Originator of Macroeconomic Hydraulics

** Arup Kanti Konar*

Abstract

Macroeconomic hydraulics or hydraulic macroeconomic model is still being constructed and reconstructed in order to satisfy different purposes. The intensity of such construction and reconstruction was spectacular after the publication of *The General Theory* (1936) by John Maynard Keynes. Owing to its "revolutionary nature," *The General Theory* has converted "Keynes" into "Keynesian revolution" and "Keynesianism". The diverse versions of Keynesianism have been classified by Coddington (1976, 1983) into the three categories: (a) Hydraulic Keynesianism, (b) Fundamentalist Keynesianism, and (c) Reconstituted Reductionism (or Disequilibrium Keynesianism). By analogy of "hydraulic Keynesians," Phillips (1950) constructed hydraulic macroeconomic model, and later on, with the collaboration of Newlyn, Phillips also constructed the Newlyn-Phillips real hydraulic machine. But the question is – who is the originator of the hydraulic macroeconomic model? Some literatures indicate that an American economist Irving Fisher was the inventor of hydraulic macroeconomic model. The present paper sheds light on this area.

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According to the American Nobel laureate (1982) economist George J. Stigler, originality has the temporal priority in the statement of an idea. Originators usually discover their leading ideas rather than excavate them from literature. This is an interesting problem, but it makes no difference whether the new ideas come from present originality or past originality. Originality should be measured against the knowledge of one's contemporaries. If one opens our eyes to new ideas, new perspectives on old ideas, or new errors/inconsistencies, she/he is an originator. Originality means difference, not improvement, and one may invent new errors as well as new truths (Stigler, 1955).

The construction and reconstruction of hydraulic macroeconomic model(s) still proliferates (e.g. Kyer & Maggs, 2011). Such proliferation became intensive after the publication of *The General Theory of Employment, Interest and Money* (by Keynes, 1936), who was the product and pride of the Cambridge University. For the sake of convenience, many economists prefer to substitute only the short title *The General Theory* (GT) for the long title *The General Theory of Employment, Interest and Money*.

The GT is revolutionary from the three perspectives. Firstly, the GT arose out of the context of reducing or ruling out the worldwide deplorable depression in the 1930s. Secondly, the GT is a denial and devoid of, and departure from the de-contextual macroeconomic literature introduced by the pre-Keynesian school(s) of macroeconomic thought. Thirdly, the GT has brought about a "reinterpretive or reconstructive revolution" in the sense that the GT induced, inspired, and/or influenced many economists to undertake the "interpretation, reinterpretation and/or misinterpretation of the GT". That is why, in 1992, the *Economic Journal* said of its former editor, "The Keynes industry….is now surely running a close second to the output of the Marx industry" (McInnes, 1994, p.1), while the *Journal of Post Keynesian Economics* declared that "Each year seems to bring

**Associate Professor of Economics,* Achhruram Memorial College, Sidho-Kanho-Birsha University, Jhalda, Purulia, West Bengal -723 202. E-mail: akkonar@gmail.com

forth yet another 'new interpretation' of Keynes" (McInnes, 1994, p. 1). Similarly, O'Donnell (1991) remarked that "The excessive proliferation of interpretations of Keynes's (philosophical) thought is a matter of concern" (p. 48). Moreover, Wolff (2009) argued that "Of course, different interpretations of Keynes (as of Marx) have always contested with one another" (p.1).

Thus, since its publication on February 4, 1936, there is no end of proliferation of "interpretation, reinterpretation, and/or misinterpretation of the GT," which can be substituted with, or reduced to the "reconstruction of the GT". Hence, since its publication in 1936, the GT has acquired the "endless free play" of its "multitude of reconstructions". The phenomenon of exponential growth of reconstruction of the GT over time may be sufficient to arrive at the following three similar propositions:

(1) The GT has become the fable of the blind men touching the elephant.

(2) The GT has proved to be a snake-like concept, whose twists and coils are difficult to pin down.

(3) The GT can be likened to the skin of a living organism, which is metamorphic.

