UNIVERSITY OF LILLE – DOCTORAL SCHOOL SESAM

Searching for Alternative Microfoundations

A Study of R.W. Clower's Contributions to Macroeconomics and Monetary Theory (1949-1975)

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Defense : 10/11/2016

A thesis prepared under the supervisions of Professor Goulven RUBIN (University of Lille) and Professor Stéphane VIGEANT (University of Lille).[1]

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To Laura,

Résumé

A la recherche de fondements microéconomiques alternatifs : une étude des contributions de R.W. Clower à la macroéconomie et à la théorie monétaire (1949-1975).

Ma thèse étudie les contributions de Robert W. Clower à la recherche de fondements microéconomiques pour la macroéconomie et la théorie monétaire, sur la période 1949-1975. L'objectif est de reconstruire son programme de recherche. Pour réaliser cet objectif, j'analyse les publications de Clower et les archives (correspondances, documents de travail…) confiées à l'université Duke, je caractérise le contexte intellectuel dans lequel il évoluait, et j'établis ses sources d'inspiration. Entre 1949 et 1975, Clower fit plusieurs propositions pour construire un modèle d'équilibre général capable de lier de manière satisfaisante les comportements individuels et les relations agrégées constitutives de la macroéconomie. Dans une certaine mesure, toutes ses propositions avaient vocation à s'accumuler pour constituer un cadre conceptuel *alternatif* à la théorie Walrassienne de John R. Hicks (1939). Quatre problèmes analytiques furent l'objet d'investigations : la dynamisation du modèle d'équilibre général, l'intégration du chômage involontaire et de la monnaie dans la théorie des prix, et les ajustements de marchés en dehors de l'équilibre. Chaque chapitre de ma thèse est centré sur l'un de ces problèmes et discute des solutions apportées par Clower. Au fil du parcours, je souligne l'existence d'interactions entre la macroéconomie Walrassienne de Hicks et Don Patinkin, et les modèles de non-tâtonnement de Kenneth Arrow, Frank Hahn et Takashi Negishi. De telles interactions ont joué un rôle dans l'émergence de la recherche de fondements microéconomiques de déséquilibre et, par extension, dans la transformation de la macroéconomie qui a eu lieu dans les années 70.

Mots-clefs : fondements microéconomiques de la macroéconomie, intégration de la monnaie à la théorie de la valeur, chômage involontaire, cycles d'affaire, analyse stock-flux, dynamique de marchés en dehors de l'équilibre, Clower, Patinkin.

Abstract

Searching for Alternative Microfoundations: A Study of R. W. Clower's Contributions to Macroeconomics and Monetary Theory (1949-1975).

My dissertation studies Robert W. Clower's contributions to the microfoundations of macroeconomics and monetary theory, over the period 1949-1975. The aim is to reconstruct his research program. For this purpose, I analyze Clower's articles as well as the archival documents (Clower's correspondences, unpublished manuscripts…) found at Duke University, I characterize the intellectual context in which he was involved, and I establish the influences from which he benefited. Between 1949 and 1975, Clower made several propositions to elaborate a general-equilibrium model linking individuals' behaviors with aggregates. To a certain extent, all the propositions intended to be aggregated so as to lay a conceptual framework *alternative* to the Walrasian theory of John R. Hicks (1939). Four analytical problems were addressed: how to dynamize the general-equilibrium theory, how to integrate involuntary unemployment and money in value theory, and how to account for the adjustment processes occurring in non-clearing markets. Each chapter of my dissertation is centered on one of these problems and discusses Clower's solutions. Along the way, I stress the existence of interactions between the Walrasian macroeconomics of Hicks and Don Patinkin, and the non-tâtonnement economics of Kenneth Arrow, Frank Hahn, and Takashi Negishi. Consequently, such interactions were central to the emergence of the search for disequilibrium foundations and, in turn, to the transformation of macroeconomics that took place in the 1970s.

Key-words: microfoundations of macroeconomics, integration of monetary and value theory, involuntary unemployment, trade cycle, stock-flow analysis, dynamic of non-clearing markets, Clower, Patinkin.

Remerciements

Cette thèse marque la fin d'une expédition de plusieurs années au cœur de l'histoire de la macroéconomie et de la théorie monétaire. Pour mener cette expédition à son terme, il importait de pouvoir partir dans de bonnes conditions, d'avoir de bons guides, et de disposer d'une bonne base arrière en cas de coups durs. Ces trois conditions ont été réunies grâce aux soutiens de personnes et d'institutions. J'aimerais leur faire part de ma reconnaissance.

Mes premiers remerciements vont à Goulven Rubin, mon directeur de thèse. Son soutien a été des plus précieux lorsqu'il a fallu définir le cap de mon travail de recherche. Par la suite, il s'est avéré être un guide hors pair. C'est grâce à nos longues et régulières discussions que j'ai réussi à identifier et à creuser des pistes de recherche. De plus, la profondeur des réflexions menées dans mes chapitres de thèse doit beaucoup à ses exigences et ses méthodes de travail. Au-delà de cet encadrement, je voudrais aussi le remercier pour la constance de ses encouragements. Sa capacité à toujours rappeler les progrès réalisés a permis que l'expédition tourne le moins souvent possible au calvaire. Mon co-directeur de thèse, Stéphane Vigeant, a aussi eu un rôle important dans ce parcours. Sa curiosité pour les théories du déséquilibre et sa connaissance de l'économie mathématique ont été d'un grand renfort pour débloquer certains problèmes.

Incontestablement, cette expédition n'aurait pas pu être réalisée sans le soutien financier de plusieurs institutions que j'aimerais remercier. Le laboratoire Economie Quantitative, Intégration, Politiques Publiques, et Econométrie et le collège doctoral européen (université Lille Nord de France) ont substantiellement contribué au financement de mon premier séjour de recherche à l'université Duke, aux Etats-Unis. Sans cette aide, je n'aurais pas pu accéder aussi rapidement à des documents pourtant essentiels à la mise en œuvre de mon programme de travail. Par la suite, un second séjour à l'université Duke a été rendu possible grâce aux financements apportés par le laboratoire Lille Economie Management et le Center for the History of Political Economy. Cette aide a été décisive. En me permettant d'intégrer une équipe de recherche où évoluaient des spécialistes dans mon domaine (Mauro Boianovsky, Kévin Hoover et Roy Weintraub), j'ai trouvé un second souffle pour finir ma thèse.

Au cours de mes quatre années d'expédition, plusieurs personnes ont guidé mes recherches et ainsi contribué à faire avancer mon travail. Roger Backhouse, Alain Béraud, Mauro Boianovsky, Jean Cartelier, Ghislain Deleplace, Michel de Vroey, Paul Dudenhefer,

Kevin Hoover, Harald Hagemann, Herrade Igersheim, Jean-Sébastien Lenfant, et Roy Weintraub méritent particulièrement d'être remerciés pour leurs commentaires sur des versions préliminaires des chapitres de ma thèse. Plus généralement, j'aimerais remercier les chercheurs présents lors de la présentation de mes travaux au séminaire du Center for the History of Political Economy (Université Duke), au séminaire d'Economie Politique Lillois (Université de Lille), aux séminaires internes organisés par le laboratoire Lille Economie Management (Université de Lille), aux séminaires Histoire de la Macroéconomie et des Théories Monétaires (Université Paris I Panthéon La Sorbonne), et lors des conférences orchestrées par l'European Society for the History of Economic Thought en 2014, 2015 et 2016. Enfin, j'aimerais saluer la disponibilité des bibliothécaires de l'université Duke et de l'Université d'Oxford lorsque j'ai rassemblé les matériaux pour écrire cette thèse.

Mes derniers remerciements vont à la base arrière de cette expédition : ma famille et mes amis. Pendant ces quatre années de doctorat, j'ai souvent opposé mon travail de recherche à des projets communs. A tel point qu'à la fin, beaucoup se plaisaient à anticiper cette phrase désormais célèbre: « Je ne peux pas, j'ai ma thèse à travailler ». En un sens, cela montre qu'ils se sont habitués à mon rythme de travail sans (trop) se lasser. Leur patience mérite d'être saluée. Leur soutien aussi. La fierté que ma mère, mon père, et mes grands-parents ont tirée de ce doctorat a été une source intarissable de motivation ; Laura, ton amour a été le puissant carburant grâce auquel j'ai pu mener ce travail de recherche ; Ian, Olivier, Pierre, Thiébaud, et Yann, sachez que j'aurais difficilement pu achever ce doctorat sans vous. Votre amitié est de celles qui, pour reprendre les mots de Francis Bacon, doublent les joies et réduisent de moitié les peines. Merci pour votre présence !

Acknowledgment

I am indebted to Roger Backhouse, Alain Béraud, Mauro Boianovsky, Jean Cartelier, Ghislain Deleplace, Paul Dudenhefer, Kevin D. Hoover, Harald Hagemann, Herrade Igersheim, Jean-Sébastien Lenfant, Goulven Rubin, Stéphane Vigeant, and Roy Weintraub for their helpful comments on earlier drafts of the chapters of this dissertation.

I would also like to thank the participants of seminars organized by the Center for the History of Political Economy (Duke University), and by French research labs including the Centre Lillois d'Etudes et de Recherches Economiques (University of Lille), Economie Quantitative, Intégration, Politiques Publiques, et Econométrie (University of Lille), Lille Economie Management (University of Lille), and Philosophie, Histoire, et Analyses des Representations Economiques (Paris I Pantheon Sorbonne University) for their suggestions on some chapters of this dissertation.

Financial support from the Center for the History of Political Economy, from the Collège Doctoral Européen, from Economie Quantitative, Intégration, Politiques Publiques, et Econométrie, and from Lille Economie Management is gratefully acknowledged.

My final thanks go to the staff of the David M. Rubenstein Rare Book and Manuscript Library (Duke University) for their help with the Robert Clower Papers, and to Simon Bailey (Oxford University Archives) who helped me to obtain the report of Clower's thesis defense.

"To understand a science, it is necessary to know its history."
Auguste Comte

General Introduction

Recent historical studies showed that the search for a satisfactory relationship between micro and macroeconomics started long before the Lucasian revolution (Pedro G. Duarte and Gilberto T. Lima, 2012; Roger E. Backhouse and Mauro Boianovsky, 2013; Michel de Vroey, 2016).[2] Microfoundational programs were developed during the Keynesian era (Kevin D. Hoover, 2012). One consisted in elaborating general-equilibrium models to link individuals' behaviors with aggregates (unemployment, inflation, trade cycle…). It was initiated by John R. Hicks in *Value and Capital* (1939) and culminated with the fixed-price models developed by Jean-Pascal Benassy (1975), Jacques Drèze (1975), or Edmond Malinvaud (1977).[3] Over this period, economists changed their views about the appropriate microfoundations for macroeconomics. Assumptions concerning individuals' optimization plans, the technology of exchange (e.g., tâtonnement or not), and the market structure (e.g., perfect competition or imperfect competition) were modified. Robert W. Clower was among the important architects of this evolution of the microfoundational program. He formulated penetrating criticisms and original ideas in two articles: "The Keynesian Counter-Revolution: A Theoretical Appraisal" (1965) and "A Reconsideration of the Microfoundations of Monetary Theory" (1967). In both cases, Clower criticized the Walrasian macroeconomics of Hicks (1939), Oskar Lange (1945), and Don Patinkin (1956). In 1965, he gave emphasis to the microfoundations of Keynesian macroeconomics. Clower argued that there was no room for involuntary unemployment in general-equilibrium theory so long as the tâtonnement hypothesis was maintained. Under this assumption, economic activities took place only when all individuals realized their standard

[2] The issues related to aggregation are barely addressed in the present dissertation. For a systematic treatment of aggregation methods in an historical perspective, see Kevin Hoover's contribution to the volume of Duarte and Lima (2012).

[3] For an exhaustive list of the theorists involved in the fixed-price literature, see Backhouse and Boianovsky (2013).

optimization plans. Yet, involuntary unemployment characterized situations in which workers failed to sell the quantity of labor desired at the given market prices (1965: p. 40). Therefore, the elaboration of a Keynesian general-equilibrium framework required rejecting the tâtonnement hypothesis and formulating a theory of choice adapted to disequilibrium situations. For this purpose, Clower proposed the "dual-decision" theory of the consumer. In 1967, he considered the problem raised by the integration of monetary and Walrasian value theory. Clower argued that nothing ensured the use of money in transactions if its intermediary role in the exchange process was not formally specified. Yet, money entered in Patinkin-type models just like any other commodity. To ensure that money was the counterpart of exchange, Clower proposed to dichotomize the Walrasian budget constraints into separate "expenditure" and "income" branches. Individuals would be forced to have money to consume and to receive money in return for their sales.

Clower's (1965; 1967) contributions to the microfoundations of macroeconomics and monetary theory attracted the attention of economists and historians. Economists found inspiration in the optimization plans devised by Clower. Two examples are well-known.[4] In 1971, Robert Barro and Herschel I. Grossman used the "dual-decision" theory to lay the foundations of Keynesian macroeconomics. Their model paved the way for the "fix-price" literature. In 1980, Robert Lucas built the seminal "cash-in-advance" model on the dichotomized budget constraint. Because of these influences, Clower became an important figure in the history of modern macroeconomics. Until now, historians analyzed his contributions from two perspectives. The first one was to focus on the theoretical propositions developed in the 1965 and in the 1967 articles. It was notably adopted by Roy Weintraub (1979), Meier Kohn (1988), Ghislain Deleplace (1999), Boianovsky (2002), De Vroey (2004),

[4] See also Jean Cartelier (1993, 1995) and Carlo Benetti (1998). They both used the "dual-decision" hypothesis to justify the existence of equilibria with involuntary unemployment in a Marxian perspective.

and Goulven Rubin (2005). De Vroey and Rubin focused on the "dual-decision" hypothesis and the related demonstration of the invalidity of Walras' law to address the debates over the microfoundations of Keynesian macroeconomics. On their sides, Kohn and Boianovsky focused on the dichotomized budget constraint to position Clower in the history of cash-in-advance models. Lastly, Weintraub and Deleplace discussed the logical links between the 1965 and 1967 articles, and their implication for monetary economics. The second approach adopted by historians was to insert the 1965 and 1967 articles in a broader picture of Clower's contributions. Such overviews can be found in Elisabetta de Antoni's article, "R.W. Clower's intellectual voyage: The 'Ariadne's thread of continuity through changes" (1999) or in Backhouse and Boianovsky's (2013) book, *Transforming Modern Macroeconomics: Exploring Disequilibrium Microfoundations, 1956-2003*. De Antoni surveyed Clower's works from his early contributions to disequilibrium macroeconomics and monetary theory in the 1960s, to his "neo-Marshallian" program of microfoundations expounded with Axel Leijonhufvud in 1975. Backhouse and Boianovsky enlarged the scope of investigation. They went back to the doctoral dissertation that Clower prepared between 1949 and 1952 at Oxford, under Hicks' supervision. Either way, neither the historians nor even less the economists proposed to reconstitute the logic underlying the development of Clower's thought over the period 1949-1975. By extension, there is no detailed study of the origins, the development, and the scope of Clower's contributions to the microfoundations of macroeconomics and monetary theory. My dissertation aims to fill these gaps.

The temporal delimitation is chosen so as to offer the story of Clower's emancipation within Hicks' microfoundational program. Clower started his career with the conviction that "after making appropriate alterations to the theory of economic behavior (as expressed e.g., in *Value and Capital*)", the Walrasian framework would be a "satisfactory" (1952a: p. 8) foundation for economic analysis. In 1975, Clower came to the conclusion that "contrary to

[his] earlier presumptions, the [Walrasian] theory [was] categorical rather than noncategorical – closed to extension in certain crucial directions including, specifically, those directions that would permit explicit formal analysis of [the] adjustment processes" (1975: p. 197) occurring in capitalist economies. This resulted in the decision to elaborate a "neo-Marshallian" general-program of microfoundations. Over the period 1949-1975, Clower deeply influenced the course of modern macroeconomics and monetary theory. But unlike economists such as Paul A. Samuelson or Robert Solow, his strength was not to provide a model that gave bread and butter to generations of economists. His force was to ask important analytical questions and to indicate promising avenues to answer. And all of this in the context out of which emerged the Lucasian revolution. Therefore, a detailed study of Clower's contributions will enable us to address central analytical problems whilst enriching the analysis of the transformation of macroeconomics that took place in the 1970s.

The reconstitution of Clower's intellectual journey and the reconstruction of his theoretical projects are difficult tasks. The first reason has to do with Clower's personality. He is known as an iconoclast, a maverick, and a dramatist. In the preface of *Money and Markets*, a book gathering Clower's main articles, Donald A. Walker argued that Clower was "iconoclastic but constructive" (1984: p. ix); Leijonhufvud wrote in a letter of recommendation (when Clower applied for a position at University of California Los Angeles in 1971) that "Clower [was] known as a maverick, a scholar who made several important contributions";[5] lastly, in the afterword of *Money and Markets*, Clower defined himself as a story-teller, explaining that he "always thought that the essential art of economics […] was to tell a good story in a persuasive way" (1984: p. 264).[6] These three facets can be found in the 1965 article. There, Clower fiercely

[5] R. W Clower Papers, Box 4, Rubenstein Rare Book and Manuscript Library.

[6] When I was at Duke University, I had several occasions to speak about the personality of Clower with Hoover and Weintraub. They knew him notably because Clower was president of the History of Economics Society, from 1997-1998. The term "dramatist" was always used in the description of Clower's personality.

defended a break with the Keynesian orthodoxy embodied by Hicks (1939), Lange (1945), and Patinkin (1956).[7] This view was supported by a deep and decisive criticism of standard general equilibrium models that reoriented the research agenda in Keynesian macroeconomics. And Clower made this influential contribution by telling a story in which Hicks, Lange, and Patinkin would be "counter-revolutionists" rooting Keynesian macroeconomics in the very framework that John Maynard Keynes (1936) had attacked. The problem with these personality traits is twofold. On the one hand, it makes his position in the intellectual landscape hard to capture. Since Clower was prone to attack all the economists he quoted, it is often difficult to trace his sources of inspiration. For instance, his attitude towards Hicks, Lange, and Patinkin may lead the reader to believe that a deep gap separated Clower from these authors although, as I will show below, he was inspired by their respective contributions. On the other hand, Clower's personality traits make the development of his thought hard to reconstitute. The negative side of telling self-consistent stories around one specific criticism is the absence of apparent connections between the theoretical insights. The 1965 and 1967 articles are cases in point. In the afterword of *Money and Markets*, Clower stressed that "most readers [had] seen [the 1967] article as the beginning of a series of papers on money rather than a continuation of [his] early work on Keynesian economics" (1984: p. 264). This is not surprising since Clower (1967) did not even mention his "dual-decision" hypothesis, and more generally, the problem of disequilibrium trading.

The second reason why my investigation is a difficult task has to do with the nature of Clower's contributions. First, they are scattered in various fields. As a result, it is difficult to

[7] In the conclusion of the article, Clower claimed: "contemporary general equilibrium theories can be maintained intact only if we are willing to barter Keynes for orthodoxy" (1965: p. 56).

bring them together into a coherent whole. This problem was stressed by Leijonhufvud when he wrote the letter of recommendation previously mentioned:[8]

> Professor Clower's theoretical investigations have led to influential publications on a large number of topics in numerous areas of economics. *American Men of Science* lists as his fields: mathematical economics, econometrics, the theory of capital, interest, and price determination […] Keynesian economics, monetary theory, and development economics. Although this method of characterizing an economist's work in most cases gives a good short-hand description, it is apparent that conventional classification of Clower's work yields a fairly incoherent picture, suggesting a 'jack-of-all-trades'.[9]

An explicitation of Leijonhufvud's statement is the occasion to provide an overview of Clower's academic itinerary and of his main published contributions over the period 1949-1975.[10] Initially, Clower wrote a dissertation on the trade cycle in which he addressed economic fluctuations in a framework *à la* Roy Harrod (1939) and Hicks (1950). This dissertation was failed. Clower left Oxford with a Bachelor of letter. In 1952, he was hired by the Washington State University as Assistant Professor. There, he started working in collaboration with a mathematician specialized in dynamics, Donald Bushaw.[11] Together, they studied the static and dynamic properties of 'stock-flow' market models. This structure had the specificity to take

[8] Of course, Leijonhufvud tried to explain that "all but a few of the works listed in Professor Clower's bibliography [*were*] parts of such a coherent, systematic, sustained (and continuing), and certainly major research effort – although the conventional division of economic theory into areas and sub-areas, etc., may tend to conceal this." According to him, "the common denominator of Professor Clower's most important contributions is the effort to amend and extend this body of pure theory [the "neo-walrasian" framework of "Hicks, Samuelson, Arrow, Hurwicz, Debreu, etc.,"] so as to make it useful for ["explaining observed economic processes"]."

[9] R. W Clower Papers, Box 4, Rubenstein Rare Book and Manuscript Library.

[10] For a complete account of Clower's academic itinerary, see Walker (1984: pp. ix-xi).

