} X_n = Z/(1-\alpha). \tag{3}$$

Super-reversibility is a feature of unit-root hysteretic systems according to Setterfield:

$$X_n = X_{n-1} + Z_n, \tag{4}$$

or

$$X_n = X_0 + \sum_{i=1}^{n} Z_i, \tag{5}$$

where any level of an output variable X is a de facto equilibrium level, as long as this system is not affected by an exogenous shock Z. Such as system exhibits a non-unique equilibrium (locally stable multiple equilibria, LSME) (Setterfield, 1995, p. 10). After being struck with a shock of the same value as the original shock but the opposite sign, this system restores its starting position. An irreversible system does not restore its starting configuration under such conditions. For this to occur, a shock needs to be applied with the opposite sign but of a different value from that of the original shock. Obviously, such systems exhibit a certain kind of asymmetry. Nonetheless, they are still revocable since the starting configuration may be reached. What characterizes irrevocable systems (Setterfield, 1995, p. 5), though, is an absolutely specific and completely unrepeatable configuration prevailing at any moment of time, with the consequence that such a system, after being

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[1] Compare a notion of persistence in Setterfield, 1998a, p. 290 to that in Setterfield, 2008, p. 30; Katzner, 1999, p. 175; 1993, p. 331; Franz, 1990, p. 120.

shifted out of its equilibrium, cannot be restored to this equilibrium by any sequence of shock of any values whatsoever.

We were critical towards Setterfield's perception of irreversibility in our previous paper (Chytil, Maslo, 2014). Drawing upon Amable's distinguishing between two kinds of shocks (Amable, 1993, p. 128), we suggested to distinguish among what we called irreversibility of "true" hysteretic systems (symptomatic for static systems of strong and weak hysteresis with untrue indirect shocks), quasi-irreversibility (arising in dynamic systems with true indirect shocks) and direct reversibility (specific for systems which exhibit what we refer to as "Lavoie's" hysteresis).

Setterfield's Hysteresis

Setterfield (1998a) presents his own theory of hysteresis based on his concepts of deep endogeneity of parameters and adjustment asymmetries. Deep endogeneity means a current level of a parameter is not determined exogenously but it is endogenized through its functional dependence on past levels of the (output) variable in question. E. g. in a model of the natural level of unemployment (Setterfield, 2008, p. 17)

$$U_n = g\,(Z) \tag{6}$$

$$Z_t = h_t\,(U_{t-1}), \tag{7}$$

where U_n is a natural (equilibrium) level of unemployment depending on the parameter Z which stands for the willingness of agents to look for a job. This parameter Z is deep-endogenized: its current value in a given time period is functionally dependent on a current level of unemployment in the previous period. A non-zero value of the operator h which expresses the deep endogeneity of the parameter Z is referred to as a condition (a) by Setterfield:

$$(a)\ h_t\,(\ ) \neq 0. \tag{8}$$

Let us assume now that the current level of unemployment U finds itself at its natural level U_n. Following an exogenous shock the current value U gets deviated out of its equilibrium level and, in the end, U gets restored to its equilibrium level U_n - be it automatically, by virtue of a convergence process of equilibrium restoration in systems of traditional equilibrium, or after the system having beeng struck with a counter-shock. The output variable equilibrium restoration path is going to exhibit cumulative neutrality (Setterfield, 2008, p. 20):

$$DU = \sum_{t=1}^{n} dU_t = 0. \tag{9}$$

The question is whether the level of a parameter Z is the same or different after the output variable U gets back to its initial level. If the

cumulated effect of changes in the level of the output variable U on the parameter Z is zero, then Setterfield's condition (b) is satisfied:

$$(b)\, DZ = \sum_{t=1}^{n} h_{t+1}(dU_t) = 0, \qquad\qquad (10)$$

and as a consequence of the initial and final value of the parameter Z being identical, the equilibrium level U_n stays unchanged, too. In the opposite case, when the cumulated effect of changes in the level of U to the parameter Z is non-zero, Setterfield's condition (c) characterizes the system:

$$(c)\, DZ = \sum_{t=1}^{n} h_{t+1}(dU_t) \neq 0, \qquad\qquad (11)$$

so, since the final value of the parameter Z is different from its initial level, the equilibrium level U_n will be different, too. To put it in other words: before the system makes it back to its equilibrium configuration in time, this very configuration has changed down to the deep endogeneity of a parameter. In this case, the system exhibits adjustment asymmetry. The condition (b) - presence of deep endogeneity of parameters - is a necessary condition of hysteresis in Setterfield's concept and the condition (c) - deep endogeneity resulting in adjustment asymmetry - is a necessary and sufficient condition of hysteresis (Setterfield, 2008, pp. 20-23; 1998a, pp. 289-292). Setterfield explains the existence of the condition (c) by means of the existence of "threshold moments" (/"event thresholds"): as long as the output variable does not cross its threshold value, the system meets the condition (b) and the deep endogeneity (despite its presence) does not result in hysteresis. As soon as the output variable crosses its threshold value, the condition (c) gets activated which results in emergence of adjustment asymmetry and the system exhibits hysteresis. Setterfield himself regards his concept of hysteresis more general than that on which unit/zero-root hysteretic models are based. The thing is, whereas hysteresis only occurs as a special case in unit/zero-root hysteretic models - a case of the coefficient α being equal to 1 or one of the root of the characteristic equation being equal to 0 - Setterfield's hysteresis, unlike the unit/zero case, is a general model, a special case of which is the traditional equilibrium case. The last mentioned occurs when the threshold values - crossing of which activates the condition (c) - are relatively high (or low) in relation to the potential shocks to the output variable (Setterfield, 2008, pp. 23-24).

Dynamic NC Model

An amendment suggested by Setterfield (2008, pp. 23-24) to build in irreversibility is his concept of "event thresholds" or "threshold effects". This amendment can be shown by means of the dynamic NC model of Lavoie (2008, p. 7):

IS $\Delta u = - b. \Delta f$ (12)

PC....$\Delta\Pi = \gamma(u - u_n) + \varepsilon$ (13)

RF.....$\Delta f = \alpha(\Pi - \Pi^T) + \beta(u - u_n).$ (14)

Positive determinant of the matrix of coefficients and negative trace of this matrix (Lavoie, 2007, p. 7) in this model[2] implies a unique stable equilibrium[3]. Such a system has to be super-reversible by its essence since a stable equilibrium implies a temporary nature of any deviation out of it following a direct shock. A system like this shows a tendency to return to its initial configuration. As a result, any counter-shock will only have transitory effects and the system will keep returning to its pre-determined equilibrium configuration (the system exhibits persistence):

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[2] Compare to a static model of Lavoie (2006, pp. 169-170).

[3] The reason for construction of a dynamic rather than a static system is to eliminate the necessity to know the natural interest rate (as Setterfield, 2005, p. 45 points out, the problem of natural rates is not eliminated by this move, though, because it keeps existing in the natural rate of capacity utilization u_n). However, this system has an equally unique stable equilibrium as a static system. The equilibrium conditions are $(\Delta f = 0) \cap (\Delta\Pi = 0) \cap (\Delta u = 0)$. We can see in the PC equation that $\Delta\Pi = 0$ only if $u = u_n$ (unless the system affected by exogenous supply shocks). So, if $u = u_n$, then $\Delta f = 0$ only if $\Pi = \Pi^T$ (see Lavoie, 2008, pp. 7-8). The uniqueness and stability characteristics of the equilibrium are secured by an addition of the $\beta(u - u_n)$ member into the reaction function. See Setterfield, 2005 for a more detailed analysis of stability and uniqueness of equilibrium in NC models and in the PK amendments thereof.
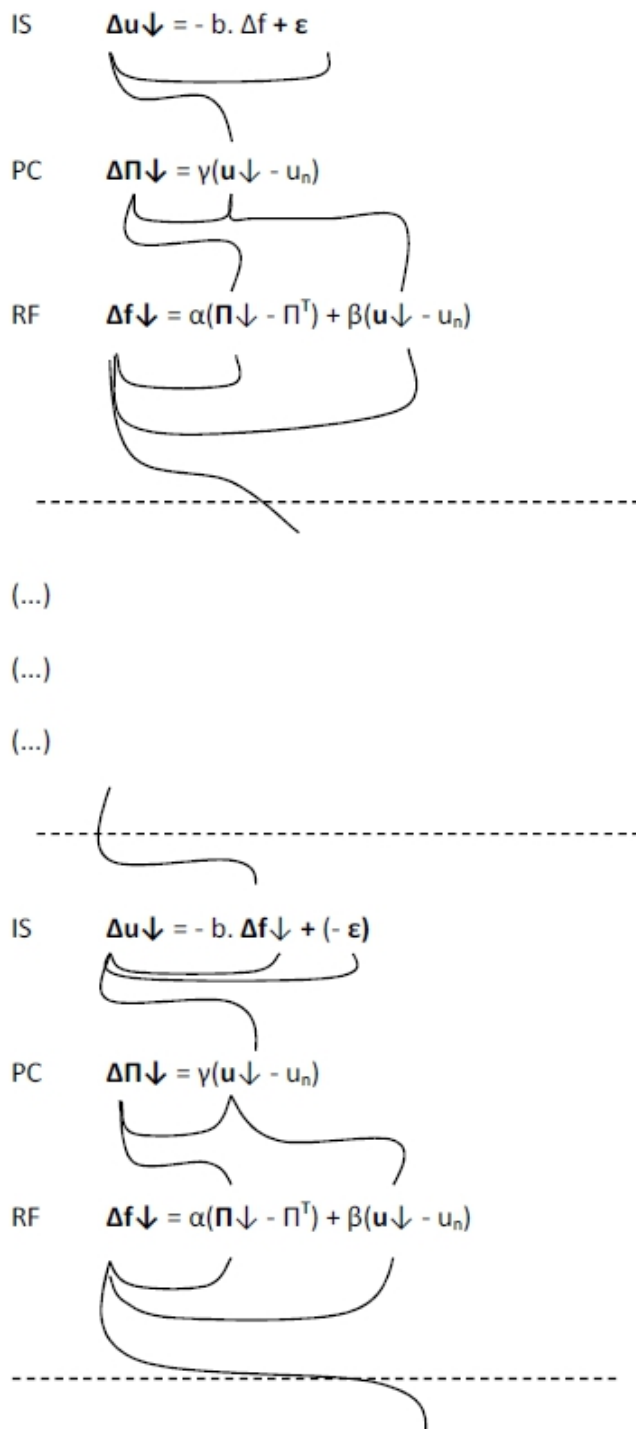
IS $\quad \Delta u\downarrow = - b. \Delta f + \varepsilon$