Thus, Skidelsky (1992) rightly argued that *The General Theory* is no one's property. Keynes's anti-fundamentalism attitude, which influenced, inspired, or induced many economists to reconstruct the GT by their own desire, discretion, or direction to adapt to the different contexts or the changing context, was reflected in the remark of Paul A. Samuelson: "We don't want unreconstructed Keynesians. We want people, who will carry the scientific analysis further" (Backhouse & Bateman, 2010, p.17). Similarly, Skidelsky (2011) suggested that "We do not need a new Keynes. We do need the old Keynes, suitably updated. He will not be our sole guide to the economic future, but he remains an indispensable guide" (p. 13). Most importantly, the frequency of reconstruction of the GT has assumed such a figure that Weintraub (1979) designed or designated a chapter, entitled, "The 4,827th Reexamination of Keynes's System!"

All the varied reconstructions of the GT are being termed as "Keynesianisms," while all the reconstructors of the GT are being designated as "Keynesians". Needless to note, Keynesianism is synonymous with Keynesonomics, Keynesiology, Keynesian macroeconomics, and Keynesian macroeconomic model. Owing to its "revolutionary nature," the GT has converted "Keynes" into "Keynesianism" as well as "Keynesian revolution". "Keynesianism" is such an important "ism," by which the macroeconomic schools of thought have been categorized into pre-Keynesianism, post-Keynesianism, neo-Keynesianism, new-Keynesianism, and so forth.

Although it can be discovered that the 4,827th reconstruction of the GT was executed by Weintraub (1979), yet we must confront with much toil and trouble to assert who executed the *nth* (where $n = 1, 2, 3, 4, 5, 6, \ldots\ldots\ldots$) reconstruction of the GT. In order to tackle such a difficult problem, the English economist Alan Coddington suggested a classification of the "endless chain of reconstruction of the GT" into the following three broad variants (Coddington, 1976, 1983):

(1) Hydraulic Keynesianism (HK), which consists of two Keynesian macroeconomic models: (a) simple Keynesian model and (b) IS-LM Keynesian Model, devised by Hicks (1937), Meade (1937), Samuelson (1939a, 1939b, 1946, 1947, 1948), Lerner (1944), Lange (1944), Modigliani (1944a, 1944b), Harrod (1937), Klein (1944, 1947), Hansen (1936a, 1936b, 1938, 1941, 1947, 1949, 1951, 1953), Smith (1956), and so forth.

(2) Fundamentalist Keynesianism (FK), developed by Robinson (1962a, 1962b), Shackle (1967, 1974), Davidson (1978, 1994), and so forth.

(3) Reconstituted Reductionism (RR) or Disequilibrium Keynesianism (DK), designed by Patinkin (1948, 1956), Clower (1965), Leijonhufvud (1968), Barro and Grossman (1971), Malinvaud (1977), and so forth.

Each of the three "Keynesianisms" includes many analogous or homologous Keynesian macroeconomic models. It is noteworthy that Coddington (1976, 1983) was the originator of the foregoing categorization, but not the originator of any Keynesian macroeconomic model, which can be included in any one of the foregoing three Keynesianisms. Moreover, it needs reiteration that Coddington (1976, 1983) was neither the originator of the term "hydraulic," nor the originator of "hydraulic macroeconomic model". Hence, we can/should ask: Who is the originator of the hydraulic macroeconomic model? This question can be answered just after the next paragraph.

By analogy of hydraulic Keynesians, Alban William Housego (Bill) Phillips drew the "little plumbing diagram" to help him to understand how the stocks and flows of a commodity interacted in a market (Phillips, 1950). The little hydraulic diagram of Phillips (1950) is designed to work according to the hydraulics pictured, but is simultaneously subject to the rules of reasoning from the economic content enshrined in the arrangements of the parts: where demand and supply, and price and quantity can be changed in particular ordered ways. Moreover, with the collaboration of the monetary economist Walter Newlyn, such "little plumbing diagram" grew into a "large physical hydraulic machine of the economic system as whole" (Morgan & Boumans, 2004). The Newlyn-Phillips Machine is a big apparatus – "a real hydraulic model" – of which we can see only a "drawing in a two-dimensional diagram". The physical model itself operates according to the language rules of hydraulics with the flow of water flowing around the machine controlled by physical valves. But the overall form and parts of the machine were designed to imitate the stocks and flows of money (red water) around an economy, and the behavioural functions of the economic relations are drawn into the small rectangular "slides," which can be seen on the drawing. These, in their turn, control the opening and closing of the valves in the hydraulic system. Despite its complexity, and even without knowing what these economic relations are, we can see how the "rules of form" (hydraulics) and "content" (macroeconomics) are instantiated in the hydraulic machine (Morgan, 2009). More specifically, Phillips (1950) devised a "hydraulic system" with pipes and tanks, which was meant to put in concrete form the relations between macroeconomic stocks, flows, and price level (Beaud & Dostaler, 2005).