[11] Bushaw did his PhD in mathematics at Princeton, under the supervision of Salomon Lefschetz. He defended his thesis in 1952. According to Mike Kallaher (professor at the Washington State University), Bushaw's dissertation contributed to the development of modern optimal control theory (see: www.math.wsu.edu/Events/bushawobituary.php, consulted on 19 August 2016).

into account current activities and their resulting effects on the stocks held in the economy to explain price determination. It was used to tackle various issues including the theory of capital, interest, the stability of competitive equilibrium, monetary theory, and econometric estimation of households' behaviors.[12] At the same period, Clower also addressed the issue of price determination in monopolistic markets.[13] He left Washington State University in 1958 to move to Northwestern University where he stayed until 1971. Over the period, Clower led various studies on underdeveloped countries, notably on Puerto Rico and Liberia.[14] This interest for underdeveloped countries traced back to his first visits to the University of Lahore (West Pakistan) in 1954 and was renewed when Clower became director of the Northwestern University Economic Survey of Liberia in 1961 (Walker, 1984: p. x). In parallel to these studies, Clower formulated his disequilibrium interpretation of the *General Theory* and his "Reconsideration" of the integration of monetary and value theory. Thereafter, monetary economics became his major theme of investigation, as evidenced by a series of articles published in 1968, 1969, 1970, and 1971.[15] Lastly, Clower moved to University California Los Angeles where he started collaborating with Leijonhufvud on a "neo-Marshallian" program of microfoundations. Outlines of this project were presented in two articles, in 1975.[16] In view of

[12] In the order set out above : "An investigation into the Dynamic of Investment" (Clower, 1954a), "Productivity, Thrift, and the Rate of Interest" (Clower, 1954b), "Price Determination in a Stock-Flow Economy" (Bushaw and Clower, 1954), *Introduction to Mathematical Economics* (1957), "On the Invariance of the Demand for Cash and Other Assets" (Meyer Burstein and Clower, 1960), and "Income, Wealth, and the theory of Consumption" (Clower and Mikael B. Johnson, 1968).

[13] See two articles: "Competition, Monopoly, and the Theory of Prices" (1955) and "Some Theory of an Ignorant Monopolist" (1959b).

[14] See *Growth without Development: an Economic Survey of Liberia* (Clower and al, 1966) and *Puerto Rican Shipping and the U.S. Maritime Laws: an Economic Appraisal* (Clower and John Harris, 1965). For other studies of underdeveloped countries, see the reference given by Walker (1984: p. x).

[15] In chronological order: "Comment: The Optimal Growth rate of Money" (Clower, 1968), the introduction of *Monetary Theory: Selecting Readings* (Clower, 1969), "Is There an Optimal Money Supply" (Clower, 1970), and "Theoretical Foundations of Monetary Policy" (Clower, 1971).

[16] There are two articles: "Reflections on the Keynesian Perplex" (Clower, 1975) and "The Coordination of Economic Activities: A Keynesian Perspective" (Clower and Leijonhufvud, 1975).

this short account, one cannot fail to be struck by the apparently fragmented nature of Clower's contributions.

The second feature of Clower's contributions is that they are elusive. It is often difficult to understand the kind of theory and the aim contemplated by Clower. This is largely because he rarely provided complete models. The 1965 and 1967 articles are cases in point. In 1965, the "dual-decision" hypothesis was presented as the choice-theoretic basis for a theory of demand adapted to disequilibrium. In situations of involuntary unemployment, workers received an income lower than the one planed. Thus, income was supposed to act as a constraint on consumption decisions. The "dual-decision" theory of the consumer accounted for the resulting (downward) revisions of consumption plans. While presenting this microeconomic framework, Clower made no reference to the supply side of his disequilibrium model. The issue of firms' behavior in situation of disequilibrium was left opened. Though in a different way, the 1967 article was also incomplete: Clower did not deduce the excess-demand functions related to his optimization plan and made almost no reference to the market structure in which individuals were supposed to evolve. Besides, Clower was often vague on the next stages of his researches. Unfaithful appropriations followed. It is known that Clower disowned the "fix-price" literature. In the afterword of *Money and Markets*, he claimed that it "developed its own impetus and analytical uses, quite apart from the source (or sources) that originally inspired it" (1984: p. 267). It is still an issue to identify the research program contemplated by Clower in the 1965 article. The same is true with "A Reconsideration of the Microfoundations of Monetary Theory" (1967). An anecdote is worth telling: even Peter Howitt (one of the closest colleagues of Clower by the mid-1970s) failed to provide a faithful interpretation of the 1967 model. In 1991, Howitt was asked to write an article on the "cash-in-advance" literature for the *New Palgrave Dictionary of Money and Finance*. Since Lucas built this approach to monetary macroeconomics on Clower's dichotomized budget constraint, Howitt felt the need to discuss

the properties of the 1967 optimization plan. In the first draft of his article, he formulated two interpretations. First, Howitt argued that Clower's constraint specified "that current sales of good [could] not be used immediately as a source of purchasing power". Thus, like in "cash-in-advance" models, the cash received by individuals in return of their selling would have been available to be spent with a lag. Second, Howitt considered that Clower's "emphasis on the circular flow of transactions represents a return to the approach to monetary theory followed by [Dennis] Robertson (1933)." He added that "Clower was not the first to have postulated an explicit finance constraint in addition to the usual budget constraint, having been preceded by [Karl] Brunner (1951) and [Sho Chieh] Tsiang (1966). But it was not until the influential paper by Lucas (1980), which built explicitly on Clower's contributions, that the approach became widespread."[17] Howitt sent his draft to Clower for comments. Clower replied in a long letter in which he sharply refuted Howitt's interpretations. Clower argued that there was no lag in his model:

> Your description of my 1967 article is misleading […] If you read my paper, starting with the section where the dichotomous constraint is introduced, you will see that there is no question of 'immediately' […] In short, there is no lag, and no hint of any kind of timing problem.[18]

Then he urged Howitt to disengage him from the tradition to monetary theory of Robertson and Tsiang:

> You could do yourself, the profession, and more particularly me, a great favor if you [could] disengage me from this long line of research. I have never liked being associated with the cash-in-advance literature, and the fact that people

[17] All the quotations are taken from a preliminary draft of "Cash-in-Advance Economy" (1992). R. W Clower Papers, Box 1-1999-0352, Rubenstein Rare Book and Manuscript Library.
[18] Letter from Clower to Howitt (04/29/1991). R. W Clower Papers, Box 1-1999-0352, Rubenstein Rare Book and Manuscript Library.

> spell my name correctly does not make me any happier! What pains me most is the apparent inability of people to read accurately what I wrote. However that may be, I think in your paper, at least, you should be made clear that the Lucas gambit, though it may owe its inspiration to me, owes nothing more. There is no intellectual or logical link between his slope and mine! Let me leave it at that![19]

Clower concluded the letter by claiming that "none of them [Robertson, Tsiang, Lucas and other cash-in-advance theorists] had any conception of the problem" comparable with his conception, "nor [had] anyone since". Unfortunately, he did not say much about his own conception at this point. As a result, the mystery was left intact.

In short, the challenge is to bring Clower's scattered and elusive theoretical propositions together into a well-defined, coherent, and comprehensive picture. To meet this challenge, I explore in-depth the published and unpublished documents written by Clower over the period 1949-1975.[20] Particular attention is given to Clower's doctoral dissertation, to the correspondences held with Patinkin, to the research proposals written circa 1965, and to various unpublished manuscripts. Some of them deserve to be mentioned at this stage: "Keynes and the Classics: A Reinterpretation" (1958) because it contains Clower's first disequilibrium interpretation of the *General Theory*, "On the Theory of a Money Economy" (1966), because it sheds light on the logical connections between the 1965 and 1967 articles, "The Keynesian Paradigm: An Attempt at Reconstruction" (1971a) because it accounts for the evolution of Clower's disequilibrium program of microfoundations, and "Lectures on Recent Developments in the Keynesian Counter-Revolution" (1973), because it provides information about Clower's

[19] Letter from Clower to Howitt (04/29/1991). R. W Clower Papers, Box 1-1999-0352, Rubenstein Rare Book and Manuscript Library.

[20] Almost all the unpublished documents were found at the Rubenstein Rare Book and Manuscript Library (Duke University). The exception is the report of Clower's thesis defense, archived at Oxford University. Note that without the support of Hoover, I would not have been able to access this unpublished document.

decision to base macroeconomics on Marshallian foundations. Then, I characterize the intellectual context in which Clower was involved. During the investigation, particular attention will be given to two concerns: the search for a theoretical framework adapted to Keynesian macroeconomics, marked notably by the works of Hicks and Patinkin; and the stability analyzes of non-tâtonnement processes led in particular by Kenneth Arrow, Frank Hahn, and Takashi Negishi. Last but not least, I identify the influences from which Clower benefited. Interestingly, by the end of the 1950s, the developments in the Walrasian macroeconomics of Patinkin and in the non-tâtonnement economics of Hahn and Negishi influenced Clower. Besides, Clower's studies on underdeveloped countries and on microeconometric estimation have been left aside. Put simply, they played no important role in his reflections on the microfoundations of macroeconomics and monetary theory.

The 1965 and 1967 articles are like the tip of an iceberg. They are part of a long and continuous effort to elaborate a general-equilibrium framework useful in explaining how the actual market system worked. From 1949 to 1975, this effort had two driving forces: the conviction that the microeconomic theory devised by Hicks (1939) was inappropriate for that purpose; and a research strategy that consisted of formulating general frameworks, able to include existing theories as special cases. This resulted in successive and, to a certain extent, cumulative propositions to lay a conceptual framework *alternative* to Hicks':

1. The first proposition was to dynamize the general-equilibrium theory. Like Hicks (1939), Clower could have assumed that during any given market period, individuals made decisions on present and future economic activities by taking into account present and expected market prices. But he opted for a much simpler option. It consisted of assuming that given current market prices, individuals made two decisions: one on the flow of commodities to consume or produce during the period, and one on the stock of

commodities to hold at the end of the period.[21] This resulted in the 'stock-flow' market models, formalized and extensively developed during the 1950s. In the 'stock-flow' market structure, the interaction between individuals' decisions set the economic system in motion. Whether a stationary state was reached depended on how the stocks of commodities held in the economy moved through time.

2. The second proposition was to leave room for involuntary unemployment in the general-equilibrium framework. The basic ingredients were expounded in the 1965 article. Let me summarize the rationale: i) workers and employers were supposed to maximize their objective functions in a non-tâtonnement context; ii) if exchange took place while there was non-clearing labor market, then workers had to undertake downward revisions of their consumption plans. To do so, they were supposed to take into account the quantity of labor effectively sold in the labor market in addition to the given market prices ("dual-decision" theory of the consumer); and iii) under these circumstances, instead of "notional" excess-demand functions (derived from standard optimization plans), the economic system was composed of "effective" excess-demand functions (derived from constrained optimization plans). Clower showed that the substitution of the later to the former in the weighted sum of excess-demand functions invalidated Walras' law. Walras' law was replaced by a more "general" relation "at most equal to zero" (1965: p. 53). This meant that the general-equilibrium framework left room for situations in which an excess-supply in the labor market was not counterbalanced by an excess-demand elsewhere in the economic system.

[21] "A major shortcoming of modern economic theory is that it does not include a set of analytical tools sufficiently simple and precise, yet sufficiently familiar in terms of traditional ideas, to permit economists to deal effectively with elementary dynamic problems. In the previous discussion an attempt has been made to develop a technique which meets these requirements by [allowing] the simultaneous treatment of stock and flow variables. This generalization adds certain essentially dynamic features to traditional […] analysis" (1954a: p.73)

3. The third proposition was to integrate money in the general-equilibrium theory. The key idea was expounded in the 1967 article. It was to formally specify the intermediary role of money in the exchange process. This resulted in the dichotomized budget constraint. Interestingly, Clower considered that this micromodel was not enough to integrate monetary and value theory. On the one hand, it had to be accompanied by an explanation of why individuals sought to hold money, i.e., why money yielded utility. Clower assumed that the activity of exchange was costly (efforts related to the search of a trading partner and bargaining). By resolving the problem of the double coincidence of wants, money would lower the costs of exchanges. Hence the holding of money by individuals. On the other hand, Clower required elaborating a market structure where the trading activity was organized so as to ensure the use of money in transactions.

4. The fourth and last proposition was to devise a technology of exchange adapted to a non-tâtonnement context. This raised two issues. The first issue was to rationalize the operation of trade. From 1965 to 1975, Clower considered that a "market authority" was charged to set prices, to control the effectiveness of individuals' purchase orders, and to act as a clearing house. Initially, these tasks were realized by a "central market authority" (1965: p. 50). Then, Clower considered that "traders" did the job, in autonomous markets. The second issue was to specify how the market system behaved out of equilibrium. In the 1965 article, Clower assumed that the variation of a price in a given market depended on the excess demand in that market, and on the quantity effectively exchanged in all other markets. Thereafter, he opted for a much simple adjustment rule. If buyers were frustrated in a given market, then the "trader" had to increase the price. Conversely, if sellers were frustrated, the "trader" had to lower the price in the market. Lastly, Clower considered that "traders" addressed the coordination process whilst following private interests. A priority issue of the "neo-Marshallian"

program of microfoundations was to give flesh and blood to this non-mechanistic approach.

The present thesis is composed of four chapters. Each chapter tells a story centered on one of the propositions:

Chapter 1 uses Clower's doctoral dissertation to show that the elaboration of 'stock-flow' market model was part of a project intending to offer microfoundations to a Keynesian theory of the trade cycle. This theory was inspired by Keynes (1936) and was supposed to include the Harrod (1939) and Hicks (1950)-type models as special cases. The possibility of achieving such a unification was allegedly due to the 'stock-flow' characteristic of the model. Clower considered the relation of stocks and flows as the essence of capital accumulation processes and in turn, as a central feature of trade cycle analysis. On that basis, the challenge was to incorporate the relation of stocks and flows into standard microeconomics and to determine whether it could be used as a foundation for Keynesian business cycle models. Bushaw and Clower pursued this program during the 1950s. Later, Cliff L. Lloyd (1960) and William J. Baumol (1962) attempted to use their approach to address the debate over liquidity preference vs. loanable funds theories of interest. In light of these studies, I conclude that under Bushaw and Clower's assumptions, the 'stock-flow' market theory could hardly be a relevant foundation for Keynesian macroeconomics. Clower reached this conclusion in the early sixties. Yet, he kept considering that the 'stock-flow' market theory was a relevant framework. This was notably because it could be investigated again, under alternative assumptions.

Chapter 2 shows that the disequilibrium interpretation of the *General Theory* offered in the "Counter-Revolution" article marked an inflexion on Clower's intellectual path. Two stages emerge when trying to reconstitute the path that led Clower (1965) to shape his approach to the microfoundations of Keynesian macroeconomics. The first stage includes the 'stock-flow'

general-equilibrium program of microfoundations and Clower's investigations on price determination, in imperfect competition. The outgrowth of these reflections appears in *Introduction to Mathematical Economics*, a book published in 1957.[22] During the first stage, Clower considered that Keynesian macroeconomics was compatible with market clearing and with Walrasian microfoundations. To put the matter differently, he was not concerned with involuntary unemployment, and more generally, with the issues related to individual disequilibrium and its consequences. Besides, he considered that simple extensions of the Walrasian microeconomic theory were enough to ground Keynesian macroeconomics. He moved away from these positions in a two-step process opening the second-stage of his research program. In "Keynes and the Classics: A Reinterpretation" (1958), Clower formulated his first disequilibrium interpretation of the *General Theory*. Then, he came to the conclusion that the tâtonnement hypothesis and the Walrasian theory of the consumer had to be rejected to leave room for Keynes' insights in a general equilibrium framework. These two ideas appeared together for the first time in the "Counter-Revolution" article, when it was first presented at the Royaumont Conference (France), in 1962. The importance that Clower suddenly gave to disequilibrium in Keynesian macroeconomics is presented as a side effect of his reading of *Money, Interest, and Prices* (1956); his decision to reject part of Walrasian microfoundations is explained as the result of his own concerns with unstable dynamics, and of his confrontation with the Walrasian macroeconomics of Patinkin (1956, 1958), and with the non-tâtonnement economics of Hahn and Negishi (1962).

Chapter 3 explains that the 1967 article paved the way for a reorientation of Patinkin's (1956) project to integrate monetary and value theory. During the 1950s and early 1960s, Clower defended the integration strategy formulated in *Money, Interest, and Prices*. This appears

[22] The results expounded in "Some Theory of an Ignorant Monopolist" (1959b) are contained in *Introduction to Mathematical Economics*.

clearly in his correspondences with Patinkin. In this context, Clower acknowledged that the introduction of money in utility functions and the real-balance effect were essential pillars of a sound and reliable monetary theory. He also acknowledged that he had no decisive objection to make against Patinkin's approach. Yet, this situation changed when he realized that the tâtonnement hypothesis and the Walrasian theory of the consumer were incompatible with Keynesian macroeconomics. This result led him to challenge the monetary theory expounded in *Money, Interest, and Prices*. Clower came to conclude that Patinkin's model portrayed a barter economy because of the tâtonnement hypothesis. Since this assumption was a source of anomalies, its rejection and the formulation of a microeconomic theory adapted to disequilibrium systems became the *sine qua non* of monetary theory. From there, whilst retaining the two pillars of Patinkin's integration, Clower made various propositions to elaborate a disequilibrium monetary theory. The conclusion is that despite their limited scope, Clower's propositions found an echo. They were inspiring, notably for the money-type non-tâtonnement economics *à la* Arrow and Hahn (1971).

Chapter 4 demonstrates that over the period 1958-1975, Clower sought to lay the foundations of a "general" theory of adjustment processes. To put the matter differently and more precisely, the goal of his disequilibrium research program was to devise a choice-theoretic basis for a market theory able i) to address the determination of prices and income in a monetary framework; ii) to include Walrasian theory as a special case; and iii) to account for the market adjustment mechanisms occurring in situations of involuntary unemployment and inflation. Such a market theory was viewed as a dynamical system describing the adjustments of market prices out of equilibrium. The challenge was to set the related technology of exchange and to study its stability properties. Between 1958 and 1975, Clower proposed three market structures. But whatever the model considered, the stability results expected were the same. Clower sought to obtain unstable market adjustment processes to portray scenarios of persistent involuntary

unemployment and persistent inflation. The successive modifications made to the market structures are analyzed by taking into account the intellectual context. In the first case, I identify a small group of economists including Robert Crouch (1972), Peter Frevert (1968; 1970), Grossman (1969; 1971), Leijonhufvud (1968), Trout Rader (1972), and Donald Tucker (1968). These economists attracted Clower's attention because they attempted to develop the kind of dynamic disequilibrium theory outlined in the "Counter-Revolution" article. In the second case, Clower's perception of the field of money-type non-tâtonnement economics is compared with Arrow and Hahn's (1971). It turns out that in the early 1970s, these three authors came to the conclusion that the existing foundations of economics were inappropriate for analyzing the disequilibrium adjustment processes occurring in capitalist economies. This was the background of Clower's decision to base macroeconomics on Marshallian foundations.

Chapter I: The origins, development, and fate of Clower's 'stock-flow' general-equilibrium program

Introduction

Before becoming the hallmark of macroeconomics *à la* Wynne Godley, the 'stock-flow' analysis was already developed in microeconomics and general equilibrium theory.[1] Basically, the goal was to study the formation of economic plans and the determination of market prices when individuals were supposed to consume, produce, and hold commodities for future disposal. It is acknowledged that Clower was a central figure in this context because of his pioneering and extensive works on 'stock-flow' market models (Glenn W. Harrison, 2008). Yet, for both his contemporaries and for historians, his contributions remained essentially technical. No attention was paid to the theoretical project underlying the statics and dynamics analyses of his 'stock-flow' price theory. My chapter aims to fill this gap. To do so, I make an extensive use of the archival material found at Duke University. Particular attention will be given to Clower's doctoral dissertation. This unpublished manuscript is the central piece needed to solve the theoretical puzzle. The elaboration of 'stock-flow' market models was part of a project aiming at offering sound microfoundations to a business cycle theory inspired by Keynes (1936) and supposed to include the models of Harrod (1939) and Hicks (1950) as special cases. Since the 'stock-flow' structure was used to support this unification, the incorporation of the relations of stock and flows into standard microeconomics and into the general equilibrium theory became the cornerstone of the project. My paper offers a detailed

[1] Godley is often considered as one of the founding fathers of the "stock-flow consistent models" (Claudio H. Dos Santos and Gennaro Zezza, 2004).

presentation of the resulting 'stock-flow' general equilibrium program of microfoundations. I analyze its origins, trace its development, and discuss its fate.

The 'stock-flow' market models were developed in partial and general equilibrium frameworks in a series of papers published in the early 1950s, and in a book titled *Introduction to Mathematical Economics* (1957). In 1953, Clower set the basic structure of the 'stock-flow' price theory. His point was that when commodities were consumed, produced, and held by individuals (e.g., capital goods stored by entrepreneurs), the determination of equilibrium prices required taking into account current activities and the resulting effects on the stocks held by individuals. This paper paved the way for formal investigations on the statics and dynamics properties of 'stock-flow' market models. They were presented in three articles: "An investigation into the Dynamic of Investment" (1954a), "Productivity, Thrift and the Rate of Interest" (1954b) and "Price Determination in a Stock-Flow Economy" (1954). The last two papers were written with a mathematician specialized in dynamics, Bushaw. This marked the beginning of a collaboration which culminated with the writing of *Introduction to Mathematical Economics*, a book almost entirely devoted to 'stock-flow' market analyses.

This market theory was developed with no clear reference to a search for microfoundations of macroeconomics. Macroeconomic issues were always put in the background, and in *Introduction to Mathematical Economics*, Bushaw and Clower devoted only a short appendix to the derivation of a Keynesian macromodel from the 'stock-flow' price theory. In view of this, it is not surprising that neither Clower's contemporaries nor the historians perceived the theoretical project underlying the analysis of the 'stock-flow' models. Reviewers of *Introduction to Mathematical Economics* (Diran Bodenhorn, 1958; John A. Nordin, 1958; Victor E. Smith, 1958; Allen Spivey, 1958; and William J. Baumol, 1959) essentially praised the clarity and rigor of the mathematical treatment of price determination processes. Those who used the 'stock-flow' price theory considered that Bushaw and Clower

provided only a general analysis that needed to be oriented, either to ground Keynes' theory (Cliff L. Lloyd, 1960; Baumol, 1962) or to enhance the understanding of microeconomic behaviors of entrepreneurs (Vernon L. Smith, 1961; Sam Jr. Chase, 1963; Richard S. Higgins, 1972) and of consumers (Josef Hadar, 1965). With regard to the historians, emphasis was given to the role played by Bushaw and Clower in dynamics since they pioneered the Lyapunov technique to study the stability of competitive equilibrium (Weintraub, 1991; Giancarlo Gondolfo, 2010; Backhouse and Boianovsky, 2013). Therefore, until now, a technical rather than theoretical interpretation has prevailed among reviewers, theorists, and historians.