PC $\quad \Delta \Pi\downarrow = \gamma(u\downarrow - u_n)$

RF $\quad \Delta f\downarrow = \alpha(\Pi\downarrow - \Pi^T) + \beta(u\downarrow - u_n)$

(...)

(...)

(...)

IS $\quad \Delta u\downarrow = - b. \Delta f\downarrow + (- \varepsilon)$

PC $\quad \Delta \Pi\downarrow = \gamma(u\downarrow - u_n)$

RF $\quad \Delta f\downarrow = \alpha(\Pi\downarrow - \Pi^T) + \beta(u\downarrow - u_n)$

Fig. 1. Causal sequence in a dynamic NC model affected by a direct shock and a counter-shock *(source: own)*

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For the given values of parameters and constants:

parameters	
α	0,5
γ	0,5
b	0,5
ε	0,04
− ε	-0,04
β	0,5
constants	
Π^T	0,04
un	0,06

Table 1. Parameters and constants of a dynamic NC model

we can observe behavior of such a system affected by a sequence of a direct shock and a counter-shock in time diagrams:
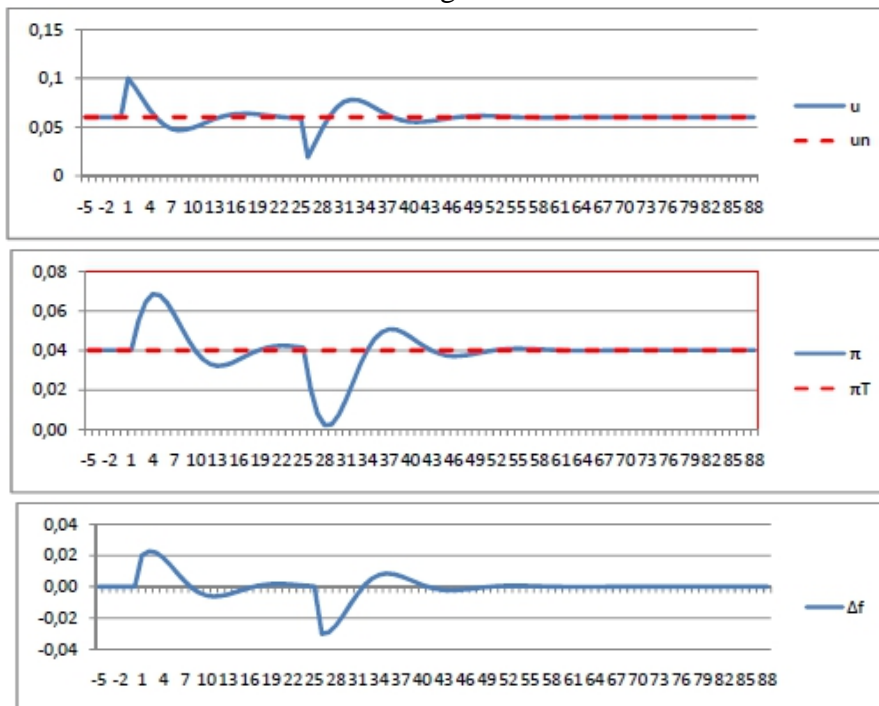

Fig. 2, 3, 4. Time Diagrams of a dynamic NC model affected by a temporary direct shock ε (period 1) and a counter-shock (-ε) (period 25) and exhibiting super-reversibility *(source: own)*

As already mentioned, this system is super-reversible. The output variable u, after it is affected by a direct shock, returns automatically to its

long-run equilibrium u_n and a direct counter-shock in a later period, of the same value and opposite sign to the previous shock, only leads to a short-run persistence but does not affect the equilibrium itself.