In response to the question of the originator of the hydraulic macroeconomic model, it is worthy to recall that: "No scientific discovery is named after its original discoverer" (Stigler, 1999). Stephen M. Stigler's (1999) remark holds true for an American economist, Irving Fisher, who not only coined the term "hydraulic," but also invented "hydraulic macroeconomic models," which will be evident from the following six literatures:

(1) Dimand and Betancourt (2012) claimed that Fisher (1892) not only imagined, but also actually built a "hydraulic mechanism" to simulate the determination of equilibrium prices and quantities - in effect, a "hydraulic computer" in the days before "electronic computers".

(2) Brainard and Scarf (2005) took on the task of investigating how the "model of Fisher's hydraulic computer" worked in "How to compute equilibrium prices in 1891". They reprinted the sketches of Fisher's "hydraulic computer" from his dissertation of 1891. It apparently consists of a series of cisterns, rods, floats, bellows, tubes, levels, valves, levers, cams, and so forth. It represents three consumers and three commodities that they consume. "How to compute equilibrium prices in 1891" by W. C. Brainard and H. E. Scarf examines Fisher's exposition of general equilibrium by the "hydraulic model" through MATLAB. Fisher articulated the limitations of static analysis and the necessity of dynamic analysis in the appendix of his *Mathematical Investigations in the Theory of Value and Prices* (1892).

(3) According to Morgan (2009), Irving Fisher (1892/1925), in his *Mathematical Investigations in the Theory of Value and Prices*, designed and constructed a "hydraulic macroeconomic model" to represent, explore, and so understand the workings of a "mini-economy," one with only three commodities, three persons, and three equations. He built his "hydraulic macroeconomic model" in the name of "hydraulic mini-economy model" to represent the ideas embedded in the *Elements of Pure Economics* (Walras, 1874/1954) of the French economist

Marie Esprit Leon Walras, and to figure out by exploring with his model the process, by which the latter's mathematically postulated and proved general equilibrium might be arrived at. He accompanied this work with an outright defense of the three research objects: (a) mathematics, (b) graphs, and (c) real machines that he designed and used for his economic analysis. Fisher's thesis of 1891 was published in 1892 and republished in 1925, displaying a photograph of the mechanism in the frontispiece labeled "model of mechanism". The fact that he used mathematical ideas from "physical systems" demonstrates not only the closeness of mathematics and sciences, but also shows how treacherous relying on analogies as indicators of reasoning style can be.

(4) Morgan (1999) also pointed out that in choosing a "mechanical balance as a model" for the "equation of exchange" between money and commodities, Fisher (1911), in *The Purchasing Power of Money*, recognized the similarity between the "mechanical balance" and the "economic subject matter" in his arithmetic "equation of exchange". Here also, the "hydraulic macroeconomic model" was congealed and concealed in Fisher's (1911) text.

(5) Francis Ysidro Edgeworth invited Fisher to apply a simplified version of his hydraulic macroeconomic model to *The Mechanics of Bimetallism* (Edgeworth, 1894) to the Economics Section of the British Association for the Advancement of Science and then publication in the *Economic Journal* (September, 1894), which Edgeworth edited (as cited in Dimand & Betancourt, 2012).

(6) More recently, in an article by Dimand and Ben-El-Mechaiekh (2012), it was clearly claimed that the hydraulic macroeconomic model is embedded in Fisher's *Mathematical Investigations in the Theory of Value and Prices* (1891).

Thus, Coddington (1976, 1983) may be assumed to borrow the term "hydraulic Keynesianism" from the "hydraulic macroeconomic model" of Fisher (1892, 1911) or Phillips (1950). This commemorative article will be incomplete if we do not consider how Irving Fisher has/had been eulogized for his contribution to the diverse spheres in economics and statistics. Such eulogies can be summarized by the following eight points:

(1) DeLong (2000) said that the story of 20th century macroeconomics began with Irving Fisher.