Yet, Clower's 'stock-flow' market models were an outgrowth of a theoretical project outlined in his doctoral dissertation. The project can be summarized as an attempt of synthesis between Hicks's *Value and Capital* (1939) and Hicks's *Contribution to the Theory of the Trade Cycle* (1950). At the macroeconomic level, Clower also drew inspiration from Keynes's *General Theory* to build his own theory of capital accumulation. The resulting macromodel was structured around the articulation of stocks and flows, a feature considered as the essence of the capital accumulation process. This supported Clower's claims to have found a "general theory of capital accumulation" that could include the models of Harrod (1939) and Hicks (1950) as special cases. At the microeconomic level, Clower set about revising the framework found in *Value and Capital* to ground the relations of stocks and flows. But he did not manage to formulate a general theory of markets. Accordingly, Clower could neither clarify the logical properties of his business cycle model nor demonstrate the consistency between his theory of choices and aggregates. The program of microfoundation was incomplete. This was one of the reasons why Clower failed to obtain his Oxford D. Phil. Thereafter, Clower developed the 'stock-flow' market models in view of carrying out his project to provide microfoundations to Keynesian business cycle models.

1. Clower's PhD dissertation as the origins of the 'stock-flow' general-equilibrium program

Clower's doctoral dissertation sketched a program to provide microfoundations to Keynesian macroeconomics. In the introduction of his dissertation, Clower indicated his intention to follow in Hicks's (1939) footsteps to "lay the foundations of a general theory of capital accumulation" (1952a: p. 11). This theory, inspired by Keynes (1936), would include the kind of business cycle models developed by Harrod (1939) and Hicks (1950) as special cases. The reason was that its structure, the articulation of stocks and flows, was considered as the essence of the capital accumulation process. Since the relation of stocks and flows was not taken into account in standard microeconomics, Clower set about revising the theory of choice. He formulated the "producer-consumer" theory of the firm and used it to justify some properties of Keynes's and Keynesian business cycle models. But the resulting connections with macroeconomics remained limited because a general theory of markets was lacking.

1.1 Microfoundations of Keynesian macroeconomics

Clower's doctoral dissertation, *Theories of capital accumulation with special reference to their ability to explain the experience of the U.S since 1870* (1952a), was separated into three sections: macroeconomics, empirical testing, and microeconomics. After the introduction (chapter 1), Clower expounded a model of aggregate supply (chapter 2). Then, he presented the Keynesian theories developed by Harrod (1939) and Hicks (1950) (chapter 3) and his reformulation of Keynes' theory of the trade cycle (chapters 4-5). The last two chapters were devoted to a statistical study aiming at testing the empirical content of his macromodel. After the conclusion (chapter 8), in appendices, Clower dealt with microeconomic issues: the introduction of assets into the standard theory of the firm (appendix I); the validity of the "traditional" law of demand when individuals were supposed to consume and hold commodities

(appendix II); and the introduction of interdependent preferences in the standard theory of the consumer (appendix III).

In the introduction, Clower claimed that the dissertation was written in reverse order. This indicated his intention to provide sound microfoundations to Keynes's and Keynesian theories of capital accumulation:

> The writer began by examining the general pure theory of economic behavior (as expressed e.g., in *Value and Capital*) in an attempt to discover whether that theory was in any way inadequate as a foundation for capital accumulation theory. After making appropriate alterations to the general theory, the writer tried to fit various recent theories of capital accumulation [Reference to Keynes (1936), Harrod (1939) and Hicks (1950)] into it as special cases (1952a: p. 8).

Clower believed that the understanding of capital accumulation processes required starting from individual behavior (1952a: p. 12). But since practical results could hardly be obtained at this level of analysis, he also expressed the need to formalize aggregative models similar to those developed by Harrod and Hicks (1952a: p.12). Of course, Clower raised the issue of the compatibility between these two levels of analysis. In the introduction of his dissertation, he questioned in particular the compatibility between Keynes's *General Theory* and standard microeconomics, as expressed by Hicks in *Value and Capital*. According to him, Walrasian and Keynesian theories were fundamentally compatible. But this compatibility was conditional on modifications of Walrasian microeconomics:

> From a formal point of view, is the *General Theory* a special case of established general equilibrium theory? Once again, there are essential differences between the two levels of analysis, differences which may not be reconcilable until the foundations of general equilibrium theory are broadened (1952a: p. 5).

In brief, Clower intended to follow in Hicks's (1939) footsteps.[2] Influenced by the "pure logical analysis of capitalism" ([1939] 1946: p. 4) expounded in *Value and Capital*, he considered i) that macroeconomics had to be deduced from sound and reliable microeconomics; and ii) that the formulation of a general equilibrium model was necessary to prove the compatibility between these two levels of analysis. Viewed from this microfoundational angle, Clower's originality lay in his intention to modify Walrasian microeconomics to offer "the foundations of a general theory of capital accumulation" (1952a: p. 11).

1.2 The "general theory of capital accumulation" and the articulation of stocks and flows

To understand the general nature of Clower's theory of capital accumulation, it is necessary to go beyond the explanation of trade cycles to focus on the basic structure of the model. Clower started from Keynes' liquidity preference theory and deduced a macromodel with an explicit 'stock-flow' architecture. He wanted to show that the cyclical dynamic was ultimately related to the variations of the stock of capital assets, variations due to the difference between capital inflows and outflows. According to him, the same was true in the models developed by Harrod and Hicks. The cyclical dynamic was mainly explained by the accelerator, a relation linking the rate at which the flow of output was changing with the stock of capital assets. Because of that, the relation of stocks and flows was perceived as the dynamic essence of trade cycles. Since this relation was at the heart of his macromodel, Clower claimed to have found a "general theory of capital accumulation."

1.2.1 From Keynes (1936) to the articulation of stocks and flows

In contrast with Keynes, Clower did not focus on the marginal efficiency of the capital but on the liquidity preference to build his business cycle model. In chapter 22 of the *General*

[2] For an exhaustive presentation of Hicks' method, see Weintraub (1979). For a short presentation, see Hoover (2012).

Theory, Keynes (1936) considered that the marginal efficiency of the capital was the only component of the effective demand that fluctuated repeatedly and cyclically. But according to Clower, he neither gave decisive arguments to discard other components (the propensity to consume and the liquidity preference) nor did he succeed in explaining why the marginal efficiency of the capital fluctuated cyclically (1952a: p. 80-83).[3] All of this justified a reorientation. The starting point was an extension of the liquidity preference theory. Clower tried to show that Keynes' monetary theory could be applied to physical assets. Transactions, precautionary, and speculative motives remained relevant to analyze investment decisions. The transaction motive was equivalent to a production motive. Firms needed to hold physical assets to produce (1952a: p. 69). The precautionary motive was at work when entrepreneurs decided to use only part of their production capacity, what Clower called "desired excess-capacity" (1952a: p. 71). Finally, entrepreneurs held capital assets for the sake of their expected yield, which characterized the speculative motive (1952a: p. 70). Keynes stressed the role of speculative behaviors in the determination of the rate of interest and therefore in the determination of income. Clower added that speculative behaviors could also have an effect on the capital accumulation process and therefore on fluctuations:

> The theory of liquidity preference was linked by Keynes to the theory of output in such a way that economic activity in the real sphere could be shown to be "mirrored" in the money market. From there it was a short step to the conclusion that speculation (in the broadest sense) largely governs the behavior of real output, employment and capital accumulation (1952a: p. 185).

[3] In fairness to Keynes, the exclusion of the propensity to consume was suggested by its formalization. Since it depended partly on realized income, it could not be considered as a cause of fluctuations. With regard to the liquidity preference, Keynes maintained that its modifications would necessarily be the consequence of a previous variation of entrepreneurs' long-term expectations (1936: p. 316). Accordingly, this component could not be viewed as a cause of fluctuations: "Liquidity preference […] does not increase until after the collapse in the marginal efficiency of capital" (1936: p. 316). Yet, it could be a factor prolonging the slump (1936: p. 316).

To formalize this twofold effect, he elaborated a macroeconomic model in which the level of income and its fluctuations across time were presented as the consequences of the interaction between the stocks and the flows of capital assets. As depicted in figure 1, he assumed first that the rate of interest (v) was determined when entrepreneurs wanted to hold the whole stock of existing assets (C=K); second, that the level of gross investment (k) was fixed when the flow of new capital assets was such that the supply price equaled the rate of interest (1952a: p.76); and third, that the equilibrium was stationary when the flow of gross investment equaled the flow of depreciation (d). Clower graphically portrayed this framework by distinguishing the stock part from the flow part of the model (1952a: p.75). The two were interconnected in dynamical analyses in order to describe the process of the rise and fall of the stock of capital, once the flow of gross investment did not match the flow of depreciation.

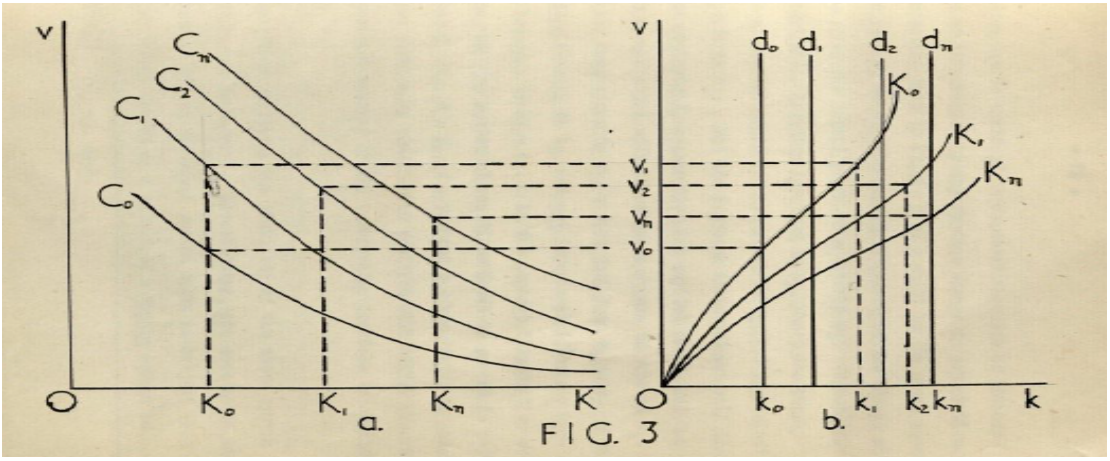

Figure 1 Clower's (1952a: p. 75) diagram showing the market for capital assets

To explain fluctuations on this basis, Clower claimed to follow the intuitions expressed by Keynes in chapter 5 ("Expectation as determining output and employment") of the *General Theory*. There, Keynes put forward the distinction between short-run and long-run expectations as well as a proposal to explain the trade cycle.[4] He maintained that a disturbance of

[4] In the short-run, entrepreneurs had to anticipate the price at which output would be sold as well as the capacity of absorption of the economy during a given market period; in the long-run, they had to anticipate the future

entrepreneurs' long-term expectations led to the emergence of a new stationary position, and that the process of transition to this position could be used to explain fluctuations. Like Keynes, Clower considered "the process of transition to the (new stationary) position" to address the trade cycle (1952a: p. 74). In figure 1, the economy was initially in a situation of stationary equilibrium. Entrepreneurs' stock-demand for capital assets (C_o) set the rate of interest at the level (v_o) at which the flow of gross investment (k_o) equaled the flow of depreciation (d_o). In figure 1, the process of transition towards a new stationary equilibrium (after a positive disturbance of entrepreneurs' long-term expectations) was expressed via the transition from K_o to K_n. According to Clower, this process was stable in the absence of uncertainty: entrepreneurs' absolute confidence on the returns on investments led them to increase their stock-demand for physical assets until the stationary position was reached. Yet, in the context of uncertainty considered by Keynes (1936), assets demand would have been subject to violent and repeated changes so that the economy would have never reached the new stationary position. Because of this instability of the stationary equilibrium, the stock of capital assets would have varied continuously thus explaining the trade cycle (1952a: p. 88-92).

1.2.2 The articulation of stocks and flows: the essence of the capital accumulation process

Clower repeatedly stressed that the 'stock-flow' architecture was not specific to his interpretation of "Keynes' views on the trade cycle" (1952: p. 11). In the introduction of his dissertation, the Keynesian models in the tradition of Harrod (1939) were reduced to this structure:

proceeds of an additional unity of capital taking into account the potential modifications of the taste of consumers, of the effective demand, and of the variations of nominal wages.

> On a fairly rigorous but highly restrictive *mechanical* level of analysis, capital accumulation is considered as one aspect of the more fundamental distinction between stocks and flows (i.e., the acceleration principle) (1952a: p. 2).

Following the seminal work of Harrod (1939), the ambition of Keynesians was to account for capital accumulation as an endogenous process resulting from the interaction of the multiplier and the accelerator.[5] Since the accelerator was a function linking the rate at which the flow of output was changing with the stock of capital assets, Clower considered that this approach deduced cyclical dynamics from the interactions of stocks and flows. Because of this common structure, Clower concluded that he had found a way to unify Keynesian theories of capital accumulation:

> The argument in previous chapters has been devoted primarily to demonstrating the unity of recent theories of capital accumulation. In retrospect, it appears that the thread which links together various theories – a thread that is hidden by difference in method and content – is to be found in the distinction between the *using* and the *holding* of assets [reference to Keynes (1936)]. This distinction obviously implies but it is not implied by the distinction between stocks and flows [reference to the models following Harrod (1939) and Hicks (1950)] (1952a: p. 184).

In this quotation, Clower suggested that his own macromodel could serve as a basis to elaborate the general theory of the trade cycle since the 'stock-flow' architecture referred back to individuals' decisions and so, was deeply grounded. Thanks to Keynes' liquidity preference theory, Clower linked the relation of stocks and flows to entrepreneurs' decisions to hold

[5] Clower indicated that "the models of Mr. Harrod and Professor Hicks are only two of many possible mechanical theories of capital accumulation [references to Metzler (1941) and Samuelson (1944)], but since the results and shortcomings of these two models are broadly characteristic of mechanical analyses, generally, we need not consider other theories" (1952a: p. 53).

(precautionary and speculative motives) and to use (transaction motive) assets. This way of justifying the general nature of his theory might reveal a methodological argument. Clower might have been seduced by Paul A. Samuelson's (1947) methodology, inspired by Eliakim H. Moore's principle of generalization by abstraction.[6] His "general theory" seemed to stem from the application of the assertion that "the existence of analogies between central features of various theories implies the existence of a general theory which underlies the particular theories and unifies them with respect to those central features" (Samuelson, 1947: p. 3). Since the articulation of stocks and flows (the analogy between Keynesian business cycle models) was at the heart of his macromodel, Clower thought he had found a "general theory of capital accumulation".

1.3 Microfoundations of the "general theory of capital accumulation"

Clower sought to develop his own theory of choice, the "producer-consumer" theory of the firm, to ground the 'stock-flow' structure.[7] To demonstrate the relevance of this micromodel, Clower undertook to justify the central features of Keynes and Keynesian theories of the trade cycle. Yet a general theory of markets was missing. Therefore, the connections with macroeconomics remained mainly informal and incomplete.

[6] In the dissertation, Clower referred to the *Foundations* but not directly to Moore. Yet the principle of generalization by abstraction later became a clear reference, used to justify his second line of research, developed in the 1950s (see "On the existence of a general theory of price determination" (c.1954a: p. 49) Box 4).

[7] Clower also modified the standard theory of the consumer to ground his business cycle model. He started with James S. Duesenberry's (1949) idea that the preferences were interdependent. This meant that in addition with absolute income, the relative position in the society mattered in patterns of consumption. Typically, individuals would increase their consumption expenditures with increasing consumption expenditures in their social network. This micromodel was intended to endogenize the trend and the "floor" of his theory of the trade cycle. The maintenance of the consumption, to keep up with the Joneses, would underpin the minimum limit of investment at which the economy would rebound. And since this "floor" was supposed to depend on the stock of capital assets accumulated and that this stock was likely to increase over time (1952a: p. 43), a rising trend would be described. Clower presented in details his modifications of the standard theory of the consumer in an article titled: "Professor Duesenberry and Traditional Theory" (1952b).

1.3.1 The "producer-consumer" theory of the firm

Entrepreneurs were the central figure in Clower's "general theory of capital accumulation". The choices they made concerning the holding and the using of physical assets underlined the 'stock-flow' architecture and explained the fluctuations (in a context of uncertainty). Yet according to Clower, these aspects of entrepreneurs' behavior were not taken into account by the standard theory of the firm. There was no distinction between the holding and the using of assets, and no psychological dimension to account for entrepreneurs' appreciation of the business climate (1952a: p. 71). Accordingly, he proposed modifications. This resulted in the "producer-consumer" theory of the firm (1952a: p.71; p.187), a micromodel inspired by the works of Leonid Hurwicz (1946) and Johannes de Villiers Graaff (1950).[8] The first modification consisted of introducing asset holding in entrepreneurs' optimization plans. To do so, Clower proposed to account for the evolution of the wealth of the firm (x_i') in the calculation of profits (π). The second modification consisted of replacing the traditional production function by another constraint establishing both a technical and a subjective link between the quantity produced, consumed, and held at the end of the market period. To do so, Clower introduced the quantity of assets that entrepreneurs sought to hold at the end of the market period (D) in the traditional production function. There would have been uncertainty since (D) ultimately depended on entrepreneurs' expectation of assets' prices (and so of the value of their wealth), at the reopening of markets (1952a: p. 194).[9] The resulting function

[8] These two economists were the main references of Clower, both in his dissertation and in the paper that he devoted to the "producer-consumer" theory of the firm (1952c). Yet, it is important to note that in the early 1950s, there was a general concern for the economic effects of the interactions between stocks and flows. The proposals of Hurwicz, De Graaff, and Clower were part of a broader reflection on the incorporation of wealth (i.e., assets and debts) in standard microeconomics, in order to explain the influences of stocks on economic behaviors and *vice versa* (See Lawrence Klein's paper "Assets, Debt and Economic Behavior" (1951) for a review). In another way, these preoccupations underlined the proposals of Morris A. Copeland (1949) to broaden social accounting to monetary flows.

[9] Clower did not formalize explicitly the expectations. He thought that the introduction of *D* would be sufficient to account for entrepreneurs' degree of uncertainty. Thus, unlike Hicks (1939), he did not resort to intertemporal

would have remained technical because it described how entrepreneurs made their output decisions (x_i) so as to hold the quantity of wealth desired at the end of the market period. Formally, entrepreneurs' maximization plan was defined as follows:

$$\begin{cases} Max\ \pi = -\sum_{i=1}^{n} p_i(x_i + x_i') \\ s.t.\ \phi(x_1, x_2 \dots, x_n; D_1, D_2 \dots, D_n) = 0 \end{cases}$$

With x_i, the quantity used in the production less the quantity produced; x_i', the quantity that entrepreneurs decided to hold at the end of the market period less the quantity held from the outset; $\phi(x_1, x_2 \dots, x_n; D_1, D_2 \dots, D_n)$, the "decision function"; and D_i the quantity held at the end of the market period.

1.3.2 The connections with macroeconomics

The construction of aggregate was mentioned in chapter II. Clower explained that he used the "composite-commodity theorem" (1952a: p. 18). This theorem proposed by Hicks (1939) defined conditions to treat the aggregate as an individual (Hoover, 2012: p. 36). A representative consumer and a representative firm replicate the behaviors of all the individuals, and the commodities whose prices vary in the same direction and almost in the same proportions are represented by a single commodity. Clower neither formally explicated the conditions for the application of this theorem nor did he address its applicability to the real world. It was as if the issues raised by aggregation were considered as secondary. This is surprising to say the least since Clower was engaged not only in a conceptual analysis but also in an empirical study of the capital accumulation process.

optimization and expectations to address decision making in a context of uncertainty. This may be explained by Hicks's (1939) own difficulty to elaborate a theory of expectations rooted in individuals choices.

On the other hand, Clower was concerned with the justification of some macroeconomic features through individual behavior. In chapter III, he focused on the connection between the "producer-consumer" theory of the firm and the accelerator. This mechanism was supposed to work only if inputs were not fully utilized (1952a: p. 45). He argued that, in contrast with standard microeconomics, the "producer-consumer" theory of the firm could account for the underutilization of capital assets. The distinction between the holding and the using of assets, coupled with the new production function, would open up the possibility to introduce precautionary behaviors in the theory of the firm:

> Professor Hicks' formulation of the acceleration principle is not, as a rule, consistent with the usual theory of the firm. If the formal theory of the firm is modified to conform to common sense views (the existence of desired excess capacity), the difficulties considered (deduction of the accelerator) do not arise (1952a: p. 47).

Entrepreneurs would decide capacity utilization depending on their appreciation of the business climate. Clower inferred that the "producer-consumer" theory of the firm was an adequate foundation for the accelerator (1952a: p. 47). However, this conclusion remains subject to caution since nothing explains how to account for the tensions on output decisions when entrepreneurs are pessimistic. One avenue would have been to specify the new production function but it was not explored by Clower.