 "Lavoie's" Hysteresis

Lavoie (2008) proposes four amendments by means of which path-dependence can be built in to NC models of traditional equilibrium. One of these amendments is the so called "horizontal segment" of a Phillips curve which can be described as follows (Lavoie, 2008, p. 9):

$$IS........ \Delta u = - b. \Delta f + \varepsilon_1 \qquad\qquad (15)$$

$$PC...... \Delta\Pi = \gamma(u - u_n) + \varepsilon_2 \quad \text{for} \quad u > u_{nh} \quad \text{or} \quad u < u_{nl} \qquad (16)$$

$$\Delta\Pi = \varepsilon_2 \qquad\qquad \text{for} \quad u_{nl} < u < u_{nh} \qquad (17)$$

$$RF....... \Delta f = \alpha(\Pi - \Pi^T) + \beta(u - u_n). \qquad\qquad (14)$$

It is obvious that this flat segment of a PC is nothing else but a practical implementation of Setterfield's "threshold effects". What is most interesting from our perspective is less the path-dependent characteristic of the natural rate of capacity utilization resulting from such an amendment than its irreversibility. The point is a creation of a strip the upper border of which is presented by a higher value and the lower border of which is presented by a lower value than natural value estimated by the central bank. A supply shock is always reflected by the inflation rate and, as a consequence, by the interest rate and unemployment rate. The situation is different in case of a demand shock. For a demand shock to have any effect to the inflation rate, the value of this shock must cross the upper threshold (in case of a positive demand shock) or the lower threshold (in case of a negative demand shock). If a demand shock does not cross the respective threshold, the effect to the inflation rate is none, i. e. the economy finds itself on the flat PC segment[4]. For the given values of parameters and constants

parameters	
ε_1 (temp.)	0,025
ε_2	0
u_{nl}	0,04
u_{nh}	0,09
α	0,45
β	0,55
γ	0,45
b	0,5
constants	
π^T	0,04
u_n	0,075

Table 2. Parameters and Constants in a dynamic NC model with a horizontal PC segment

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[4] For example, if modeled in Excel, a conditional function "if - then" can be applied.

the behavior of the system following a one-off demand shock is following:
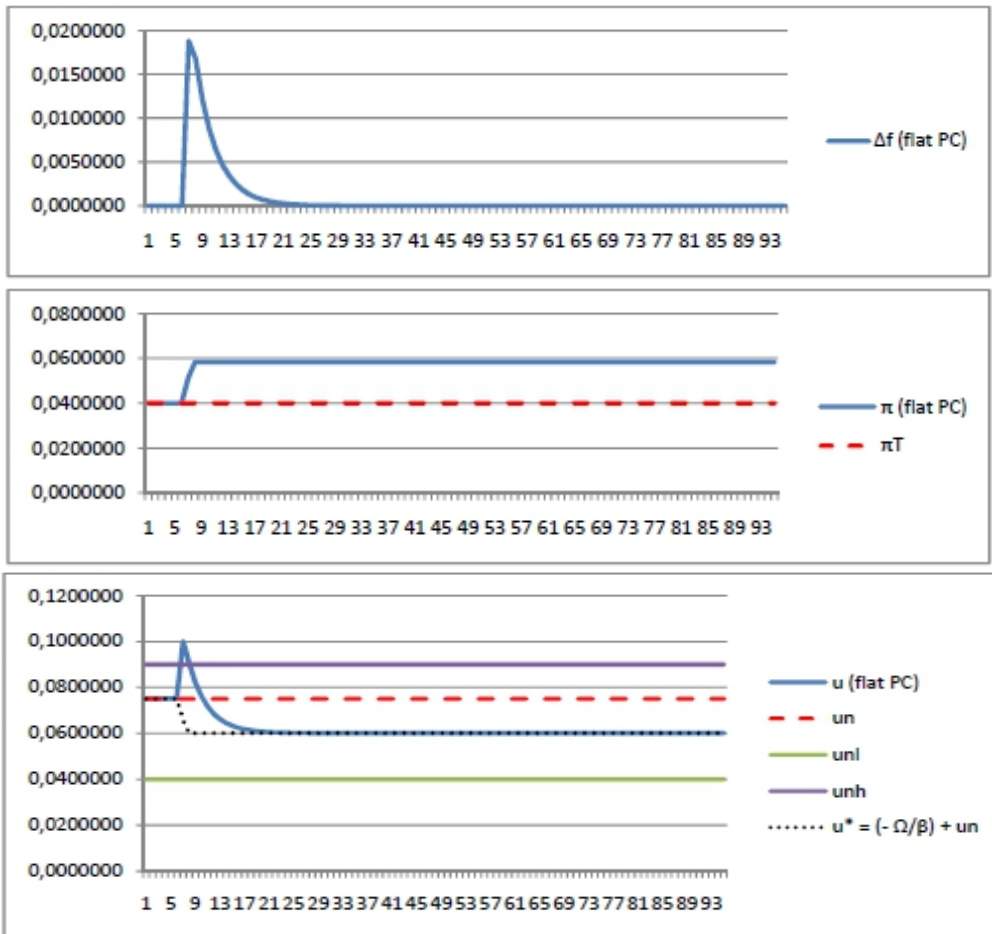