(2) Paul A. Samuelson described Fisher (1892) as the "greatest doctoral dissertation in economics ever written" (Dimand & Betancourt, 2012).

(3) Tobin (2008) described Fisher as the greatest economist America has produced.

(4) J. A. Schumpeter labeled Fisher as the greatest theoretical economist of America (Doc. Ing. Jan Isa, 2002).

(5) Fisher was the first to receive at Yale University in 1891 a Ph. D in pure economics, albeit at the Faculty of Mathematics (Doc. Ing. Jan Isa, 2002).

(6) Kei (2006) argued that Fisher was the first American academic economist who was trained in professional mathematics and put statistical methods and data to practical use.

(7) Fisher was an inveterate crusader on anything and everything (Tobin, 2008).

(8) Fisher's (1926) article "A Statistical Relationship between Unemployment and Price Level Changes," little noticed when first published by the International Labour Office, attracted rather more attention when reprinted almost 50 years later in the *Journal of Political Economy* as "Lost and Found: I Discovered the Phillips Curve – Irving Fisher" (Dimand & Betancourt, 2012).

An impression persists that Phillips (1950) was the inventor of the hydraulic macroeconomic model. But such impression is erroneous because he was a sociology undergraduate at that time. Although unfortunately, Fisher's hydraulic-mechanical analogue model has been lost, fortunately, Phillips's machine or moniac has survived, one model of which is displayed next to a display about Babbage in the Science Museum in London. Though Fisher, like Keynes, did not create a distinctive economic school of thought, he was the original inventor of many theoretical tools in economics.

By any criterion, Fisherian hydraulic macroeconomic models can be treated as the predecessor of hydraulic Keynesian macroeconomic models or hydraulic Keynesianisms. In better words, Fisherian hydraulic macroeconomic models induced some economists to construct/reconstruct different hydraulic macroeconomic models to satisfy different purposes. Up till now, there are three versions of hydraulic macroeconomic models such as : (a) Fisherian hydraulic macroeconomic models, (b) Keynesian hydraulic macroeconomic models, and (c) non-Fisherian-non-Keynesian hydraulic macroeconomic models.

Since the 1970s, which is referred to as the *Decade of Environment*, some economists such as (a) Young (1975), (b) Daly (1991), (c) Girma (1992), (d) Thampapillai (1995), (e) Thampapillai and Uhlin (1996), (f) Thampapillai and Uhlin (1997), (g) Ahmed and Mallick (1997), (h) Heyes (2000), (i) Mallick, Sinden, and Thampapillai (2000), (j) Munasinghe (2002), (k) Lawn (2003a), (l) Lawn (2003b), (m) Lawn (2003c), (n) Daly and Farley (2004), (o) Sim (2006), (p) Morales (2007), (q) Thampapillai, Wu, and Sunderaj (2007), (r) Emmanuel (2008), (s) Victor (2008), (t) Harris (2009), (u) Custers (2010), (v) Konar (2010), and (w) Konar (2014) reconstructed hydraulic Keynesian macroeconomic models or hydraulic Keynesianisms to realize/restore the different dimensions of "sustainability" (e.g. ecological sustainability, social sustainability, and so forth) in order to contribute to "macroeconomics of sustainability" despite the fact that such hydraulic Keynesian macroeconomic models or hydraulic Keynesianisms suffer from the "lurking inconsistencies" coined by Alfred North Whitehead in *Science and the Modern World* (1925, p. 76).

In the inchoate "sustainability revolution" (Edwards, 2005), backed up by "ecological revolution" (Foster, 2009), which started its effective life since the worldwide enthusiastic celebration of the First Earth Day on April 22, 1970, this article seeks to inspire/induce the potential/prospective researchers to reconstruct the hydraulic macroeconomic models (Fisherian, Keynesian, and/or non-Fisherian-non-Keynesian) to realize/restore the "sustainability" of the "tiny little islet of life amid the boundless ocean of lifelessness" (Rebrov, 1989). Hence, it is pertinent to point out that the students and practitioners of economics discipline should be acquainted with the originator of hydraulic macroeconomic models. This does not imply that the contextually constructed/reconstructed non- hydraulic macroeconomic models will be inadequate to realize/restore sustainability, since "we live in a world of model," where "The world [is] in the model" (Morgan, 2009).

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