In chapter IV, Clower focused on the connection between the "producer-consumer" theory of the firm and Keynes's theory of investment. This was undertaken in the course of a general reflection on the deduction of key Keynesian functions (1952a: pp. 60-66). Clower's procedure was to deduce individual supply and demand functions from optimization plans and then, by simple summations, to obtain their aggregated version. The supply and demand

functions resulting from the resolution of the "producer-consumer" program differed from the standard ones (1952a: p. 61):

$$\begin{cases} C^{\mathrm{s}} = C^{\mathrm{s}}(p, w, v, K_{\mathrm{o}}) \\ L^{\mathrm{d}} = L^{\mathrm{d}}(p, w, v, K_{\mathrm{o}}) \\ K = K(p, w, v, K_{\mathrm{o}}) \\ k = k(p, w, v, K_{\mathrm{o}}) \end{cases}$$

All the functions depended on prices (p), wages (w), the interest rate (v) and, what was new, on the existing stock of capital assets, K_0. In addition to the usual functions C^{s} and L^{d} which characterized the supply of consumer goods and the labor demand, Clower deduced K representing the demand for capital assets and k, the supply of *new* capital assets (1952a: p. 61). On this basis, Clower claimed to deduce Keynes' theory of investment. He considered that the asset demand curve and the supply of new capital assets could be used to replace Keynes' relations. In his theory, the marginal efficiency of capital was the discount rate which equalized the value of expected net returns of the capital with the supply price of a marginal unit of capital. The level of investment was such that the interest rate equalized this discount rate. In Clower's model, the supply of new capital goods characterized the quantity of new capital assets that the marginal producer decided to produce given the rate of interest, and the asset demand curve included entrepreneurs' calculation concerning the expected net return of holding real assets. In this context, Clower contended that the level of investment was determined, in equilibrium, at the point of the supply curve which equaled the demand price in the market for existing assets. This would have been only an "elaborate way of stating the equilibrium condition mentioned [by Keynes]" (1952a: p. 62).

In the dissertation, the main shortcoming of Clower's project to provide microfoundations to Keynesian macroeconomics was the absence of a general theory of markets. In a program *à la* Hicks (1939), this was seen as a crucial step to demonstrate that

macroeconomics could be deduced from the theory of choice.[10] Without market model, Clower could neither account for the logical properties of his "general theory of capital accumulation" nor offer formal proofs of the consistency between economic behavior and aggregate. It was partly because of this gap that Clower failed to obtain his Oxford D. Phil. His examiners, Ian M.D. Little and Charles M. Kennedy, acknowledged that the microeconomics expounded in appendices presented "some undoubted contributions to economic theory".[11] But at the same time, they stressed that there was "no very substantial connection with the main theme of the dissertation". Besides, they found that "there [was not] any new contribution" to macroeconomics and that "the statistics [study] was not of the highest quality".[12] Accordingly, they decided that the thesis justified only an Oxford B. Litt.[13] Retrospectively, Clower recognized that his thesis "was not in a form fit for publication" and "did not produce what he had hoped".[14] This would have led him to "develop healthier motivations", staying "six months at home not only with *Value and Capital* but also with Pareto and Walras". The first outgrowths of these investigations appeared in "Business Investment and the theory of prices" (1953). Clower put forward the basic structure of a 'stock-flow' market theory, the missing element of

[10] Because of the absence of market models, it is also difficult to understand the kind of theory of the trade cycle contemplated by Clower. Did he have in mind an equilibrium model of the business cycle? Or did he consider that the trade cycle had to be thought by means of derivations with regards to equilibria, like in the models of Harrod (1939) and Hicks (1950)? Whether markets were supposed to clear or not in various stages of the trade cycle modified fundamentally the understanding of this phenomenon.

[11] The quotations are taken from the jury's report. Oxford University Archives: FA4/18/3/1, SS.R (52)16.

[12] When Clower explained retrospectively why his PhD thesis was failed, he mainly put the stress on the lack of consistency between the theoretical and statistical parts of his PhD thesis. This is striking in his Presidential Address to History of Economics Society (1998) and in his interview with Brian Snowdon and Howard Vane (1999). In both cases, he explained that he undertook a statistical study on the advice of Hicks (who informed him that "to obtain an Oxford doctorate in economics", it was necessary to "exhibit skill in handling facts along with theory" (1998: p. 501)); and that eventually, the statistical and theoretical "parts did not go together [which explained] why [his] dissertation was not accepted for the Oxford D. Phil" (1999: p. 178).

[13] Although Kennedy and Little "considered asking [Clower to revise his dissertation, they came] to the conclusion that, on the more theoretical side, [Clower had] not enough of importance to say to make a satisfactory D. Phil thesis; while any great elaboration of the more practical side would result in a new thesis, rather than an improvement of this one". Note that this excerpt from the jury's report contradicts what Clower claimed in his interview with Snowdon and Vane (1999). He did not have the opportunity to revise his dissertation and to re-submit it in the hope of obtaining the Oxford D. Phil (1999: p. 178).

[14] The quotations are taken from a resume written by Clower in 1964. R. W Clower Papers, Box 1-2001-0088, Rubenstein Rare Book and Manuscript Library.

his doctoral dissertation. At that time, he taught at the Washington State University where he met Bushaw. With his help, Clower proposed the first formal analyses of the 'stock-flow' price theory, in a series of three papers published in 1954.[15] This collaboration culminated in the publication of *Introduction to Mathematical Economics* (1957).

2. The 'stock-flow' market theory: statics and dynamics

Let us focus on the main statics and dynamics properties of the 'stock-flow' market theory.

2.1 'Stock-flow' market models: statics

The 'stock-flow' market models portrayed economies in which the typical commodity was consumed, produced, and held by individuals. This resulted in the formulation of two sets of functions. The first one accounted for the flow dimension of the market theory. The functions characterized the rate at which commodities were newly produced (s_i) and newly consumed (d_i) during the market period – the excess-flow-demand $[(d_i) - (s_i)]$ is here expressed by the variable ED_F. The second set of functions accounted for the stock dimension of the market theory. The functions characterized the stock of commodities that individuals inherited from the past, at the beginning of the market period $\left(S_i^t = S_i^0 + \int_{t_o}^{t}(d_\mathrm{i} - s_\mathrm{i})\, dt\right)$ and the stock of commodities that they wanted to hold at the end of the market period (D) – the excess-stock demand $[(D) - S]$ is here expressed by the variable ED_S.[16] With the exception of the stock-supply, all the functions were supposed to depend on current market prices.[17]

[15] In the mathematical appendix of "An Investigation into the dynamics of investment" (1954a), it is indicated that "this note was prepared by R.W. Clower and D.W. Bushaw, who is instructor in mathematics at the State College of Washington, Pullman" (1954a: p. 78).

[16] This is the mathematical expression offered by Bushaw and Clower (1954: p. 328). They considered a continuous-time model. A discrete-time model required using a sum instead of an integral.

[17] (S) was a vertical line which indicated that at a given moment of time, the quantity held by individuals could not change and was independent of current market prices.

A 'stock-flow' market theory explained the determination of prices by taking into account consumption, production, and the resulting variations of the stocks of commodities in presence in the economy. In this context, the key variable was the stock of commodities held by individuals. The flows of new consumptions or productions were supposed to adjust the stocks at a quantity desired when, at the beginning of a market period, some individuals considered that the stock inherited from the past was no longer adapted given current market prices. In view of this, two types of equilibria were distinguished. The first one was called "temporary" since the stocks of commodities showed tendency either to rise or to fall.[18] The second equilibrium, called "stationary", characterized situations in which the stock of commodities was constant from market periods to market periods. Formally, the "temporary" equilibrium was a situation represented by the following system:

$$\begin{cases} ED_F + ED_S = 0 \\ ED_F \neq 0 \end{cases}$$

The first line of the system characterized the "market excess-demand". This expression represented the total quantity purchased during the market period less the total quantity offered during the market period. Put simply, when individuals desired to alter their stock of commodities, this entailed differences between the rates of consumption and production in the economic system. The condition was that at the end of the market period, all the individuals satisfied their optimizing programs (i.e., they held the quantity of stocks desired, given current market prices) and so, that the markets cleared. If the equilibrium was "temporary", then at the reopening of the markets, because of the new quantity of stocks in presence in the economy, the set of prices would be different thus leading to other adjustments of consumptions and productions. If individuals did not desire to alter their stock of commodities at the reopening of

[18] From 1953 to 1957, the terminology changed. The expression "non-stationary equilibrium" was substituted to the expression "temporary equilibrium" in *Introduction to Mathematical Economy*.

markets, then the economy was supposed to have reached the stationary equilibrium. Formally, this situation is represented by the following system:

$$\begin{cases} ED_F + ED_S = 0 \\ ED_F = 0 \end{cases}$$

2.2 'Stock-flow' market models: dynamics

In 'stock-flow' models, the price determination process was affected by current activities as well as the resulting variations of the stocks of commodities in the economy. So, changes in prices were supposed to be patterned by the excess-flow-demands and the excess-stock-demands (1954: p. 329; 1957: p. 118):

$$\frac{\partial \mathrm{p_i}}{\partial \mathrm{t}} = f_i(ED_F; ED_S)$$

This resulted in formal differences between characteristic polynomials (1954: p. 338-340) so that stable coefficient matrices in pure stock and pure flow models could be unstable in 'stock-flow' models. According to Bushaw and Clower, this result had an empirical content since the data of the economy were constantly changing (1957: p.80). This was an argument to justify the use of 'stock-flow' models:

> From the very outset, there is a presumption in favor of a stock-flow theory over a pure stock theory or a pure flow theory. Whether or not this presumption is decisive, however, depends on the extent to which the logically simpler pure stock and pure flow theories provide an adequate basis for the interpretation of empirical phenomena – on the extent to which stock-flow relationships can be ignored or else dealt with implicitly in terms of the simpler models. The preceding argument seems to shed some light on this question. If it were the case that stock-flow relationships could be safely ignored, our discussion might have

> been expected to support this surmise by indicating that the intersection of stock-flow relationships into a model would affect no essential changes in its character. But our analysis leads in fact to precisely the contrary conclusion. […] We are thus led to the inference that an effective general model for the study of price determination and kindred questions, whatever other characteristics it may have, should be a genuine stock-flow model (1954: p. 343).

Consideration of pure stock or pure flow models could lead to ignore a potential problem of instability. Those approximations were not neutral. Because of that, it would be better to use 'stock-flow' market models.

3. Decoding the 'stock-flow' market analyses

The program of microfoundations opened in Clower's doctoral dissertation was in the background of the statics and dynamics analyses of 'stock-flow' market models. A careful study of the early papers (1954a; 1954b) reveals that Clower intended to demonstrate that his market models could be an adequate interface with Keynes' theory of investment and the liquidity preference theory. Then, the link between the "producer-consumer" theory and Keynesian business cycle models can be established by combining some arguments contained in the micro and macro chapters of *Introduction to Mathematical Economics*. Finally, in the "Keynesian appendix" of this book, Bushaw and Clower undertook the derivation of the standard IS/LM models from their 'stock-flow' price theory. All of this shows that the micro-macro relation was still a focal point. Accordingly, why did macroeconomics remain in the background? There was a methodological reason for that. Clower considered that macroeconomics should not be the priority until the logical properties of disaggregated systems were fully known. Otherwise, the simplifications required to build aggregates would be a source of error that could have damaging consequences for policy recommendations.

3.1 The Keynesian connections

In 1954, Clower developed two 'stock-flow' models in partial equilibrium to address the theory of investment and the theory of interest rate. More or less explicitly, statics and dynamics properties were used to connect Keynes' *General Theory*.

Following the lines of his doctoral dissertation, Clower (1954a) explained the determination of the level of investment and claimed that "a curve K_r which Keynes would call schedule of marginal efficiency of capital" (1954a: p. 76) could be deduced from his 'stock-flow' market theory. The level of investment was set by distinguishing two logical steps. The first one was the determination of the price of capital goods, at the intersection between the stock-supply (S) and the stock-demand (D).[19] The second step was the determination of gross investment and depreciation. Clower considered that the level of gross investment was fixed when the rate of production of new capital assets during the market period (s) was such that the supply price equaled the price of capital assets (1954a: p. 67). Likewise, depreciation was determined when the rate of consumption of capital goods during the market period (d) was such that the demand price equaled the price of capital assets (1954a: p. 69). Net investment was considered as a residual, the difference between gross investment and depreciation given the current price of capital goods. On this basis, Clower proposed to deduce Keynes' theory of investment. He assumed different levels of the rate of interest. *Ceteris paribus*, for each level, the demand for existing capital assets would be different since entrepreneurs' appraisals of their discounted value would be modified. This resulted in different price of capital goods and so, different levels of net investment. According to Clower, the relation associating the different

[19] Note the modification of the formalization of the "temporary" equilibrium. There is no inconsistency with the general case expounded in 2.1. Here, Clower assumed that the price at which individuals wanted to hold stocks was independent of the variations of stocks (cf. the mathematical appendix (1954: p. 78)).

levels of interest rate and the different levels of net investment could be viewed as an approximation of Keynes' marginal efficiency of capital schedule (1954a: p. 76).

Clower (1954b) was less explicit when he turned to the connections between the liquidity preference theory and the 'stock-flow' market theory. The analysis of an unpublished manuscript (probably a first version of his 1954 paper) is necessary to support my viewpoint. In this manuscript, Clower maintained that the opposition between the liquidity preference and the loanable funds theories of interest was an opposition between short-run and long-run analyses. In the short-run, saving and investment could be considered to be negligible because of existing large stocks of assets. Therefore, the dynamic path of the rate of interest would be mainly explained by speculative behaviors. However, in the long-run, saving and investment would be the main forces underlying the course of the rate of interest. Because of the nature of this opposition, Clower maintained that it was possible to conciliate the two existing theories in one framework. He proposed the 'stock-flow' price theory:

> Changes in the rate of interest will be speculative in nature since changes in "productivity and thrift" during any short space of time can have little direct effect upon holder demands or upon existing stocks of bonds. In the long run, however, "productivity" will largely govern the quantity of outstanding bonds, while "thrift" will have a definite influence on the level of holder demands for debt. Thus, a "stock" theory of interest is preferable to a "flow" theory if attention is centered upon short-run problem. And if one is concerned mainly with traditional long-run economic questions, the use of a "flow" theory is indicated. However, to deal adequately with both kinds of problems, one must

> have recourse to a stock-flow theory of interest such as that just outlined – a theory which reconciles the two existing approaches.[20]

The distinction between short-run and long-run analyses was ultimately related to the elasticity of the excess-flow-demand curve. According to Clower, "a specific 'stock-flow' relationship" (1954b: p. 114) was that the slope of the excess-flow-demand curve depended on the length of the market period. The shorter the market period, the less the quantities of bonds newly issued and currently bought would have affected price determination because of existing large stocks. In economic terms: on the financial markets, saving and investment (represented by the excess-demand for bonds) would have almost no effect on the dynamics of the rate of interest in the short-run. Instead, it would be linked to speculative behaviors (represented by the excess-stock-demand for existing bonds), which would correspond to Keynes' theory of interest.[21]

3.2 From micro to macro

Thanks to a combination of arguments contained in the micro and macro chapters of *Introduction to Mathematical Economics*, it appears that Clower continued the microfoundational program sketched in his doctoral dissertation. In chapter VI, "Microeconomics II", Bushaw and Clower deduced the excess-stock-demand and excess-flow-demand functions of their price-theory from the "producer-consumer" theory of the firm:

> The function $\phi\ (x_1, x_2 \dots, x_n; D_1, D_2 \dots, D_n)$ is appropriately called a *decision function;* for when allowance is made for the holding of assets (one of which may be money), the essentially subjective character of the function is apparent.

[20] This quotation is from "A Suggestion for Generalizing the Pure Theory of Production" (c.1954b). R. W Clower Papers, Box 4, Rubenstein Rare Book and Manuscript Library.

[21] This "short-term" dynamic feature of 'stock-flow' models did not imply that the stationary equilibrium was unstable. Rather, Clower demonstrated that if the excess-flow-demand curve was both flat and had the same sign of the excess-stock-demand curve, the stationary equilibrium was stable (1954b: p. 113). Nonetheless, this would pave the way for such a result once uncertainty would be taken into account (1954b: p. 114).

> […] Finally, the entrepreneur is assumed to want to hold a combination of assets, to use a combination of input flows, and to produce a combination of output flows such that the quantity $\pi = -\sum_{i=1}^{n} p_i(x_i + x_i')$ is a maximum, provided such a *stock-flow plan* exists. […] Then if the first-order conditions represent a determinate statical system, the equilibrium values of the variables $x_1, x_2 \dots, x_n, D_1, D_2 \dots, D_n$ may be expressed in terms of the parameters $p_1, p_2 \dots p_n$ to obtain the n business *excess demand functions* $[ED_F]$ and the n *stock demand functions* $D_i = D_i(p_1, p_2 \dots p_n)$. The later functions, taken in conjunction with the given values $S_1, S_2 \dots S_n$ then determine corresponding equilibrium values for the investment demand variable x'_i $[ED_S]$ (1957: p. 172).

Then, in chapter III, "Macroeconomic Dynamics I", Bushaw and Clower maintained that the adjustment processes displayed in their 'stock-flow' price theory could be used to ground the business cycles models based on the accelerator:

> From a formal standpoint, it is interesting to note that model IV is identical with the basic model which underlies elementary discussions of multiplier and accelerator phenomena; and there is clearly more than a similarity involved. In effect, the present model provides a market (price adjustment) basis for aggregative models of the multiplier-accelerator variety (1957: p. 75).

Clower still pursued the elaboration of the market structure contemplated in his doctoral dissertation. Yet, when emphasis was given to the instability of the stationary equilibrium, he did not establish any relationships with the trade cycle. And there was no proposal to formally deduce the "general theory of capital accumulation" from the 'stock-flow' price theory. Instead, in the "Keynesian appendix", Bushaw and Clower undertook the derivation of the standard IS/LM model:

> A more significant difficulty is that of going from a supposedly satisfactory general model to a specialized aggregative model that is logically and empirically consistent with it. Generally speaking, most aggregative models developed in the past have been formulated independently of, and without a careful examination of their consistency with, any acceptable general theory of price determination. To the extent that one has faith in the essential correctness of a particular general theory, however, it is important to reconcile any proposed aggregative model with it. […] We shall proceed by discussing the derivation of what is undoubtedly the most influential of existing aggregative models, the so-called Keynesian system (1957: p. 43).

The starting point was a system of simultaneous equations describing respectively the equilibrium on capital market (a), securities market (b), consumer goods market (c) and labor market (l). Each market was formalized depending on the nature of the commodity considered. Consumer goods and labor were viewed as flow commodities, securities were stock commodities, and capital goods were "stock-flow" commodities (1957: p. 44):

$$\begin{cases} ED_F^a(p_a; p_b; p_c; p_l) + ED_S^a(p_a; p_b; p_c; p_l) = 0^{22} \\ ED_F^b(p_a; p_b; p_c; p_l) = 0 \\ ED_F^c(p_a; p_b; p_c; p_l) = 0 \\ ED_F^l(p_a; p_b; p_c; p_l) = 0 \end{cases}$$

On the basis of this disaggregated system, Bushaw and Clower made a few manipulations (e.g., presentation of the system in the form of national accounting and quantities-prices substitutions) to deduce the "fundamental building block of the Keynesian system" (1957: p. 46) and Keynes' standard functions (consumption, investment, liquidity preference, and labor supply). What is

[22]There is only one equation instead of two, to express the equilibrium on the capital market. This is not consistent with the standard treatment of stock-flow markets. Yet, Bushaw and Clower (1957) argued that this reflected an assumption made by Keynes in the *General Theory*, namely that the variations of the stock of capital assets were not taken into account in the determination of equilibrium prices (1957: p. 44).

proposed is frustrating for the reader. Bushaw and Clower argued that it was entirely possible to go back to macroeconomics. Yet, the macromodel was not the one contemplated in the dissertation. It was still an open question to know whether an aggregate business cycle model could be formally deduced from the 'stock-flow' price theory. Besides, Bushaw and Clower did not demonstrate that a 'stock-flow' model could be used to clarify the properties of the Keynesian theory. Unemployment, the liquidity trap, or the effects of a fall in nominal wages were outside the scope. The Keynesian appendix only claimed that the 'stock-flow' price theory was compatible with a Keynesian model.

3.3 Macroeconomics was not a priority

A methodological argument can be raised to explain this lack of interest for macroeconomic issues. Clower might have considered that a clarification of the logical properties of fully disaggregated systems was an essential step before addressing specific macroeconomic problems. This interpretation is supported by the "Keynesian appendix" of *Introduction to Mathematical Economics*. There, Bushaw and Clower patronized macroeconomics. This level of analysis was considered as approximate because of the assumptions required to construct aggregate. Aggregative models were viewed as specializations of their general theory of markets. Their appendix aimed to show that it would always be easy to back to macroeconomics:

> For our purpose it is enough to have illustrated some of the steps which must be taken moving from a general, detailed system to a more specialized system and from this in turn to a highly rarified model like that afforded by the Keynesian system (1957: p. 68).

To be brief, macroeconomics was not the priority. The reason was that the logical properties of 'stock-flow' models were still not clear. This could be problematic when policy

recommendations were formulated since the kind of simplifications required to build aggregates would be a potential source of error. In the absence of a clear knowledge of the static and dynamic features of general models, this may not be controlled:

> The first difficulty encountered in following this approach (construction of aggregated models) is that of defining aggregative variables and relations which are capable of yielding meaningful interpretations of reality; for it is only too easy to define aggregative quantities in such a way as to *embody* precisely those obscurities which occur explicitly in more detailed models (1957: p. 59).

Following this methodological principle, macroeconomics would have had to resurface in a second step. But that was not the case. How does one explain that?

4. The 'stock-flow' market theory: a blind alley

Under the assumptions adopted by Bushaw and Clower, the 'stock-flow' market models could hardly be a relevant foundation for Keynesian macroeconomics. This may explain why macroeconomics never resurfaced. Clower realized their inadequacy with the Keynesian theory at the end of the 1950s. This is suggested by arguments found in *Introduction to Mathematical Economics* and by his attitude. At that time, he reinterpreted the *General Theory* from a disequilibrium perspective and no longer attempted to connect Keynesian macroeconomics with the 'stock-flow' models developed with Bushaw. Then, the difficulties faced by the very few economists who tried to connect Keynesian macroeconomics with the 'stock-flow' market models also proved their inadequacy. Emphasis is given to the contributions of Lloyd (1960) and Baumol (1962), two economists who explicitly tried to use Clower's price theory to ground Keynes' economics. I show that Lloyd's proposal did not stand up to an argument raised by Patinkin (1958), and that Baumol's proposal was incompatible with the assumptions adopted by Bushaw and Clower.