Fig. 5, 6, 7. Time diagrams of a dynamic NC model with a horizontal PC segment affected by a temporary demand shock (period 7) *(source: own)*

Let us find the long-run equilibrium rate u*. Since it must hold true in the state of long-run equilibrium that

$$(\Delta f = 0) \cap (\Delta \Pi = 0) \cap (\Delta u = 0),$$

the following needs to hold true, as well:

$$\alpha(\Pi - \Pi^T) + \beta(u^* - u_n) = 0 \qquad (18)$$

$$(u^* - u_n) = - \alpha(\Pi - \Pi^T) / \beta \qquad (19)$$

$$u^* = u_n - \alpha(\Pi - \Pi^T) / \beta. \qquad (20)$$

In the end, a current value of the rate of capacity utilization will be adjusted to equal the path-dependent long-run equilibrium rate u*. As we can see, the initial demand shock in the value +0,025 crosses the upper threshold value which can be found in the distance of +0,015 from the estimated natural rate u_n. However, successive processes are unfolding in the limits set by the upper and lower limits, respectively, and so the demand gap does not

affect the inflation rate in any way any more and the economy finds is situated on the flat PC segment.[5]

At this moment, let us examine whether this system is reversible or not. In a certain period after the initial demand shock, let the system be struck by a counter-shock with the same value but the opposite sign. May the parameters and constants remain unchanged:
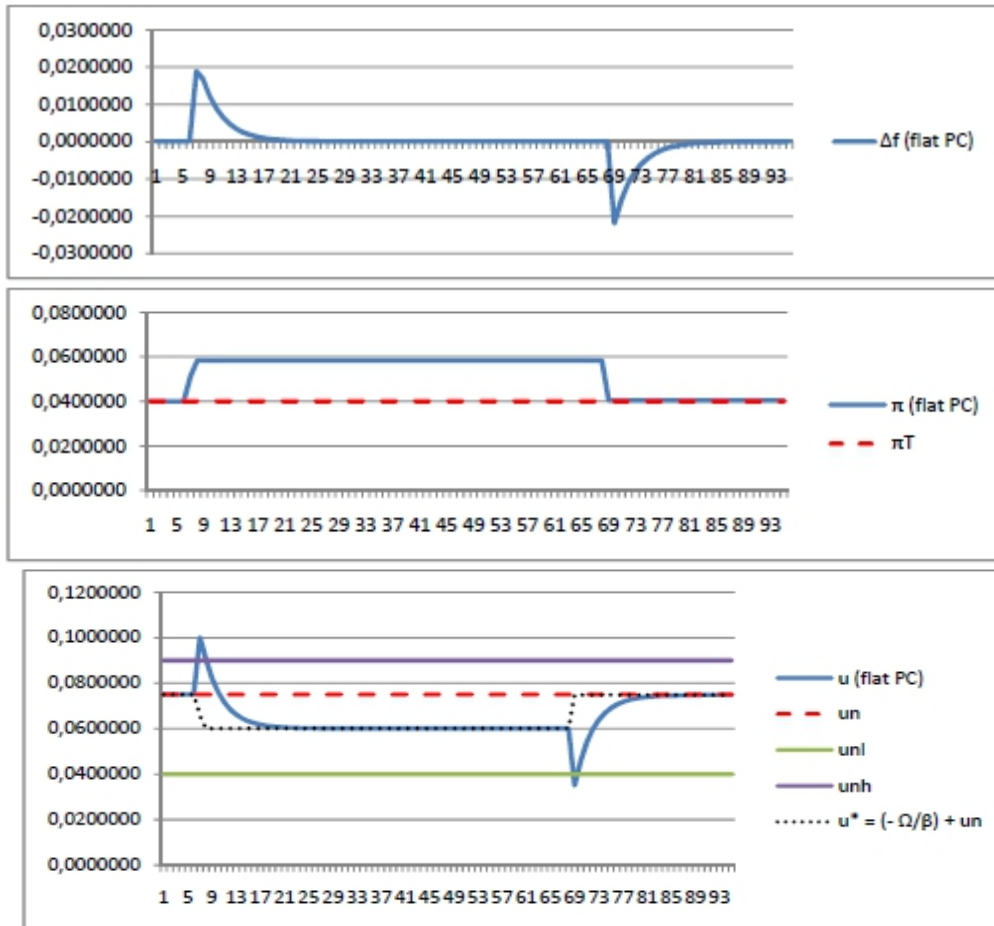

Fig. 8, 9, 10. Time diagrams of a dynamic NC model with a horizontal PC segment which exhibits super-reversibility as a special case when affected by a sequence of a temporary demand shock (period 7) and a subsequent counter-shock (period 69) *(source: own)*