4.1 A project shelved

At the end of the 1950s, Clower became interested in disequilibrium macroeconomics and no longer proposed to use the 'stock-flow' market models developed with Bushaw to study Keynesian phenomena.[23] It is hard to determine whether this was due to the recognition that the 'stock-flow' price theory could hardly be used to ground Keynesian macroeconomics.[24] Nonetheless, Clower retrospectively indicated in a research project that while writing *Introduction to Mathematical Economics*, he had realized that his hopes to provide microfoundations to Keynesian macroeconomics had been unduly optimistic:

> At the outset, I conjectured that the key to a satisfactory solution of this problem might lie in the generalization of established price theory to deal explicitly with trading on capital as well as current account. This conjecture motivated my early articles on stock-flow analysis […]. As early as 1957, however, it became clear that my initial conjecture was unduly optimistic – that the integration of value theory and income analysis would require much more than the statement of an improved theory of asset prices. The essential ingredients for a satisfactory resolution of the problem were finally suggested by work that I had been pursuing rather casually for a number of years involving disequilibrium models.[25]

[23] Clower formulated his first disequilibrium interpretation of the *General Theory* in "Keynes and the Classics: A Reinterpretation" (1958). In this unpublished manuscript (which turns out to be the preliminary version of "Keynes and the Classics: A Dynamical Perspective" (1960)), Clower's goal was to lay the foundations to a general-equilibrium model able to account for the market adjustment processes occurring in disequilibrium situations such as involuntary unemployment and inflation. This constituted the basic idea underlying his disequilibrium program of microfoundations. For more details, see Plassard (2017).

[24] For an explanation of how and why Clower came to formulate his disequilibrium program of microfoundations, see Plassard (2016a).

[25] This quotation is taken from a research proposal probably written in 1965. R. W Clower Papers, Box 5, Rubenstein Rare Book and Manuscript Library.

Following Clower's viewpoint, the goal here is to question the adequacy between the 'stock-flow' market theory and Keynesian macroeconomics.[26] The problem of the integration of Keynes' income analysis and the 'stock-flow' value theory, mentioned by Clower in the preceding quotation, was not addressed in *Introduction to Mathematical Economics*.[27] Yet, in this book, Bushaw and Clower (1957) did question the role of money in their price theory – an issue raised in the preceding quotation. They explicitly recognized that money played no role in the price determination process. This was proved following the lines set out by Patinkin (1949). They stressed the indetermination of monetary prices, due to the "invalid dichotomy":[28]

> The homogeneity properties which follow from our analysis of consumer and business behavior lead to a macroeconomic model of a *barter* economy, not to a model of a money economy. Money does not influence the price determination process in any way whatever (1957: p. 242).

Since the 'stock-flow' models portrayed barter economies instead of monetary economies, Bushaw and Clower were aware that under the assumptions adopted in *Introduction to Mathematical Economics*, their price-theory could hardly ground Keynesian macroeconomics.

[26] Unfortunately, I will not be able to question the adequacy between the 'stock-flow' market theory and the business cycle model contemplated by Clower in his doctoral dissertation. This is because I found no article (published or not) in which Clower or his contemporaries used 'stock-flow' models to discuss the properties of the trade cycle. Note simply that Clower had doubts about the possibility to link the instability of the stationary equilibrium with fluctuations of economic activity. In "Stock-flow Analysis" (1968), he acknowledged that it was "an open question" to know "whether intertemporal instability [deserved] to be regarded as anything more than a theoretical curiosity" (1968: p. 276).

[27] As evidenced of that, neither the concept of involuntary unemployment nor the concept of unemployment is listed in the index of *Introduction to Mathematical Economics*.

[28] According to Clower, a dichotomous model was inappropriate for analyzing the formation of the temporary equilibrium but appropriate for analyzing the properties of the stationary equilibrium. This explains why he kept using 'stock-flow' models (without real-balance effect) in debates over the integration of monetary and value theory. His article with Meyer Burstein, in 1960, is an example. Burstein and Clower considered a 'stock-flow' economic system ideally situated at the stationary equilibrium to demonstrate the quantity theory (1960: p. 36). See Plassard (2016b) for a detailed presentation of Clower's strategy to integrate monetary and value theory.

4.2 Very few followers, no solid connection with the Keynesian theory

Lloyd (1960) and Baumol (1962) explicitly tried to use the 'stock-flow' market models to connect Keynesian macroeconomics. The liquidity preference theory was the target.[29] According to Lloyd, the double equilibrium condition could be used to support Keynes' position. Yet his thesis did not stand up to the static analysis of Patinkin (1958). On his part, Baumol suggested that in dynamics, 'stock-flow' models might be used to connect Keynes' liquidity preference theory. Yet I show that this required rejecting the assumptions made by Bushaw and Clower.

4.2.1 Lloyd vs. Patinkin

The 'stock-flow' market theory emerged in the context of the controversy over liquidity preference versus loanable fund theories of interest, reopened by Hicks' demonstration of their formal equivalence, in *Value and Capital* (1939: pp. 158-162).[30] Hicks argued that by virtue of Walras' law, one could omit one equation of the general equilibrium system to set equilibrium prices. Whether this equation was the excess-demand-for-money (viewed as a representation of the liquidity preference theory of interest) or the excess-demand-for-bonds (viewed as a representation of the loanable funds theory of interest) did not change anything. Therefore, the two existing theories of interest would have been equivalent.

Lloyd tried to challenge this thesis using the 'stock-flow' market models developed in *Introduction to Mathematical Economics* (1960: p. 206). He pointed out that two independent equations characterized the equilibrium conditions in markets when commodities were

[29] George Horwitch (1957) also proposed to use the 'stock-flow' price theory to analyze the dynamics of the rate of interest under various scenarios (open-market policy, disturbance of saving or investment…). But his analysis is here omitted since he was not really concerned with the derivation of Keynes' theory of interest from the 'stock-flow' market models. Instead, he was involved in an assessment of the existing positions regarding the determinant factors of the rate of interest.

[30] For a review of these debates, and in particular of the role played by the distinction between stocks and flows in this context, see Harry G. Johnson (1962).

consumed, produced, and held by individuals (1960: p. 208). Accordingly, one could omit two equations instead of one to set equilibrium prices. On that basis, Lloyd assumed that the two omitted equations were the excess-flow-demand-for-money and the excess-flow-demand-for-bonds. Moreover, he considered like Hicks (1939) that the former represented the liquidity preference theory of interest and the later represented the loanable funds theory of interest. Then he argued that the equivalence between the two equations required formulating additional assumptions, e.g., money was created and destroyed only by bankers through purchases and sells of bonds (1960: p. 208). Lloyd inferred that in general, the two theories of interest might not be equivalent:

> In this case [stock-flow commodities] certain limiting conditions must be met before Hicks' proof is valid. […] In order to eliminate a stock-flow good from our equation system we must eliminate not one but two equations. One way we might do this is to make certain assumptions concerning the institutional make-up of the model we are working with, thus causing some of the equation in our system to be redundant by connecting them to other equations. In particular, it is possible to link the excess flow demand function for money to the excess flow demand function for bonds in such a way as to make them equivalent (Lloyd, 1960: p. 208).

Lloyd's view did not stand up to an argument raised in Patinkin's article "Liquidity Preference and Loanable Funds: Stocks and Flow Analysis" (1958). In an attempt to close the debate over liquidity preference vs. loanable funds theories of interest, Patinkin (1958) contended that the distinction between the two theories was a non-sense in a general equilibrium model. By virtue of Walras' law, the interest rate was determined by the general system of equations (1958: p.

301).[31] Accordingly, it did not make sense to isolate one market rather than another to explain its determination.

4.2.2 Baumol's intuition

In a dynamical context, Baumol suggested an avenue to connect Keynes' theory of interest with the 'stock-flow' models (1962: p. 50). His original intuition was that the speeds at which markets moved back to balance might be used to explain what would be the relevant theory of interest. He assumed that if one market was faster than another to return to equilibrium, then it was the primary determinant of the interest rate (1962: p. 52). Considering that bond markets were highly organized, Baumol maintained that the stock equilibrium would be established in no more than a few minutes while the real sector would still be unbalanced. Therefore, speculative behaviors would be the primary determinant of the interest rate, in the short-run. Real sector would become a determinant but over longer periods of time (1962: p. 52-53). According to him, 'stock-flow' models could be useful to support this position:[32]

> For the argument only states that, in the very short-run, interest rate determination will satisfy the stock but *not* the flow equilibrium condition for the bond market (1962: p. 52).

[31] Patinkin (1958) particularly showed that the interest rate was the same whether one assumed a stock demand for money instead of a flow demand for money, and a stock supply of money instead of a flow supply of money. This was because market prices were determined by the system of excess-demand equations, and that the excess-stock-demand for money and the excess-flow-demand for money were identical (1958: p. 304). While making this point, Patinkin claimed that "the excess demand for money as a stock [had] the dimension of a flow" (1958: p. 303), a claim that prompted a reaction from Clower. In "Stock and Flow: A Common Fallacy" (1959), Clower pointed out that stocks were measured at points of time while flows were measured over a period of time. Consequently, the excess-stock-demand for money and the excess-flow-demand for money could not have the same dimensions (1959: p. 251).

[32] This approach was closed to Clower's (1954b). The difference was that Clower led a partial equilibrium analysis (see 3.1).

Yet, in the formalization of the 'stock-flow' models proposed by Bushaw and Clower (1954; 1957), the "market-excess-demand" was always nil ($ED_F + ED_S = 0$), even in a dynamic analysis:

> Even though it is possible to distinguish situations of 'apparent equilibrium' (stock *or* flow, but not stock *and* flow 'equilibrium') involving the satisfaction of one of the sets of equations $X_i=0$ [$ED_F = 0$], $X'_i=0$ [$ED_S = 0$], but not both, it is not possible to attach any significance to such situations in a dynamical system of the kind considered here (1954: p.331).

Accordingly, there was no room for Baumol's intuition. It is ironic that a potential road to the *General Theory*, though complicated, was closed by those who first tried to connect Keynesian macroeconomics.

5. Conclusion: the indeterminate fate of Clower's 'stock-flow' general-equilibrium program

My chapter aimed at demonstrating that a project to provide microfoundations to Keynesian macroeconomics was hidden behind the 'stock-flow' market models developed by Clower in the 1950s. This appeared clearly in light of his doctoral dissertation.

Following in Hicks's (1939) footsteps, Clower originally aimed to lay the microfoundations of a "general theory of the trade cycle". This theory, inspired by Keynes (1936), was supposed to include the business cycle models *à la* Harrod (1939) and Hicks (1950). The reason was that its structure, the articulation of stocks and flows, was considered as the essence of the capital accumulation process. From there, the 'stock-flow' general-equilibrium program was born. Since the relation of stocks and flows had no room in standard microeconomics, Clower set about revising the theory of choice. His proposal, the "producer-

consumer" theory of the firm, was the foundation stone of the 'stock-flow' market models. It is argued that behind their statics and dynamics analyses, there were attempts to prove that Keynesian macroeconomics could be deduced from this market structure. Yet, considering that macroeconomics should not have been addressed without a complete knowledge of the logical properties of fully disaggregated systems, Bushaw and Clower preferred postponing their reflections on macroeconomic issues. But macroeconomics never resurfaced. The reason was that Clower shelved the project and that under the assumptions adopted notably in *Introduction to Mathematical Economics*, the 'stock-flow' models could hardly be a relevant interface with Keynesian macroeconomics.

In spite of this, it is not possible to discard the 'stock-flow' general equilibrium program of microfoundations. From its very origins, what mattered was the 'stock-flow' architecture, perceived as fundamental to understand the dynamics of the business cycle. Accordingly, 'stock-flow' market models could be used again, under alternative assumptions. In 1968, whilst keeping the same basic structure, Clower proposed to introduce disequilibrium transactions in a 'stock-flow' general equilibrium model. According to Clower, the dynamics of the monetary economy pictured by Keynes (1936) required formulating such a framework:

> If trading processes are not synchronized, we move from the barter economy of 'classical' economics to the money economy of John Maynard Keynes; from a world where supply creates its own demand to a world where demands are directly constrained by current accruals of cash and cash substitutes and where supplies are directly constrained by current levels of factor unemployment. To investigate the dynamic properties of such systems clearly requires the use of stock-flow analysis (1968: p. 277).

Clower never provided a full-fledged formalization of the disequilibrium 'stock-flow' model that he had in mind, thus leaving open an avenue to explore.[33] At the same time, he kept advocating for the introduction of stocks and flows into the general equilibrium theory, until the end of his career. In a paper co-written with Robert L. Sexton, Philip E. Graves, and Dwight R. Lee, "Incorporating inventories into supply and demand analysis" (1992), Clower insisted on the need to formulate a 'stock-flow' framework to understand the logical properties of models which addressed simultaneously the trade cycle and economic growth:

> However, in order to gain a full understanding of business cycles, the distinction between stocks and flows in supply and demand is essential. Explicit analysis of saving, investment, and growth processes is possible only in the context of stock-flow model (1992: p. 41).

The 'stock-flow' market theory was here presented as the only possible framework to fully capture the dynamic properties of the economic system. Therefore, the basic message of the authors was that in one way or another, the 'stock-flow' general-equilibrium program should be further developed.

Recent economics has chosen to incorporate the relations of stocks and flows by ignoring the market dimension. The 'stock-flow' analysis was either built into a microfoundational form (through dynamic optimization programs as used in new classical DSGE models) or into an aggregate form (through an accounting framework such as those used in "stock-flow consistent models"). In view of this, the relevant question is no longer whether

[33] Clower failed to manage the complexity of his 'stock-flow' disequilibrium model. His problem lay in the number of variables that had to be considered. In an unpublished manuscript written in 1971 ("The Keynesian Paradigm: An Attempt at Reconstruction"), Clower stressed that in situations of disequilibrium, undesired variations of stocks would have implied that individuals' plans included a "set of additional side constraints relating changes in actual stocks of various commodities to realized purchases and sales" (p. 10). This resulted in "an extremely complex theory of individual behavior", one which made the interactions with markets and the resulting effects on the dynamic path of the economic system hard to formally capture (p. 12).

the relations of stocks and flows deserve to be incorporated into economics, but what is the best modeling strategy to do so.

Chapter II: Clower's *volte-face* regarding the 'Keynesian Revolution'

Introduction

Clower's article "The Keynesian Counter-Revolution: A Theoretical Appraisal" (1965) was central to the transformation of Keynesian macroeconomics since it contributed to the emergence of fixed-price models, in the 1970s (Backhouse and Boianovsky, 2013; De Vroey, 2016). This influence is attributable to two ideas. The first one was that Keynes' *General Theory* (1936) should be rooted in a disequilibrium framework. Clower (1965) argued that involuntary unemployment meant that workers failed to realize their standard optimization plans because of labor market non-clearing. The second idea was that the integration of Keynes' income analysis and Walrasian microeconomics was impossible. Clower (1965) stressed that in situations of involuntary unemployment, realized income acted as a constraint on workers' decisions to consume. According to him, this was not compatible with the tâtonnement hypothesis and the standard theory of the consumer. An alternative microeconomic framework had to be conceived. Clower proposed that trade took place out of equilibrium and formulated the famous 'dual-decision' hypothesis.

Economists and historians acknowledged the relationships between Clower's (1965) theoretical propositions and other insights developed either in the non-tâtonnement economics of Hahn and Negishi (1962), or in the disequilibrium macroeconomics of Patinkin (1956). During the discussion held at the Royaumont conference (where Clower first presented the "Counter-Revolution" article), Frank Brechling "regarded Clower's paper as a contribution to

the theory of non-tâtonnement" (Hahn and Brechling, 1965: p. 302).[1] Negishi agreed with him, arguing that in "existing theories of non-tâtonnement, the process of exchange was similar to the dual decision" (Hahn and Brechling, 1965: p. 302).[2] Later, Robert Barro and Hershel I. Grossman (1971) stressed the complementarity between Patinkin's 'spill-over' effects and Clower's 'dual-decision' hypothesis: Patinkin (1956) explained that if the market for goods did not clear, entrepreneurs would take into account the quantity of goods actually sold to revise their production plans; Clower (1965) explained that if the labor market did not clear, workers would take into account the quantity of labor actually sold to revise their consumption plans. According to Barro and Grossman (1971), these two behavioral hypotheses could be used to lay the foundations of a "general disequilibrium theory" (1971: p.83). This resulted in the seminal fixed-price model. Historians have also focused on the relationship between Clower and Patinkin's insights. Rubin (2005) argued that Clower (1965) borrowed most of Patinkin's (1956) concepts, Hoover (2012) stressed that like Patinkin (1956), Clower's approach to the microfoundations of macroeconomics consisted in elaborating general-equilibrium models that displayed Keynesian features, and Backhouse and Boianovsky (2013) presented the 1965 article as an internal criticism of Patinkin's disequilibrium macroeconomics. Either way, it is still an issue to understand how Clower (1965) came to build his disequilibrium program of microfoundations and to what extent his ideas were inspired by the works of Hahn, Negishi, and Patinkin. The present chapter addresses this issue.

[1] In 1965, Hahn and Brechling published a volume gathering all the articles presented during the International Economic Association conference held from 03/08/1962 to 04/07/1962, at Royaumont (France). At the end of the volume, they printed a record of the discussion.

[2] Negishi did not give details about this analogy between non-tâtonnement models and the 'dual-decision' theory. Instead, he stressed some differences in the way to model non-tâtonnement processes. In particular, individuals were not supposed to react to price and realized income in existing models of non-tâtonnement (Hirofumi Uzawa, 1960; Hahn and Negishi, 1962): "the process of price bidding by excess demand was developed not on the basis of such dual decisions (derived from the distinction between notional income and realized income) but on the basis of utility maximization subject to a single budget constraint of the notional income" (Hahn and Brechling, 1965: p. 302).

Clower's 1965 article arises out of two research phases. The first phase starts with the doctoral dissertation that Clower prepared under Hicks' supervision at Oxford, from 1949 to 1952, and ends with the publication of *Introduction to Mathematical Economics*, in 1957. It consists of a project to provide microfoundations to Keynesian macroeconomics, and of a project to devise a price theory allowing the unification of all forms of competition (from monopoly to perfect competition). During this research phase, Clower was not concerned with involuntary unemployment, and more generally, with the issues related to individual disequilibrium and its consequences. Moreover, he considered that extensions of the Walrasian microeconomic theory were enough to ground Keynesian macroeconomics. In other words, Clower defended the equilibrium perspective and the kind of synthesis between Keynesian and Walrasian theories that he attacked in the 1965 article. Hence the existence of a *volte-face* concerning the meaning and the nature of the 'Keynesian Revolution'.

Clower's change in perspective took place in a two-step process. In an unpublished manuscript titled "Keynes and the Classics: A Reinterpretation" (1958), Clower formulated his first disequilibrium interpretation of the *General Theory*. This opened the second research phase. Thereafter, Clower came to conclude that the tâtonnement hypothesis and the Walrasian theory of the consumer had to be rejected to leave room for Keynes' insights in a general-equilibrium framework. I argue that Clower may have reinterpreted Keynesian macroeconomics from a disequilibrium perspective under the influence of Patinkin; and that his decision to reject part of Walrasian microfoundations was likely a reaction to the contradictions in the disequilibrium macroeconomics of Patinkin (1956, 1958), and a result of the confrontation between Clower's concerns for unstable dynamics and the stability analyses led in the non-tâtonnement economics of Hahn and Negishi (1962).

1. Equilibrium and synthesis perspectives: Phase I (1949-1957)

Between 1949 and 1957, Clower had two projects: to provide microfoundations to a Keynesian business cycle model and to elaborate a price theory capable of unifying all forms of competition. Despite their different objectives, these theoretical projects should be considered as part of the same research phase. All along the way, Clower considered that Keynesian macroeconomics was compatible with market clearing and with Walrasian microfoundations. More generally, the issues related to individual disequilibrium and to its consequences were never a focal point; and Clower sought to extend Walrasian microeconomics, not to break with it.

1.1 The "general theory of the trade cycle"

Clower's first project was to provide microfoundations to a macromodel inspired by Keynes (1936) and capable of addressing fluctuations and economic growth *à la* Harrod (1939). It was outlined in Clower's doctoral dissertation:

> The writer began by examining the general pure theory of economic behavior (as expressed e.g., in *Value and Capital*) in an attempt to discover whether that theory was in any way inadequate as a foundation for capital accumulation theory. After making appropriate alterations to the general theory, the writer tried to fit various recent theories of capital accumulation [Reference to Keynes (1936), Harrod (1939) and Hicks (1950)] into it as special cases (1952a: p. 8).

To elaborate his "general theory of capital accumulation", Clower proposed a "reinterpretation" and an "extension of Keynes's views on the theory of the trade cycle" (1952a: p. 11). The "reinterpretation" consisted of explaining fluctuations thanks to the variations of the liquidity preference instead of those of the marginal efficiency of the capital (1952a: pp. 80-

83). The "extension" consisted of broadening the liquidity preference theory to physical assets (1952a: p. 69). Hence, trade cycles resulted from a capital accumulation process destabilized by speculative behavior (1952a: p. 79). Starting from this explanation of fluctuations, Clower built a 'stock-flow' macromodel. The stock dimension was related to entrepreneurs' demand for the existing stock of capital assets, and accounted for the determination of the real interest rate.[3] The flow dimension was related to entrepreneurs' decisions to invest and to produce. And the inter-relationship between these two dimensions served to analyze the capital accumulation process – depending on the level of the real interest rate, the flow of new investment and the flow of depreciation may not match thus leading to variations of the stock of capital assets. Clower argued that because of speculative behavior, entrepreneurs' demand for the existing stock of capital assets was subject to violent and repeated changes. This would prevent investment, production, and capital assets from reaching stationary positions and, in turn, would explain trade cycles (1952a: p. 89). On that basis, Clower made two points. The first one was that the instability underlying trade cycles in his macromodel was related structurally to the inter-relationship between the stocks and the flows of capital assets. The second one was that the same was true in Harrod-type models since the instability was closely related to the acceleration principle, a relation linking the rate at which the flow of output was changing with the stock of capital assets (1952a: p. 11). Clower concluded that the inter-relationship between stocks and flows was the essence of the capital accumulation process.[4] Since this inter-

[3] Clower was concerned with the determination of real magnitudes: "Entrepreneurs' views concerning the profitability of owning real assets [depended on] the relative prices of inputs and outputs" (1952a: p. 68).

[4] "The argument in previous chapters has been devoted primarily to demonstrating the unity of recent theories of capital accumulation. In retrospect, it appears that the thread which links together various theories – a thread that is hidden by difference in method and content – is to be found in the distinction between the *using* and the *holding* of assets [reference to Keynes (1936)]. This distinction obviously implies but it is not implied by the distinction between stocks and flows [reference to the models following Harrod (1939) and Hicks (1950)]" (1952a:p. 184).

relationship was at the heart of his macromodel, he claimed to have elaborated a "general" theory of the trade cycle (1952a: p. 184).

The challenge was to incorporate the relation of stocks and flows into the standard theory of choice and then, to undertake the derivation of Keynes and Keynesian business cycle models. For that purpose, Clower followed the main lines set out by Hicks in *Value and Capital.*[5] He repeatedly referred to the formulation of a general equilibrium model to demonstrate the compatibility between economic behavior and aggregate. In his dissertation, Clower proposed the 'producer-consumer' theory of the firm to ground the 'stock-flow' architecture. This micromodel was inspired by the works of Leonid Hurwicz (1946) and Johannes de Villiers Graaff (1950) and consisted of introducing asset holding into entrepreneurs' programs. Unfortunately, Clower (1952a) failed to offer a full-fledged formalization of the related theory of markets. Therefore, the connections between his theory of choice and Keynesian macromodels remained essentially informal. This explained at least partly why the examiners refused to award him the degree of doctor when he defended his dissertation, in May 1952.[6] Retrospectively, Clower recognized that his thesis "was not in a form fit for publication" and "did not produce what he had hoped".[7] This failure would have led him to "develop healthier motivations", staying "six months at home not only with *Value and Capital* but also with Pareto and Walras".[8] This orientation is confirmed by the publication of a series of papers devoted to the development of 'stock-flow' market models: "Business

[5] For an exhaustive presentation of Hicks' method, see Roy Weintraub (1979). For a short presentation, see Hoover (2012).

[6] Whilst acknowledging that Clower's microeconomics presented "some undoubted contributions to economic theory", his examiners (Ian M.D. Little and Charles M. Kennedy) deplored the absence of "substantial connection with the main theme of the dissertation". These quotations are taken from the report of Clower's thesis defense, housed at Oxford University. Note that I had access to this document thanks to the help of Hoover and to the availability of Simon Bailey, a keeper of the University Archives.

[7] The quotes are taken from a resume written by Clower in 1964. R. W Clower Papers, Box 1-2001-0088, Rubenstein Rare Book and Manuscript Library.

[8] The quotes are taken from a first version of the preface of "Money, Markets and Method: Essays in honor of R.W. Clower" (1999). R. W Clower Papers, Box 1-1999-0352, Rubenstein Rare Book and Manuscript Library.

Investment and the Theory of Prices" (1953), "Productivity, Thrift and the Rate of Interest" (1954a), "An investigation into the Dynamic of Investment" (1954b) and "Price Determination in a Stock-Flow Economy" (1954c). The last two papers were written with a mathematician specialized in dynamics, Donald Bushaw. This marked the beginning of a collaboration which culminated with the writing of *Introduction to Mathematical Economics* (1957), a book almost fully devoted to 'stock-flow' market analyses.

A 'stock-flow' market theory accounted for the determination of prices when individuals' plans to produce and to consume goods in the current market period were distinguished from individuals' plans to hold goods in stocks, at the end of the market period. Formally, on the flow dimension, a set of supply and demand functions described the quantity produced and consumed during the current market period. On the stock dimension, Clower added a set of supply and demand functions describing the quantity inherited from the activities of past market periods and the quantities that individuals wanted to hold in stocks at the end of the current market period. On that basis, Clower distinguished two types of equilibria. The first one was "temporary" since the stocks available in the economy showed a tendency either to rise or to fall. For a given vector of prices, individuals would like to hold stocks of commodities different from the one inherited from the past. The stocks would be adjusted by the quantities newly produced and consumed in the market period. For that new stock available, a new price vector would be set. The process would continue until the quantity of stocks and prices became "stationary". This situation characterized the second type of equilibrium. From 1952 to 1957, Clower studied the static and dynamic properties of these models so as to know whether they could be used to link the theory of choice developed in the dissertation and Keynesian theories of the trade cycle. In the absence of conclusive results, the project petered out.

Employment fluctuations, individual equilibrium, and tâtonnement dynamics

Both the 'stock-flow' market analyses and the doctoral dissertation are useful to account for the equilibrium perspective adopted by Clower in his microfoundational program. Clower's attitude regarding involuntary unemployment indicates that individual disequilibrium and its consequences were outside the field of investigation. Clower and Bushaw did not even mention the concept in *Introduction to Mathematical Economics*. From the beginning, Clower (1952a) argued that it was not of fundamental importance to know whether workers were voluntarily or involuntarily dismissed during the downturn. The effect on economic activity would be the same. Accordingly, in the context of trade cycles studies, it would be enough to account for the fluctuations of employment:

> In practice, it is clear that large declines in employment may have the same influence on economic activity whether workers were voluntarily or involuntarily unemployed. We leave the matter at that (1952a: p. 66).

In spite of this lack of interest in the voluntary/involuntary distinction, Clower (1952a) proposed a short reflection on how to incorporate involuntary unemployment in a market framework. He gave emphasis to the form of the labor supply function.[9] According to Clower, it could be considered that "workers [were] dismissed involuntarily [if] the labor supply curve [was] infinitely elastic at the going wage rate" (1952a: p. 66). In other words, it would be enough to assume a horizontal labor supply curve to address involuntary unemployment.[10] This solution implied market clearing and so, that workers realized their standard optimization plans

[9] "One has to make a series of assumption to obtain a supply function equivalent to the one used by Keynes (i.e., a function of a form which permits one to talk about 'involuntary' unemployment)" (Clower, 1952a: p. 66).
[10] This assumption, also made by Franco Modigliani (1944) and Oskar Lange (1945), became very common in the 1950s. On its relevance to portray involuntary unemployment, see Michel De Vroey (2004).

(De Vroey, 2004). Therefore, at this stage, Clower viewed involuntary unemployment as an equilibrium situation.

More generally, Clower maintained that Keynesian macroeconomics could be rooted in a price theory in which all the markets cleared and so, in which all the individuals realized their optimization plans. This appears clearly in the short appendix devoted to the "Keynesian system", in *Introduction to Mathematical Economics*. Bushaw and Clower aimed at deriving the standard IS/LM model from a 'stock-flow' price theory where the consumer goods market, the capital goods market, the labor market, and the securities market were balanced (1957: p. 46). This equilibrium perspective is also contemplated in dynamics. While studying the stability conditions of the 'stock-flow' price theory in discrete time, Bushaw and Clower (1957) insisted on the assumption that at any market period, all the markets cleared:

> $p_1\ (t)$ and $p_2\ (t)$ assume values which make market demand equal to market supply at the beginning of each period (1957: p. 84).

The dynamic path of the economy would be determined by the variations of the stocks of commodities in the economy. It was assumed that the stationary equilibrium was reached when the net changes of stocks from period to period were nil (1957: p. 84). In continuous time, the dynamics was based on the same logic. Following economists such as Lange (1945) and Samuelson (1947), Bushaw and Clower studied the stability properties of tâtonnement processes (1954c: p. 343; 1957: p. 101). Accordingly, the focus was on the dynamic of abstract economies in which disequilibrium transactions were excluded. Individual disequilibrium and their consequences were therefore out of the field of investigations in 'stock-flow' market analyses.

The compatibility between Walrasian and Keynesian theories

In the introduction of his dissertation, Clower wondered about the compatibility between Walrasian and Keynesian theories. He claimed that the two theories were fundamentally compatible. Nonetheless, Walrasian microeconomics needed to be modified to ground Keynesian macroeconomics:

> From a formal point of view, is the *General Theory* a special case of established general equilibrium theory? Once again, there are essential differences between the two levels of analysis, differences which may not be reconcilable until the foundations of general equilibrium theory are broadened (1952a: p. 5).[11]

According to Clower, neither Keynes' theory of investment nor his theory of consumption could be linked directly to Walrasian microeconomics. In the former case, this was because the standard theory of the firm did not distinguish the holding from the using of assets, and did not account for entrepreneurs' appreciation of the business climate (1952a: p. 71). Hence Clower's decision to broaden standard optimization plans. He proposed the 'producer-consumer' theory of the firm and showed that the resulting theory of investment "was equivalent to the theory of Keynes" (1952a: p. 62). In the later case, Clower's aim was to explain why income was an independent variable at the aggregate level while it was not at the microeconomic level (1952a: p 64). For that purpose, he aggregated consumers' optimization plans, drew upon a national accounting relation to stress that money consumption depended on money income (1952a: p. 65), and made a few other assumptions to "arrive at the Keynesian propensity to consume"

[11] Clower referred to Hicks' Walrasian framework when using labels such as "established general equilibrium theory" or "standard microeconomics" (1952a: p. 8).

(1952a: p. 65).[12] Besides, Clower (1952a) addressed the issue of the compatibility between Walrasian and Keynesian theories by discussing the relationship between his microeconomics and his "general theory of the trade cycle". He modified the standard theory of the consumer (1952a: p. 226) so as to justify the "floor" and the rising trend of his macromodel. The modification consisted of assuming that preferences were interdependent and, in turn, that the relative position of consumers in society influenced their patterns of consumption. On that basis, Clower considered that the maintenance of the consumption (to keep up with the Joneses) would underpin the minimum limit of investment at which the economy would rebound. Then, since this "floor" was supposed to depend on the stock of capital assets accumulated and that this stock was likely to increase over time (1952a: p. 43), a rising trend would be established. In parallel, Clower argued that the 'producer-consumer' theory of the firm was a relevant foundation for the accelerator (1952a: p. 57) and could be used to justify the 'stock-flow' architecture of his Keynesian business cycle model.[13]

Thereafter, Clower developed the 'stock-flow' market theory to further his reflection on the compatibility between his microeconomics and Keynesian macroeconomics. The Walrasian flavor of the general equilibrium models could hardly be overemphasized.[14] Symmetry and market clearing characterized the system of equations (1957: p. 46). Moreover, Clower assumed that individuals' decisions were taken simultaneously. Indeed, when Bushaw and Clower (1957) gave details on the exchange technology underlying their 'stock-flow' price theory, they

[12] Clower started from optimization plans and deduced aggregate versions of supply and demand functions by simple summation (1952a: p. 61; p. 63). Clower justified this aggregation procedure by referring to Hicks' commodity theorem. The theorem defined the conditions to treat the aggregate as an individual (Hoover, 2012: p. 36).

[13] Clower presented in details his modifications of standard microeconomics in two papers: "Mr. Graaff's Producer-Consumer Theory: A Restatement and Correction" (1952b) and "Professor Duesenberry and Traditional Theory" (1952c).

[14] On the Walrasian representation of the functioning of a market economy, see De Vroey (1999).

referred to a "central market authority" (1957: p. 31) setting prices so that supplies equaled demands (1957: p. 34).

Though largely implicit, connections with Keynesian macroeconomics were proposed both in partial and general equilibrium frameworks. In partial equilibrium, Clower was concerned with Keynes' theory of investment (1954a) and with the liquidity preference theory (1954b). Clower (1954b) demonstrated that the dynamic path of the rate of interest was largely determined by the excess-stock-demand for bonds, not by the excess-flow-demand for bonds (p. 114). This feature was presented as a proof that the rate of interest was governed by speculative behavior, not by saving and investment. Then, Clower (1954a) demonstrated that given different levels of the rate of interest, the relation between the stock demand and the associated level of net investment could be used to obtain "a curve K(r) which Keynes would call schedule of marginal efficiency of capital" (p. 76). Besides, in general equilibrium, Bushaw and Clower (1954c) referred to the project sketched in the doctoral dissertation. The 'stock-flow' price theory could ground the "models based on the acceleration principle" (1954c: p. 328). The reason was dynamic. The inter-relationship between stocks and flows was viewed as a source of instability ignored in pure stock and pure flow models (1954: pp. 341-342).

In *Introduction to Mathematical Economics*, Bushaw and Clower recognized that "the path from their own (or from any similar model) to the Keynesian system [was] rather tortuous" (1957: p. 44). But in the "Keynesian appendix", their "discussion [served to] show that a path exist[ed]" (1957: p. 44). Starting from a disaggregated general-equilibrium model, they made various assumptions and modifications to finally deduce the "Keynesian building block Y= C+I" (1957: p. 46) and standard Keynesian functions (1957: pp. 46-49). Regardless of the rigor of this derivation, this proves that until 1957, Clower considered that Walrasian and Keynesian theories were fundamentally compatible.

1.2 The "general theory of price determination"

In parallel with his 'stock-flow' general-equilibrium program of microfoundations, Clower developed a second theoretical project purporting to develop a price theory allowing the unification of all forms of competition (from monopoly to perfect competition). It was outlined in two unpublished manuscripts, written over the first half of the fifties: "On the existence of a General Theory of Price Determination" (c.1954a) and "Toward a General Theory of Price Determination" (1955). Then, Clower presented his main developments and results in the concluding chapter of *Introduction to Mathematical Economics*, in three sections titled: "Toward a Generalized Theory of Price Determination", "A Unified Theory of Price and Quantity Determination" and "Monopoly and Competition: An Appraisal". Reflections in this area continued until the end of the fifties through unpublished manuscripts and one paper: "On the Microdynamics of Price Formation in N-Seller Markets" (c.1958), "A Study of Elementary Learning and Response Mechanism in Dynamical Monopoly Model" (1958a), "Inductive Inference and Business Behavior" (1959a) and "Some Theory of an Ignorant Monopolist" (1959b).[15]

Clower's reading of *Monopolistic Competition and General Equilibrium Theory* would have been the original impulse. In this book, Robert Triffin took up the criticism of his supervisor (Edward H. Chamberlin) on the lack of realism of perfect competition. Triffin proposed to integrate some elements associated with monopolistic competition such as strategic behaviors and the interdependence of firms, into the Walrasian theory (Maria Cristina Marcuzzo, 2012). In the conclusion of his book, Triffin recognized the huge difficulties posed by this project and, in turn, maintained that it would be impossible to build a simple, elegant,

[15] R. W Clower Papers, Box 4, Rubenstein Rare Book and Manuscript Library.

and general price theory on monopolistic foundations. Such a project had to be viewed as a "philosopher's stone" (1940: p. 289).

Clower reacted to this conclusion. While developing his 'stock-flow' models, he would have found the way to complete Triffin's project via the elaboration of a "general theory of price determination":

> As a result of recent work in the theory of competitive price […] Professor Triffin's dictum no longer has to be accepted. On the contrary, *it is now possible to exhibit a consistent and unified general theory of price determination* (c.1954a: p.2)

The key to understand the project is to acknowledge that whatever the forms of competitive structure, the determination of equilibrium prices is based on the same logic. Clower considered that individuals (whether a "market authority" embodied by the figure of the broker, a seller, or a group of sellers) would try to find equilibrium prices trying to avoid unwanted stocks. Clower pointed out that, in perfect competition, brokers were responsible for setting equilibrium prices following a tâtonnement process. He concluded that a broker could be viewed "as an actual unit of economic decision similar to consumer and business units" (c1954a: p. 31), supposed to set prices following an internal equilibrium condition represented by a "desired excess-demand". Clower's point was that the equilibrium condition of a broker did not match necessarily the market one. In this case, the broker would observe unwanted variations of stocks. This would be a signal to vary prices. This procedure of revision would occur until the brokers' "desired excess demand" and market excess demand would be simultaneously nil. After having presented this procedure of revision of prices, Clower turned to non-competitive structures. He argued that, if the assumption of "demand certainty" was dropped, price determination would appear to be analogous to the one occurring in perfect competition. In a monopoly, the seller

decided on the level of production by estimating the price at which he would sell the integrality of the production and would maximize his profits. Of course, he may make mistakes, failing to correctly anticipate the objective demand. Accordingly, he would be forced to increase his stocks of goods or would not be able to exploit all the profit opportunities. To avoid the repetition of such scenarios, the seller would revise price until his internal equilibrium coincided with the market equilibrium. According to Clower, once this element of uncertainty was introduced in the standard monopoly theory, the extension to oligopoly model would be quasi natural. The difficulty would lie in the treatment of firms' interdependences. By showing that price determination was based on the same logic whatever the competition structure, Clower thought he had found the way to elaborate a "general price theory" allowing the unification of all forms of competition.[16]

To undertake this unification, Clower set dynamical systems with various adjustment rules describing the behavior of prices, outputs, and realized sales:

> It will now be clear that the more general model is neither competitive nor non-competitive. Instead, it is a general theory of market adjustment (c.1954a: p. 43).

The difficulty was to define the adjustment processes in a sufficiently general way to ensure the deduction of specific behavior related to the market structures. During the 1950s, Clower sought for the best formalization of these adjustment processes. Unfortunately, the complexity of the dynamical systems made it difficult to study their stability conditions. Most of the time, dynamic analyses were therefore absent. This problem of tractability was put forward by

[16] Following Samuelson (1947), Clower quoted Eliakim H. Moore's *Principle of Generalization by Abstraction* (1910) to justify this viewpoint: "Until a short time ago, however, neither proposition was ever required in such an explicit form as that it is presented in this paper. Although I was well aware of E.H. Moore's principle of generalization of abstraction, therefore viz., 'the existence of analogies between central features of various theories implies the existence of a general theory which underlies the particular theories and unifies them with respect those central features.' [footnote to refer to Samuelson (1947: p. 3)], its relevance to the case in question was never clear." (c1954a: p. 49)

Clower to explain why it would be preferable to stick to the assumption of perfect competition (1957: p. 190). Since he was unable to find a way to simplify these models, the project petered out.

Disequilibrium was not the issue

Despite the diversity of models developed by Clower, he always considered situations in which "individuals" (whether a "market authority", a seller, or a group of sellers) set prices and made mistakes thus leading to disequilibrium transactions. For example, Clower (1957) assumed that independent sellers produced in time (t-1) a homogeneous good that they brought to the market in time t. At the beginning of the market period, they set the price at which they undertook to deliver the goods during the market period. The market price was supposed to be the minimum of the prices set by sellers. Those who set higher prices would not be able to sell the quantity they had planned. Symmetrically, consumers would not be able to realize their consumption plans when the quantities sold at the market price were not sufficient. Accordingly, situations of individual disequilibria were considered in Clower's "general theory of price determination".

Yet, three features of these studies show that disequilibrium *à la* Clower (1965) was not the issue. First, in all the papers mentioned, Clower excluded the effects of disequilibrium transactions on individuals' choices by assumption. The sellers could not take into account the level of demand during the market period and readjust their production on this basis. Such adjustments were considered to be at work but would have consequences only on the next market period. Second, Clower considered only a partial equilibrium approach. As a result, he ignored the consequences of the non-realization of optimization plans on other markets, what Patinkin (1956) called 'spill-over' effects. Third, every study was led as if the dynamic properties of the models were a secondary issue. Clower set dynamic systems but mainly

discussed the properties of their equilibria. Of course, this was partly due to the complexity of the dynamic systems. But beyond that, a deeper reason, consubstantial with his project, justified this approach. The goal was to demonstrate that a single price determination process, with a common criterion (supply/demand balance), characterized all forms of competition.[17] This explains why Clower was mainly concerned with market clearing situations.

Extension of the "traditional general equilibrium theory"

Now, let us focus on Clower's synthesis perspective. In his first manuscript, Clower claimed that his "general theory of price determination" was the result of an extension of the "traditional" general equilibrium theory:

> *The* [general] *theory follows immediately from generally accepted postulate of traditional analysis in conjunction with one simple, almost obvious, further assumption which, while already at hand in elementary dynamical considerations underlying established analysis, is here utilized for the first time* (c.1954a: p.2).

The extension concerned the dynamic procedure of revision of prices implied by the tâtonnement hypothesis. To stress the existence of a "general theory of price determination", Clower proposed to couple this procedure with the assumption that the Walrasian broker did not want to hold unwanted stocks.

During the development of his project, Clower wondered whether simple extensions of Walrasian microeconomics were sufficient to account for the kind of behavior addressed in his

[17] "Therefore, market equilibrium (in monopoly) is defined by the intersection of the supply curve *s* with the demand curve *d*— a result which is remarquably similar to that which defines market equilibrium price in an isolated competitive market! […] Here, precisely as in the case of the monopoly, market equilibrium is defined by the intersection of the market supply and demand curves *s* and *d*" (1957: p. 189).

"general" theory. In 1959, he mentioned the possibility of a break with the "traditional price theory". But he claimed that it was preferable to remain in this established framework:

> The inadequacies of traditional price theory as an instrument for describing observed market behavior have become increasingly apparent in recent years. It is still an open question, however, whether these shortcomings can be removed by appropriate generalizations of existing theories or whether modifications of a more fundamental kind will be required. […] It seems to me that both points of view entail interesting programs of research and that neither can be said to involve anything more than this at the present time.[…] Meanwhile, it is interesting to speculate about the possible fruitfulness of an approach which lies somewhere between the two extremes. […] The purpose of the present paper is to elaborate upon this theme by sketching a simplified "learning model" of oligopoly which is broadly consistent with traditional doctrine yet sufficiently general to include both established monopoly theory and the accepted theory of pure competition as special cases (1959a: p. 2).