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[5] As long as the capacity utilization rate keeps crossing its respective thresholds, the system behaves as a traditional-equilibrist system until the moment when the capacity utilization u stops crossing the threshold values – at that moment, the PC equation drops out of the system, the inflation rate stops changing and stays at the level at which it was when the PC equation dropped out. Only the capacity utilization and interest rate will undergo changes since that moment, with the inflation rate fixed. Obviously, the equilibrium level of u depends on the precise level of inflation rate at which the PC equation dropped out: $\Delta f = \alpha(\Pi - \Pi^T) + \beta(u - u_n)$, where $\Delta f = 0$ in equilibrium, and so $\alpha(\Pi^{fixed} - \Pi^T) + \beta(u - u_n) = 0$.

We can see this system exhibits super-reversibility because the counter-shock restores the initial configuration and the system does not show path-dependence in the short-run equilibrium. Might this be a mere coincidence? Is this model super-reversible under all circumstances? Let us try keeping the estimated value of the natural rate unchanged but let us change the position of the lower threshold: may it be $u_{nl} = 0,05$. Then:
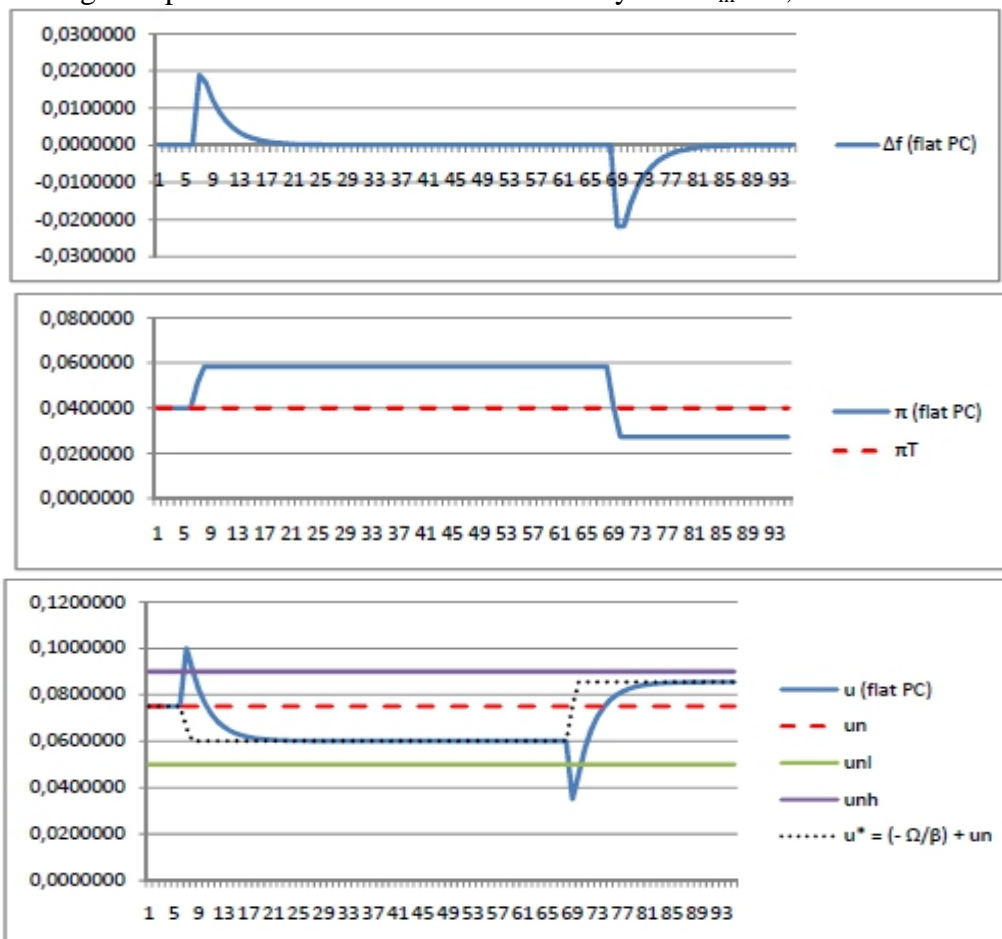

Fig. 11, 12, 13. Time diagrams of a dynamic NC model with a horizontal PC segment which exhibits irreversibility as a general case when affected by a sequence of a temporary demand shock (period 7) and a subsequent counter-shock (period 69) *(source: own)*

Notice that "Lavoie's" hysteresis implies limited[6] money non-neutrality in the long-run as a consequence of irreversibility and both the