Therefore, Clower considered that his "general theory of price determination" was compatible with Walrasian economics.

To conclude, until 1957 Clower developed two theoretical projects in which he was never interested in involuntary unemployment and more generally in individual disequilibrium its consequences (e.g., spill-over effects). Moreover, he always considered that extensions of "established" general equilibrium theory were sufficient to build his theoretical models. Therefore, what happened to him? How does one explain that in little more than three years, at the Royaumont conference (1962), he proposed a disequilibrium interpretation of the Keynesian theory whilst defending the need to break with Walrasian microeconomics?

2. Clower's *volte-face*: Phase II (1958-1962)

In 1958, Clower reopened his investigations on Keynesian macroeconomics. In an attempt to shed new light on the Keynes-Classics debate, he radically broke with the equilibrium and synthesis perspectives that prevailed until now. As a result, his reflections are considered here as part of another research phase (Phase II). Clower's *volte-face* took place in two steps. In "Keynes and the Classics: A Reinterpretation" (1958) and in "Keynes and the Classics: A Dynamical Perspective" (1960), Clower displayed a disequilibrium interpretation of the *General Theory* whilst maintaining that Keynesian and Walrasian theories were compatible. Thereafter, he came to conclude that the tâtonnement hypothesis and the Walrasian theory of the consumer had to be rejected to leave room for Keynes' insights in a general equilibrium framework. Clower reached this conclusion soon before the Royaumont Conference. The origins of such a radical change in perspective are mysterious. But it is clarified by the intellectual context and the invariants of Clower's works.[18] Clower probably considered that Patinkin's disequilibrium interpretation of the *General Theory* opened a fruitful avenue of research to address the two very issues on which he was working on since his PhD dissertation: the microfoundations of Keynesian macroeconomics and the dynamics of market economies. Besides, Clower's concerns for unstable dynamics may have led him to realize, in reaction to Patinkin's own contradictions and to the developments in non-tâtonnement economics, that a

[18] With regard to the intellectual context, emphasis is given to the disequilibrium macroeconomics of Patinkin and to the non-tâtonnement economics of Hahn and Negishi. In the former case, this is justified since Clower started interacting with Patinkin as early as 1958 (see their correspondence on the distinction between stocks and flows in Don Patinkin papers, Box 25, Rubenstein Rare Book and Manuscript Library). In the later case, there are evidences that Clower followed the developments of non-tâtonnement models in the early 1960s. At that time, he was engaging with Negishi and made comments on the first draft of "Monopolistic Competition and General Equilibrium" (1961: p. 196). Then, in a letter sent to Meyer Burstein, Clower referred to Negishi's analyses of non-tâtonnement processes: "Negishi [introduced] transaction rules that [were] artificial and [left] prices to vary dynamically on basis of desired rather than actual [magnitudes]". This letter is undated. Yet, there are strong grounds for believing that it was written before the Royaumont Conference. Indeed, Clower was very vague about how to explain individuals' behaviors out of equilibrium (see letter from Clower to Burstein: R.W. Clower papers, Box 8, Rubenstein Rare Book and Manuscript Library).

break with the Walrasian framework was imperative. In particular, Clower's (1965) decision to reject Walras' law may be justified on two grounds: Walras' law was violated in the dynamic analysis proposed by Patinkin (1956, chapter XIII), and it was one of the necessary conditions to ensure the stability of non-tâtonnement processes in Hahn and Negishi's (1962) model.

2.1 A two-step reorientation

Clower (1958) proposed a disequilibrium interpretation of the *General Theory*. The main ingredients of disequilibrium economics were mobilized. First, involuntary unemployment was the focal point. This concept was viewed as the dividing line between Keynes and the "Classics", both in static and in dynamic frameworks. In the former case, Clower proposed to follow in Keynes' footsteps to show that the "Classical point of full employment equilibrium" was an "*upper limit* to possible equilibrium level of employment in the Keynesian model" (1958, p.7). Yet, according to Clower "the relative merits of Keynesian and Classical [theories could not] be discussed profitably on a static level of analysis" (1958, p. 8). That was why he formulated a dynamic interpretation of the Keynes-Classics debate. The matter was instability of the full employment equilibrium in Keynes's theory versus stability in the "classical" theory. Second, involuntary unemployment was presented as a disequilibrium situation. When Clower sought to account for the "unlimited number of equilibrium states" in Keynes' *General Theory*, his ambition was to explain that entrepreneurs could set the volume of employment whilst leaving the labor market in excess supply (1958, pp. 6-7). Third, Clower considered involuntary unemployment as a dynamic phenomenon. The demonstration of its persistence through the analysis of market adjustment processes was the aim of his "dynamical interpretation" of the Keynes-Classics debate (1958, p. 2). Fourth and finally, Clower intended to account for the consequences of disequilibrium transactions. This was suggested through the distinction between two scenarios of the dynamic analysis: "*Case I:* it [was] assumed that all market transactions at output prices other than those which 'clear the market' [were] strictly

provisional (i.e., the output market [operated] according to Walrasian or Edgeworthian principles). […] *Case II* [was] rather different for it [rested] upon Keynes' version of Say's law; i.e., it [depended] on the proposition that "supply [created] its own demand" in the strictest possible sense" (1958, p. 9). Here, what Clower called Say's law in the sense of Keynes meant that the model took into account the income constraints imposed on workers' consumption when they failed to sell the quantity of labor planned. By assumption, workers would express a demand for goods determined by the level of employment imposed by firms.

It is striking that whilst developing this disequilibrium interpretation of the *General Theory*, Clower kept maintaining that there was no fundamental difference between Keynes and the "Classics". In 1958, Clower contended that the "Classical equilibrium problem [paralleled] that given by Keynes in chapter 2 of the *General Theory*; in particular, it [was] consistent with his treatment in every respect." And in 1960, he claimed that "the essential formal difference between Keynes and the classics [was] more one of subject matter than of underlying postulates" (1960: p. 25). Keynes would have been interested in addressing "depression states" while the "Classics" would have been interested in addressing equilibrium situations. Accordingly, there would be no problem to synthesize the two theories.

This position radically changed shortly before the Royaumont conference.[19] A letter sent to Patinkin on March 1962 is often quoted to show Clower's break with Walrasian microeconomics (Backhouse and Boianovsky, 2013: p. 50; Rubin, 2005: p.18). Here in contrast, Clower's radical reorientation is emphasized drawing from a letter sent to George Delehanty (Massachusetts Institute of Technology):

> The heart of the problem seems to be that Keynes, unlike the specialists in tâtonnement economics, assumes that market excess demands depend in part on

[19] As a reminder, the conference took place from 03/28/1962 to 04/07/1962.

> the level of current transactions (that is to say, income flows). Dependence upon income as an independent variable is obviously inconsistent with traditional preference analysis since, if income is taken as given it is not possible to define factor supply functions. Why this difficulty has not been noticed before I cannot say, but I can tell you that it is more difficult to get over than one might suspect at first sight. My own proposal is a kind of dual decision theory of the consumer, which makes sense in a dynamic context, and happens to include traditional preference analysis as a special case – valid under full employment conditions.[20]

The argument mentioned was the heart of the 1965 piece. Clower realized that Keynesian relations such as the consumption function could not be derived from Walrasian microeconomics. This was because realized income was an independent variable in Keynes' theory of consumption while it was not in the Walrasian theory. In the latter, individuals were supposed to chose their income when determining their selling and purchasing plans. Income was endogenous. No adjustment of consumption was possible unless prices varied. As a result, realized income could not act as a constraint in the Walrasian demand for consumption goods. For that to be possible, Clower contended that an alternative theory of the consumer was required. He proposed the 'dual-decision' hypothesis.

2.2 Why such a *volte-face*?

There is a coincidence in time between the emergence of Clower's disequilibrium interpretation of the *General Theory* and the beginning of his interactions with Patinkin. At the end of the fifties, Clower and Patinkin started a correspondence. Initially, Clower reacted to "Liquidity Preference and Loanable Funds: Stocks and Flow Analysis" (1958), a paper in which

[20]Letter from Clower to Delehanty, (02/19/1962): R.W. Clower Papers, Box 2, Rubenstein Rare Book and Manuscript Library.

Patinkin addressed the validity of Walras' law in situations of involuntary unemployment. Then, the two authors started a new correspondence on monetary theory in reaction to the publication of George C. Archibald and Richard G. Lipsey's paper "Monetary and Value Theory: A Critique of Lange and Patinkin" (1958). In this context, Clower repeatedly expressed his admiration and his interest for the reasoning developed in *Money, Interest and Prices*:[21]

> Re-reading your book, I am more than ever impressed by the consistency of the analysis – given the assumptions—and with the absence of anything but minor slips.[22]

Although Clower referred to the compatibility between the micro and macro parts of *Money, Interest, and Prices*, he did not discuss Patinkin's unemployment theory during the correspondence. Yet, it seems that it was not a simple fact of timing if Clower wrote "Keynes and the Classics: A Reinterpretation" at the same moment.[23] First, like Clower, Patinkin sought to provide microfoundations to Keynesian macroeconomics. And like him too, Patinkin insisted on the need to understand the dynamics of market economies. To be more specific, Patinkin proposed to explain involuntary unemployment as a dynamic phenomenon. Workers' inability to realize their Walrasian optimizing plans induced pressures on wages which, in turn, provoked market adjustments. These were the two points of entry in Clower's (1958) reconsideration of Keynes' *General Theory*. In 1958, behind the label "Keynes-Classics debate", Clower really addressed the compatibility between Walrasian and Keynesian theories and the stability of the market economy.

[21] See Rubin (2005: pp.17-18) for other quotations.
[22] Letter from Clower to Patinkin (03/10/1959): Don Patinkin Papers, Box 25.
[23] Backhouse and Boianovsky (2013) acknowledged that Clower and Patinkin were engaging at the end of the 1950s. Yet their analysis of the background in which Clower wrote the 1965 article may suggest that Patinkin was not influential in the emergence of Clower's (1965) ideas. According to me, Clower's reading of *Money, Interest, and Prices* triggered his reconsideration of Keynesian macroeconomics from a disequilibrium perspective.

Second, the theoretical proximity between the two authors is undeniable. In 1958, Clower nearly paraphrased Patinkin (1956) to criticize Keynes (1936) for having defined involuntary unemployment as an equilibrium situation:

> Perhaps the most curious aspect of the matter is the fact that *if* w and p just happen to fall at the same rate of time then, starting from an initial position of Keynesian equilibrium (with excess supply in the labor market), the economy will remain 'in equilibrium' indefinitely although prices and wages are constantly falling over time! Under these circumstances, it is perhaps natural to speak of the difference $N^s - N^d$ as 'involuntary unemployment'; but it is a curious of language to refer to the situation as a whole as one of equilibrium (1958, p. 13).

> All, then that Keynes means by the statement that the system may settle down to a position of 'unemployment equilibrium' is that the automatic workings of the system will not restore the system to a position of full employment equilibrium. He does not mean 'equilibrium' in the usual sense of the term that nothing tends to change in the system. All that is strictly in equilibrium is the level—or, possibly, only the fact—of unemployment; but there is no equilibrium of the money wage rate (Patinkin, 1956: p. 471).

Likewise, he nearly paraphrased Patinkin to emphasize the need to use dynamics to account for Keynes' theory of involuntary unemployment:

> Although Keynes himself never made a complete transition from statical to dynamical modes of thought, his work prompted many of his contemporaries to do precisely this, and so wrought a fundamental change in intellectual perspective in the space of few years […] The fruits of the Keynesian Revolution

> have been, and are being, gathered primarily by a new generation of economists, a generation that has finally accustomed itself to thinking in terms of points and planes instead of curves and crosses (1960: p. 323).

> Indeed, it is the very departure from these curves, and the resulting striving of individuals to return to the optimal behavior which they represent, which provides the motive power of the dynamic process itself. Thus our task in studying involuntary unemployment is to free ourselves of the mental habit – long ingrained by the methods of static analysis – of seeing only the points *on* the demand or supply curve (Patinkin, 1956: p. 220).

Lastly, Clower resorted to the logic of the 'spill-over effect' in the disequilibrium model put forward in 1958. The same mechanism underlined his application of "Keynes' version of Say's law". Patinkin described the behavior of entrepreneurs that failed to sell the quantity of goods they had planned. They would take into account the level of demand as an additional constraint and would redefine their labor demand. Clower described the income constraints imposed on workers' consumption when they failed to sell the quantity of labor they had planned. This was the symmetric effect.

Now, let us explain why Clower eventually considered that the Walrasian and Keynesian theories were fundamentally incompatible, a position diametrically opposed to Patinkin's (1956). Rubin (2005) considered that the roots of Clower's break with the Walrasian framework lie in Patinkin's own contradictions. Whilst studying their positions on the validity of Walras' law, Rubin showed that Patinkin (1956; 1958) preferred contradicting himself rather than rejecting the Walrasian framework. Clower (1965) would have identified the gaps and

would have drawn the consequences that the invalidation of Walras' law was the *sine qua non* of the Keynesian theory.[24]

Rubin's viewpoint is here reinforced by putting Patinkin's contradictions in perspective with the contemporaneous development in non-tâtonnement economics and with Clower's ambition to account for the instability of market economies, in his disequilibrium theory.

The dynamics of market economies and, more specifically, the possibility of a long-lasting depression was core to Clower's disequilibrium interpretation of the *General Theory*.[25] A disequilibrium model would have to account for i) the rationing suffered by workers in the market for labor; ii) workers' incentive to change the employment situation and the resulting pressures on wages; and iii) the dynamic of the whole economy, given that entrepreneurs have no interest to modify the employment situation. In this context, Clower insisted on the inability of the market system to bring the economy back to the full employment equilibrium.

In view of Clower's concerns for unstable dynamics, the contributions of Patinkin (1956; 1958) on one side, and of Hahn and Negishi (1962) on the other side, may explain why the rejection of Walras' law became a focal point. In chapter XIII, section II of *Money, Interest and Prices*, Patinkin broke with Walras' law when he explained the dynamic of his disequilibrium model. In situation of involuntary unemployment, the excess demands for goods and labor were based on notional supplies and effective demands so that their sum (weighted

[24] "Either Walras' law is incompatible with Keynesian economics, or Keynes had nothing fundamentally new to add to orthodox economic theory" (Clower, 1965: p.41).

[25] "On the other hand, any point which lies on the demand curve but above the supply curve refers to a state of *involuntary unemployment* in the sense of Keynes. […] Under the latter circumstances, the marginal utility of the real wage exceeds the marginal disutility of labor, whereas the marginal product of labor is equal to real wage; hence *households alone* have an incentive to expand employment. By analogy with situations of a similar sort experienced in practice, it is natural to regard these as 'depression' states of the model. The interesting thing about 'depression' states is that it is not directly plausible to say that they cannot persist indefinitely. No doubt it can be asserted, with good reasons that any particular 'depression' state tends to be followed by another 'depression' state, and so on, *indefinitely*. This is clearly a dynamical stability question" (1960: p. 23).

by market prices) would be less than zero ([1956] 1965: p. 321). Then, in 1958, Patinkin addressed the validity of this law in Keynesian macroeconomics. He realized that the formulation of involuntary unemployment as a rationing in the labor market questioned its validity. By virtue of this law, it would not be possible to have an excess-supply in the labor market without having an excess-demand elsewhere in the economic system:

> Walras' law relates to an economy in which all markets are in equilibrium. In the case of involuntary unemployment, on the other hand, there exists a state of excess supply –and hence of continued disequilibrium – in the market for labor. At first sight then, there would seem to be no place for the operation of Walras' law (Patinkin, 1958: p. 314).

In spite of these contradictions with his disequilibrium interpretation of the *General Theory*, Patinkin sought to maintain the validity of Walras' law. To this end, he assumed that workers adjusted passively their labor supply to the demand for labor:

> One way out of this difficulty (there may well be others) is to assume it away by attributing to workers a completely passive behavior pattern according to which they adjust the amount of labor they plan to supply to the amount employers demand at the going wage rate (Patinkin, 1958: p. 314).

Under these circumstances, "equilibrium always [existed] in the labor market" (1958: p. 314) and so, Walras' law was respected. Patinkin acknowledged that his solution "[dodged] the real difficulties" (1958: p. 315). But the problem really was that the very existence of his disequilibrium analysis was in question. If the labor market was in "equilibrium", the dynamic pressure supposed to act on wages in situation of involuntary unemployment did no longer exist. Accordingly, involuntary unemployment stopped being a dynamic phenomenon and so, Keynesian macroeconomics lost its status of disequilibrium theory. In a different way, the

contemporaneous development in non-tâtonnement economics also emphasized the dynamic consequences of keeping Walras' law valid. Hahn and Negishi (1962) demonstrated that a general equilibrium system with disequilibrium transactions but in which Walras' law held good was stable. Clower may have heard about this article before the Royaumont conference since he was in touch with Negishi and followed the developments of the non-tâtonnement literature. And of course, as a careful reader of Patinkin's works, he surely noted Patinkin's contradictions. Accordingly, Clower may have considered that the precondition to account for unstable dynamics in a disequilibrium model was to discard Walras' law.

It turns out that the theoretical message underlying the 1965 piece was that a break with the Walrasian framework was the key to vindicate the Keynesian heterodoxy. Such a view was expressed in section II of the "Counter-Revolution" paper, when Clower established a link between three "Keynesian indictments": the instability of the full employment equilibrium, the rejection of Walras' law, and the breaching of the "second postulate" (1965; p. 40). The core of the "Counter-Revolution" paper was devoted to the relation between the 'dual-decision' hypothesis and Walras' law. Clower demonstrated that the substitution of a "constrained demand" to a "notional demand" turned Walras' equality into an inequality in case of non-clearing labor market (1965: p. 53).[26] This is the best known part of his argumentation, which is not the case of the relation between Walras' law and the instability of the full employment equilibrium. Clower contended that its validity entailed the existence of symmetric pressures on wage and price so that the return to the full employment equilibrium was ensured (1965: p. 52). But what would be the dynamic path of the economy if Walras' law was rejected? To answer this question, Clower considered a "typical" Keynesian situation. The labor market was in excess supply and the market for goods cleared – workers' effective demand was supposed to match entrepreneurs' notional supply of goods (1965: p. 54). In these circumstances, Clower

[26] Note that market non-clearing and the breaching of the "second postulate" are two sides of the same coin.

seemed to consider that the economy might not return to a situation of full employment equilibrium:

> The point of the example is merely to illustrate that, when income appears as an independent variable in the market excess-demand functions – more generally, when transactions quantities enter into the definition of these functions – traditional price theory ceases to shed any light on the dynamic stability of a market economy (1965: p. 55).

Since the disequilibrium theory sketched in the 1965 piece could integrate consistently the three main "Keynesian indictments", Clower firmly believed that he was taking the right direction to ground Keynes' economics.[27] That is also why he did not hesitate to reject Walrasian microeconomics.

Conclusion

My chapter aimed to explain the genesis of the "Counter-Revolution" paper. This was a difficult task since it entailed solving the mystery which, very often, surrounded Clower's contributions. He was an ambitious economist, asked important questions to understand the functioning of market economies, and always provided promising intuitions to answer. But he rarely succeeded in formalizing the models that fully supported his views. So, intuitions were often put in the back burner. This makes it difficult to reconstitute the logic of his thought. Because of that, an archival work was necessary. It helped to reveal the intuitions, the intellectual influences, and the aims contemplated.

[27] Clower ended the discussion of his article at the Royaumont conference arguing that "people, including himself, had failed to understand that there was a general equilibrium interpretation of Keynes, namely the one he had developed, which made all of the more familiar interpretation in terms of equational inconsistencies, rigid wages, liquidity traps, etc., unnecessary (Hahn and Brechling, 1965: p.309).

The 1965 piece was presented as the result of a *volte-face*. Clower's (1965) advocacy of a disequilibrium theory and of an alternative to Walrasian microeconomics marked a break with the perspectives adopted in his early theoretical projects. There, Clower was not concerned with involuntary unemployment, and more generally, with individual disequilibrium and its consequences. Moreover, he considered that simple extensions of the Walrasian general equilibrium theory were sufficient to undertake the construction of his models. He moved away from these positions in a two-step process. In "Keynes and the Classics: A Reinterpretation", Clower offered his first disequilibrium interpretation of the *General Theory*. Then, between 1960 and 1962, Clower came to conclude that the tâtonnement hypothesis and the standard theory of the consumer had to be rejected to ground Keynesian macroeconomics. In view of the interactions between Clower and Patinkin at the end of the 1950s, the author of *Money, Interest, and Prices* may have played a key role in the first move. Then, Clower's decision to reject part of Walrasian microfoundations was explained as the result of his ambition to feature unstable market adjustment processes, and of his confrontation with both Patinkin's (1956; 1958) contradictions and with the stability analyses led by Hahn and Negishi (1962). These influences show that interactions between Walrasian macroeconomics and non-tâtonnement economics contributed to the emergence of the search for disequilibrium foundations for Keynesian economics.