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[6] By this we mean that not every demand shock will cause a permanent change in the long-run equilibrium capacity utilization rate. A flat PC segment implies a long-run money neutrality as long as the changes in capacity utilization rate do not cross the lower or upper threshold. At the same time, a flat PC segment implies a long-run money non-neutrality as soon as the capacity utilization rate crosses its respective thresholds. So, monetary

short-run and long-run path-dependence. The limitation results from the exact positions of the upper and lower thresholds, respectively. Within these limits, though, the current rate of unemployment can find itself above or below its natural level in the long run - or, more precisely, above or below the value of this level estimated by the central bank. The shift in the lower threshold has resulted in irreversibility, as obvious. Consequently, we can state an apparent dependence of system reversibility or irreversibility on the precise configuration of the positions of thresholds, the estimated natural rate and the values of the shocks. Following shocks sufficiently small, the system will not cross the limits set by the upper and lower thresholds, respectively, and it is going to behave as a classic system of traditional equilibrium. Or, to put it in other words, a system of traditional equilibrium is just a special case of a general model with threshold effects characterized by the values of the upper and/or lower threshold being set "sufficiently" far away with respect to potential shocks.[7]

"Lavoie's" Thresholds and "Setterfield's" Thresholds: Outcome Determinateness

Setterfield himself says on relatedness of the threshold effects to path-dependence: "[A]bsent condition (a), there is no possibility whatsoever of condition (c) – i.e., the event thresholds discussed above simply would not exist." (Setterfield, 2008, p. 26). This seems to contradict the above said, though, as there is no deep endogeneity present with any parameter in the flat PC model just examined which excludes the condition (a), by definition. According to Setterfield, though, this just implies non-existence of threshold effects. However, the presence of threshold effects in the examined model is evident (Lavoie refers to them as "limits" - see Lavoie, 2008, p. 9). What then? It is a terminological issue, of course. Setterfields grasps the notion of a threshold effect in the framework of his theory of hysteresis, i. e. in the framework of the concepts of deep endogeneity, adjustment asymmetries and long-run path-dependence. Even though "Lavoie's" threshold effects are accompanied by the emergence of path-dependence in the short-run and long-run value of the output variable and even the irreversibility of the system, the endogeneity of parameters is not present here - unlike "Setterfield's" threshold effects related to Setterfield's hysteresis and his condition (a). After all, it is Setterfield alone who indicates that our distinction between "Lavoie's" thresholds and "Setterfield's" thresholds is

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expansion which brings about a sufficiently big demand shock will result in a long-run money non-neutrality, but if this expansion does not cause a sufficiently intensive demand shock, its result will be a long-run money non-neutrality. So, long-run monetary non-neutrality resulting from a flat PC segment is only limited.

[7] Which is a conclusion similar to that made by Setterfield (2008, pp. 23-24).

more than just some unnecessary terminological hair-splitting. The thing is, from our viewpoint, this distinction is a key to understand the difference between Setterfield's hysteresis and the multiple-equilibria case, the "selection - creation" problem (Setterfield, 1995, p. 10). Setterfield says on this: "This local stability means that systems with multiple equilibria display a form of path dependence, in the sense that initial conditions matter in the determination of long-run outcomes. [...] What this draws to our attention, however, is that initial conditions simply determine which of a number of otherwise pre-determined final positions the system will converge towards. [...] With hysteresis, then, whilst definite final outcomes - such as equilibria - are possible, it may only be within our powers to identify these outcomes *ex post*, after they have actually been established. They need not exist *ex ante*, independently of the actual history of adjustments in the system to which they pertain, as multiple equilibria are commonly supposed to." (Setterfield, 1998a, pp. 293-294). An equilibrium which is a priori deducible from exogenous data is referred to by Kaldor as a determinate equilibrium: "though equilibrium may still be determinate on our definition of the term, since all the possible equilibrium positions may still be deduced from the date of the initial situation." (Kaldor, 1934, pp. 131-132). This definition of determinateness is taken from Kaldor by Setterfield (1998, p. 537). In this sense, systems exhibiting path-dependence of their equilibria which are deducible from initial data are systems of locally stable multiple equilibria (LSME). Setterfield (1995, p. 10) puts these systems in opposition to indeterminate systems. So, LSME present systems with determinate equilibria. As we can see in the time diagrams of the system with a flat PC segment, even though the position of the long-run equilibrium rate of capacity utilization depends on the precise position of the thresholds, on the value of the natural rate of the capacity utilization estimated by the central bank and on the values of shocks, as soon as these factors are known, the value of the long-run equilibrium rate of capacity utilization can be computed according to the formula

$$u* = u_n - \alpha(\Pi - \Pi^T) / \beta. \tag{20}$$

Obviously, this form of a model with a flat PC segment presents a LSME case, not Setterfield's hysteresis the outcomes of which are characterized by indeterminateness. Discussing the issues of determinism, a question could be brought up to what extent a model would meet the criteria of Setterfield's hysteresis which satisfies the condition (a) and condition (c) - i. e. a model incorporating threshold effects and deep endogeneity of parameters - where the precise functional form of deep endogeneity would be known to us and, as a result, we would be able to express the long-run equilibrium outcome ex ante (under the assumption it exists). Setterfield says on this: "If so, then a `meta-theory' of hysteretic change could be formulated

which, in a non-stochastic environment, would make the long-run outcomes associated with hysteresis perfectly predictable, given only the initial conditions of the system. In this case, an analogy between systems with multiple equilibria and the model of hysteresis developed above [i. e. the model satisfying the conditions (a) and (c), Z.C., L.M.] might ultimately be apposite. However, it is not clear that these conditions need always apply." (Setterfield, 1998a, p. 294). "Dynamic determinism dilemma" - as we may refer to characteristics of a model which, on the one hand, is perfectly deterministic formally but which, on the other hand, incorporates path-dependence or even irreversibility, and so it cannot be counted among systems of traditional equilibrium of the neoclassical mainstream - is dealt with by Setterfield with a substantially lower degree of scrutiny in different places where Setterfield resorts to the concept of twofold level of historical time (Setterfield, 1997, p. 60; 1996, p. 143; 1995, p. 24). A higher level (philosophical level) of historical time captures all attributes of historical time in a full scale (irrevocability, ex ante undeducibility of future values of output variables, path-dependent long-run values of output variables, deep endogeneity and adjustment asymmetries according to ex ante unknown functional forms). A lower level (model level) of historical time neglects some attributes of the higher level to enable us to carry out modeling of the complex reality. Along this line, Setterfield might refer to his concept of hysteresis as hysteresis "at a lower level of conceptualization of historical time". In any case, the above examined model with a flat PC segment is missing one significant attribute of historical time, even at a lower level at conceptualization thereof, and this attribute is deep endogeneity (and adjustment asymmetries). Consequently, we need to exclude the presence of Setterfield's hysteresis from this model, even though it exhibits irreversibility and path-dependence in both the short-run and long-run equilibrium value of the output variable. On the other hand, we may state that with respect to presence of irreversibility this model of Lavoie captures the historical time in a substantially better way than a dynamic NC model of a traditional equilibrium which only exhibits 1) persistence and 2) super-reversibility following a temporary demand shock.

Conclusion

We have pointed out the existence of a type of hysteresis we refer to as "Lavoie's" hysteresis. It is a system which escapes the traditional-equilibrium pattern of neoclassical economics and it can be counted among path-dependent systems examined by post-keynesian economics. Above all, we have discovered the substantial difference between "Lavoie's" hysteresis and Setterfield's hysteresis. Drawing upon our previous paper (Chytil, Maslo, 2014) and Amable's (1993) distinction between two kinds of shocks,

we state irreversibility in both models of hysteresis: direct irreversibility in case of "Lavoie's" hysteresis and irreversibility of Setterfield's hysteresis in case of Setterfield's hysteresis. Even though both types of hysteresis arise as a consequence of threshold effects in an output variable (direct threshold effects), the nature of the threshold effects is fundamentally different in both cases, though. While crossing the threshold value ("Lavoie's" thresholds) does not cause a change in the value of a parameter in "Lavoie's" hysteresis (Lavoie, 2008) and so the necessary condition of Setterfield's hysteresis is not satisfied, crossing the threshold value ("Setterfield's thresholds) in Setterfield's hysteresis (Setterfield, 1998a; 2008) results not only in a change in the value of a parameter (deep endogeneity) but a cumulative non-neutrality in the effect of a change in the values of the output variables to the parameter and, via this, to the equilibrium value of the output variable (adjustment asymmetry). We have demonstrated the irreversible characteristics of Lavoie's model with a flat PC segment affected by a temporary demand shock. We base our conclusions about the substantial differences between "Lavoie's" hysteresis and Setterfield's hysteresis on 1) the definition by Kaldor (1934) - Setterfield (1995) of a determinate outcome as a priori deducible from exogenous data which implies unambiguously that "Lavoie's" hysteresis presents a locally-stable multiple equilibria case (LSME); 2) the fact that "Lavoie's" hysteresis does not meet either Setterfield's condition (a), or, by definition, his condition (c). We draw the conclusion that Setterfield's (2008) view of his own theory of hysteresis as a general one of which the traditional equilibrium is just a special case can be extended to "Lavoie's" hysteresis only to that extent that - and as long as - we ignore the crucial differences between "Setterfield's" thresholds and "Lavoie's" thresholds. Down to the absenting deep endogeneity and adjustment asymmetries, "Lavoie's" hysteresis is a less perfect conceptualization of historical time as compared to Setterfield's hysteresis. Nevertheless, with regard to the irreversibility and both the short-run and long-run path-dependence present in "Lavoie's" hysteresis, this is still a better conceptualization of historical time than that provided by a model of traditional equilibrium which only exhibits persistence and super-reversibility. Presence of "Lavoie's" hysteresis is thus sufficient to incorporate a limited long-run monetary non-neutrality.

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