Chapter III: Disequilibrium as the Origin, Originality, and Challenges of Clower's Microfoundations of Monetary Theory

Introduction

Economists have sought to formulate microeconomic foundations adapted to monetary economies at least since Léon Walras.[1] Among the important contributions to this long and still active search for a satisfactory monetary framework, Clower's article "A Reconsideration of the Microfoundations of Monetary Theory" (1967) is often mentioned. Two reasons explain why. The first reason is that it contributed to question Patinkin's (1956) project to integrate monetary and value theory. Shortly after Hahn's (1965) famous critique of Patinkin, Clower showed that the model developed in *Money, Interest, and Prices* did not portray a monetary economy. This problem was due to the Walrasian budget constraints. They did not exclude barter exchanges. Accordingly, they were not appropriate for analyzing monetary economies. To ensure that money was the counterpart of exchange, Clower proposed to dichotomize the Walrasian budget constraint into "expenditure" and "income" branches. Thus, individuals would be forced to have money to consume and to receive money in return for their sales. This dichotomized budget constraint is the second source of influence of Clower's article. In 1980, Lucas built the seminal cash-in-advance model on it. As a result, Clower became the fountainhead of one of the most widely used approaches to monetary theory since the 1980s.

While Clower recognized that he inspired the cash-in-advance literature, he rejected it. It follows a first puzzle: what was the specificity of Clower's approach to integrate money into macroeconomic models? Then, there is no clear relationship between the 1967 "Reconsideration" and the disequilibrium program of microfoundations sketched in "The

[1] On Walras's microfoundations of monetary theory, see Pascal Bridel (1997; 2002) and Antoine Rebeyrol (1999).

Keynesian Counter-Revolution: A Theoretical Appraisal" (1965). On one side, Clower (1965) modeled how individuals behaved out of Walrasian equilibrium without paying attention to the role of money in the exchange process. On the other side, Clower (1967) restricted his analysis to the behavior of an individual evolving in a market-clearing context. On top of this, Clower rejected the money-type fixed-price disequilibrium models that economists such as Benassy (1975, 1975a, 1986) or Jean-Michel Grandmont and Yves Younès (1972) built from the 1965 and 1967 articles. It follows a second puzzle: did the 1965 and 1967 behavioral hypotheses intend to be articulated so as to lay the foundations of an original monetary macroeconomics? In short, Clower's project to provide microfoundations to monetary theory is an enigma. My chapter intends to resolve it.

This is a difficult task for three reasons. First, the 1967 article is preceded by very few contributions to monetary theory, and in none of them did Clower intend to provide his own framework for analyzing monetary economies. Second, Clower simply formalized an optimization plan in his 1967 article. The kind of market structure in which individuals were supposed to evolve remained mysterious. Third, Clower never completed the monetary theory related to his 1967 microfoundations. To overcome these difficulties, I characterize the intellectual context from which the 1967 article emerged and rebuild Clower's project. Such a reconstruction is based on the analysis of published and unpublished materials, written before and after the 1967 article. Particular attention will be given to his correspondence with Patinkin in the 1960s, to the preliminary versions of the 1967 article, and to an unpublished manuscript "The Keynesian Paradigm: An Attempt at Reconstruction" (1971a).

In the process of rebuilding Clower's project, two interpretations of the 1967 article are challenged. The first one was expressed by D'Autume (1985), Kohn (1988), Howitt (1992), and Boianovsky (2002). It asserted that Clower adopted an approach to monetary theory alternative to Patinkin. It was justified by an elementary logic. Like Hicks (1935), Patinkin

(1956) sought to provide microfoundations to monetary theory by justifying the integration of money into agents' utility functions. Yet, Clower (1967) argued that their proposals were not sufficient to model monetary economies and based his integration strategy on a reformulation of standard budget constraints. Therefore, his contribution would have been part of an alternative approach to monetary theory allegedly embodied by Robertson (1933), Brunner (1951), and Tsiang (1966), and in which budget constraints were modified to account for the circulation of money in the economy. The second interpretation of the 1967 article was expressed by D'Autume (1985) and De Boyer des Roches (2003). It asserted that the projects underlying the 1965 and 1967 articles rested on two logically distinct ideas: the "dual-decision" process and the circulation of money through the economy.

By contrast, I argue that the 1967 article is best seen as a reorientation of Patinkin's approach to monetary theory and not as a stark alternative. Clower (1967) sought to elaborate a disequilibrium monetary theory whilst retaining the two pillars of Patinkin's integration, i.e., the introduction of money into utility functions and the real-balance effect.[2] I trace the origins, account for the originality, and discuss the challenges of this project.

1. Clower in Patinkin's controversy

In the early sixties, Clower was involved in the debate over monetary and value theory initiated by Archibald and Lipsey's (1958) criticism of *Money, Interest, and Prices*. On two occasions, he demonstrated that the "Classical" monetary theory defended by Archibald and Lipsey and criticized by Patinkin was valid. However, Clower considered that Patinkin had formulated the appropriate framework for analyzing the functioning of monetary economies. To make this point, I trace the roots of Patinkin's controversy. Archibald and Lipsey put forward the

[2] See Roy Weintraub (1979) and Ghislain Deleplace (1999) for other discussions about the relationship between Clower's disequilibrium program of microfoundations and his 1967 "Reconsideration" of monetary theory.

distinction between short-run and long-run analyses to criticize Patinkin. This distinction clarifies Clower's positions. On the one hand, Clower considered that Patinkin's framework was appropriate to explain the formation of the temporary equilibrium (short-run) but inappropriate to analyze the properties of the stationary equilibrium (long-run). On the other hand, he claimed that the functioning of monetary economies could be described only in a short-run framework. Clower concluded that the development of a useful monetary theory required following in Patinkin's footsteps.

1.1 Short-run vs. long-run analyses: a key distinction in Patinkin's controversy

By the late 1940s, Patinkin criticized "classical" monetary economics whilst developing his own framework to integrate monetary and value theory. The microeconomics expounded in *Money, Interest, and Prices* (1956) was the outgrowth of these theoretical reflections. Patinkin (1956) criticized the approach to monetary theory adopted by economists such as Walras, Vilfredo Pareto, Irving Fisher, or Knut Wicksell.[3] This approach, called the "classical dichotomy", consisted in separating the determination of relative prices from the determination of monetary prices. Relative prices were supposed to be set by the excess-demands for goods in the real sector of the economy while monetary prices were supposed to be set by a Cambridge or a Fisherine equation, in the monetary sector of the economy. According to Patinkin, this dichotomization of price determination was invalid. In other words, "Classical" monetary economics failed to explain consistently the formation of monetary prices. Patinkin maintained that there were contradictions between the homogeneity postulate of degree zero in money prices of the "classical" excess-demands for goods, the monetary equation, and Walras' law. To make this point, he assumed an equiproportionate variation of monetary prices and discussed how reacted the market system. Following the logic of "Classical monetary economics",

[3] List of names given by Patinkin (1956: p. 97).

Patinkin stressed two opposite conclusions.[4] On one side, market forces would have corrected the disequilibrium in the monetary sector of the economy. This was because the monetary equation was homogeneous of degree 1. On the other side, no market force would have counterbalanced the disequilibrium in the monetary sector of the economy. Because of the homogeneity postulate, individuals had no incentive to change their purchasing and selling plans. It followed that all the markets but the money market cleared. Since the money market could be ignored (by virtue of Walras' law), its disequilibrium would not be signaled, and in turn, not resorbed. From there, Patinkin concluded that an infinite combination of monetary prices could be associated to a unique vector of relative prices. The level of monetary prices was undetermined. According to Patinkin, this indeterminacy resulted from the absence of a market mechanism linking the monetary and real sectors of the economic system. To fill this gap, Patinkin introduced real balances in utility functions and formulated the real-balance effect in a Hicksian temporary equilibrium model. Individuals were supposed to plan the quantity of real-balances that they needed to realize their transactions during the market period. The real-balance effect ensured the interaction between the real and monetary sectors of the economy during the tâtonnement process. This interaction ultimately allowed the economic system to reach a monetary equilibrium. Patinkin used this framework to demonstrate the propositions of the quantity theory of money. Thanks to the real-balance effect, a positive variation of the money supply held by individuals generated a positive variation of the demand for goods. Price level increased accordingly. This upward pressure continued until individuals held their initial and desired level of real-balances. Back in equilibrium, the price level had increased in proportion to the increase of the money supply. Moreover, real choices were no longer affected

[4] According to Patinkin, the possibility to deduce two opposite conclusions (starting from the same set of assumptions) proved the inconsistency of "Classical monetary economics", and in turn, its invalidity.

by money supply since individuals had no incentive to modify their real balances. Therefore, money was neutral and the quantity theory was validated.

Patinkin's criticism of "Classical" monetary economics raised a controversy.[5] Archibald and Lipsey (1958) were among those who challenged its validity, and in turn, the need for using Patinkin's integration.[6] Their charge was based on the distinction between short-run and long-run analyses (1958: p. 2). The short-run analysis was concerned with the formation of the temporary equilibrium, i.e., the tâtonnement process on a given Monday of the Hicksian week. The long-run analysis focused on the static properties of the stationary equilibrium, i.e., a situation in which prices remained the same from market periods to market periods because individuals had no incentive to change their levels of consumption and real balances. In this context, Archibald and Lipsey (1958) claimed that the "Classical dichotomy" was valid. They argued that in statics, the issue of consistency concerned the existence (or not) of an equilibrium solution (1958: p. 11).[7] Thus, Patinkin's criticism could be invalidated by showing that a "classical" model determined relative prices, finite and positive monetary prices, with non-zero money stocks. Archibald and Lipsey used a numerical example to do so (1958: p. 14). They concluded that Patinkin's monetary framework was unnecessary to analyze the static properties of the stationary equilibrium. This conclusion was deemed to be particularly important since the quantity theory could be demonstrated by comparing stationary equilibrium positions (1958: p. 8). In stationary equilibrium, individuals' consumption was constant from market periods to market periods, and so was the level of real-balances. Thus, real-balances were no longer a variable and consumption decisions depended only on the level of real income (1958: p. 3). In

[5] For early reactions, see Walter Bradock Hickman (1950), Wassily Leontief (1950), Cecil G. Phipps (1950), and Stefan Valavanis (1955).

[6] "In this paper, we argue that the classical dichotomy is valid, and that the integration undertaken by Patinkin is therefore unnecessary." (1958: p. 1)

[7] Archibald and Lipsey acknowledged that the argument was already formulated by Hickman (1950). Their originality was to make the point by setting the conditions to have the excess-demand functions of the stationary equilibrium (1958: pp. 13-14).

view of this, Archibald and Lipsey argued that a variation of the money supply did not affect the real sector of the economy. The real-balance effect was therefore dispensable (1958: p. 8). It was sufficient to focus on the new stationary equilibrium. In this situation, the price level had increased in proportion to the variation of the money supply. Money was neutral and the quantity theory was validated.

Archibald and Lipsey's (1958) claims were discussed in a symposium on monetary theory published in 1960 by the *Review of Economic Studies*. Clower was one of the participants of this symposium.[8] With Burstein, he contributed to the rehabilitation of "Classical" monetary economics. They extended Archibald and Lipsey's demonstration of the neutrality of money to a model in which individuals were supposed to hold bonds and capital assets. Later, in 1963, Clower claimed that "the classical dichotomy [was] unreservedly valid" (1963: p. 27). This suggests an unconditional defense of the "classical" monetary framework. Yet, there was a condition. It was solely valid in the long-run.

1.2 Clower and the validity of "Classical" monetary economics

Clower admitted the validity of "Classical" monetary economics at the stationary equilibrium. In the article co-written with Burstein, this position was stressed by showing that the property of invariance of the real equilibrium to a variation of money supply held even if bonds and capital assets were introduced in the model. Intuitively, the invariance proposition was questionable since individuals might decide to vary their real income by using the extra cash to buy bonds and/or capital assets. Yet, according to Burstein and Clower the proposition remained valid:

[8] In order of appearance in this special issue of the *Review of Economic Studies*, other participants were William J. Baumol (1960), Frank Hahn (1960), Ron J. Ball and Ronald Bodkin (1960), and Archibald and Lipsey (1960). In an editorial note, it is claimed that Patinkin's answer to Archibald and Lipsey (1958) was not included because of an "inability to agree on a suitable length" (1960: p. 29). Patinkin's reactions were formulated in Chapter 3, section 7 of the second edition of *Money, Interest, and Prices* (1965).

> More generally, if we consider an economy in which all commodities except money are produced, consumed and held in the form of assets, and if the relevant supply and demand functions of the system depend only on relative prices and other real variables, then it can shown that the equilibrium demand for commodities, for real bond income, for physical assets, and for real money balances are all invariant against a change in the nominal stock of money (1960: p. 36).

Burstein and Clower pointed out that the demand functions depended on real income and other real variables such as the "relative commodity prices, the rate of interest, the real bond income, and real money balances" (1960: p. 33). But, at the stationary equilibrium, individuals were supposed to start each market period with the same quantity of bonds, capital assets, and real-balances. Thus, these variables no longer appeared in individuals' functions (1960: p. 34). Once the analysis was focused on the determination of market prices, real income was the remaining variable (1960: p. 35). Therefore, real equilibrium was not affected by variations in the stock of money.

In 1963, Clower demonstrated that the "classical dichotomy" was valid. His originality *vis-à-vis* Archibald and Lipsey (1958) was to show that Walras' law remained an "identity".[9] In their article, Archibald and Lipsey maintained that "the classical dichotomy [consisted] in building a model in which Walras' law [did] not hold" (1958: p. 16). They argued that Walras' law could not be valid whatever the values taken by the variables of the economic system since the physical volume of transactions and monetary prices were set separately. Patinkin's scenario of a disequilibrium in the monetary sector without disequilibrium of same amount and opposed value in the real sector of the economic system was an evidence of the invalidity of Walras'

[9] The term "identity" is borrowed from mathematics. It means that in a formal model, an expression is valid whatever the values taken by the variables under consideration.

law (1958: p. 16). Archibald and Lipsey concluded that the "classical dichotomy" was valid only in equilibrium (1958: p. 17). Clower (1963) expressed the same viewpoint. Nonetheless, since "every classical economist whose writings [Clower knew] clearly subscribed with full force and fervor to Walras' law" (1963: p. 27), he proposed to demonstrate that a model based on the homogeneity postulate, using a Cambridge equation, and accepting Walras' law as an identity could set monetary prices consistently (1963: p.27). To do so, he assumed that the economic system was always in stationary equilibrium (1963: p.27).[10] Since the monetary sector of the economy was balanced, so also was the real sector. Accordingly, Walras' law was valid. Besides, monetary prices were set by the Cambridge equation so as to ensure the smooth course of transactions determined by the equilibrium in the real sector of the economy (1963: p. 29).

1.3 The need to use Patinkin's monetary framework

Whilst supporting the validity of the "Classical" framework in the long-run, Clower considered that it was not appropriate for analyzing the functioning of monetary economies in the short-run. This position was expressed in *Introduction to Mathematical Economics* (1957). In this book written with the mathematician Bushaw, Clower was concerned with the analysis of the static and dynamic properties of 'stock-flow' market models – i.e., a theoretical framework which pictured price determination processes by taking into account current activities as well as the resulting consequences on the stock of commodities present in the economy. Bushaw and Clower aimed to know whether or not their 'stock-flow' price theory could be an adequate foundation for Keynesian macroeconomics. Of course, its ability to portray monetary economies was a criterion. Accordingly, they devoted a section ("General

[10] Clower (1965a) clarified the logic of his 1963 argumentation through a numerical example when he replied to the criticisms formulated by M.K. Rakshit (1965): "From the equation, for example, together with the assumption that the set of admissible values of is [-3; 3], we obtain the identity. My derivations of Walras' law and Say's law follow the same pattern and are just as valid as this example" (1965a: p. 73)

Equilibrium and the Theory of Money") to the issue of the formation of monetary prices. Bushaw and Clower pointed out that the 'stock-flow' price theory was dichotomous (1957: p. 174). They concluded that monetary prices were undetermined:

> In fact, all individual excess flow demand and stock demand functions were shown earlier to be homogenous of order zero in all prices and income, implying that an equal proportionate change in all market prices *P* and in all income variables *M* will leave the equilibrium value of all variables [excess-flow demands] and'[excess stock-demands] unaffected; and this being the case, it can be shown that the system does not determinate absolute money prices […] The last expression is simply *Say's law*; it asserts that the market excess demand for one commodity is determined as soon as the market excess demand for all other commodities (excluding money) is determined, and it asserts further (taken in conjunction with Walras' law) that the demand for money is identically zero for every set of values of the price and income variables *P* and *M*. Thus, absolute prices are indeterminate in the [general equilibrium] system; only *relative* prices can be specified in terms of these models. And there is no way in which the *absolute* price level can be determined as a function of the quantity of money since the market excess demand equation for money is always satisfied identically (1957: p. 175).

This demonstration of the invalid dichotomy nearly paraphrased Patinkin. Like him, Bushaw and Clower linked the properties of homogeneity of degree zero of their market functions with those of Walras' law to explain the indetermination of monetary prices.[11]

[11] In the quotation, Bushaw and Clower distinguished Say's law from Walras' law. Their distinction was the same as Patinkin's (1956). Say's law asserted that the aggregate value of the amounts of supply of commodities equaled the aggregate value of the amounts of demand for commodities. By contrast, Walras' law asserted that the sum of the aggregate value of the amounts of excess-demands for commodities and of the excess-demand

In the correspondence between Clower and Patinkin, Clower criticized the long-run approach developed in "Classical" monetary economics. Though interesting from a logical viewpoint, he claimed that the study of the logical properties of the stationary equilibrium was of little interest to understand monetary economies. By contrast, a short-run framework of the kind formulated in *Money, Interest, and Prices* would have been ideally suited:

> Surely, it is more effective to carry this out to its logical (an rather uninteresting) conclusion; admit that the invariance results of A-L [Archibald and Lipsey] are perfectly general [proposition of Burstein and Clower] and then go on to point out that the full equilibrium [stationary equilibrium] systems for which these results hold are completely uninteresting for dealing with short-term problems [of money economies], whereas your model is ideally suited to deal with these. It is nice to know what is implied by full equilibrium, no doubt, but this is not the kind of comparative statics that I would use to inform my judgment concerning actual events.[12]

Clower considered that the empirical content of a dynamic analysis was higher than the one of a static analysis. This point was already made in *Introduction to Mathematical Economics*. According to Bushaw and Clower, "common sense and offhand observation would [have suggested] that in any fairly realistic model, the current state will seldom be an equilibrium state; [However] purely statical theory [had] nothing to say about such non-equilibrium states" (1957: p.54). Since Patinkin (1956) studied the stability of the monetary equilibrium to address the formation of monetary prices and the demonstration of the quantity theory, Clower considered that Patinkin had identified the proper approach to monetary theory. Actually, in

for money equaled zero. Put simply, Say's law did not take into account individuals' decisions to change the amount of money held. Walras' law did.

[12] Letter from Clower to Patinkin (11/12/1959). R.W. Clower Papers, Box 4, Rubenstein Rare Book and Manuscript Library.

1963, he praised the real-balance effect. This mechanism was presented as the basic ingredient to formulate dynamic analyses and so, to develop a useful monetary theory:

> In singling out the real-balance effect as the *sine qua non* of monetary theory, Patinkin has correctly identified a major gap in classical doctrine. Because it has lacked an explicit dynamical framework, the classical theory has long been regarded as little more than an intellectual exercise. Patinkin's treatment of the real-balance effect is an important first step towards the development of a useful theory of monetary dynamics (1963: p. 33).

In the early sixties, Clower advocated for a dynamic monetary theory, built on sound microfoundations, and able to demonstrate the quantity propositions. Since his approach rested on Patinkin's, it is surprising that Clower never tried to develop the model formulated in *Money, Interest, and Prices*. One reason for this could simply be that Clower had nothing to say that had not already been said by Patinkin. This is what Clower suggested in a letter to Patinkin dated from October 1960. At that time, Patinkin was working on a revised version of *Money, Interest, and Prices* (published in 1965) and asked Clower for comments. Clower confided that "[he could not] put [his] finger on any particular objections other than the minor ones mentioned in the present note".[13] This attitude contrasts sharply with his 1967 charge against Patinkin's microfoundations of monetary theory. How does one explain that?

2. Disequilibrium microfoundations of monetary theory

The circumstances underlying Clower's "Reconsideration" of Patinkin's microfoundations of monetary theory are clarified by two unpublished documents. The first one is a letter sent by Clower to Patinkin before the presentation of the draft of the 1965 article at the Royaumont

[13] Letter from Clower to Patinkin (11/10/1960). Patinkin's Papers: Box 25, Rubenstein Rare Book and Manuscript Library.

Conference (held from 03/28/1962 to 04/07/1962). The second are the preliminary drafts of the 1967 article, written by Clower between 1965 and 1966. The analysis of these documents shows that the 1967 "Reconsideration" is rooted in Clower's (1965) disequilibrium program of microfoundations. On the one hand, Clower's (1965) criticism of Walrasian macroeconomics led him to question Patinkin's integration of monetary and value theory. On the other hand, Clower's (1965) disequilibrium interpretation of the *General Theory* was instrumental in shaping the 1967 microfoundations of monetary theory.

2.1 The 1965 criticism or how to challenge Patinkin's monetary theory

By the late 1950s, Clower had two irons in the fire: to contribute in a critical and constructive way to the debate over monetary and value theory; and to provide disequilibrium microfoundations to Keynesian macroeconomics.[14] Since Patinkin made decisive contributions in these two fields of research, he became a preferred interlocutor during this period. In a letter sent in March 1962, Clower informed Patinkin that he had found an inconsistency between the microeconomics and the macroeconomics developed in *Money, Interest, and Prices.*[15] According to Clower, the demand functions used by Patinkin (1956) to address involuntary unemployment could not be deduced from Walrasian microfoundations. Clower argued that it was not possible to integrate income as an independent variable in workers' demand functions. Indeed, income was supposed to be chosen by workers – after a consumption-leisure trade-off. Moreover, their standard optimization plans were always satisfied because of the tâtonnement hypothesis. Thus, realized income could not act as an additional constraint on workers' consumption plans in situation of involuntary unemployment. Clower concluded that there was

[14] On the genesis of Clower's (1965) disequilibrium program of microfoundations, see Plassard (2016).
[15] Letter from Clower to Patinkin (03/03/1962). D. Patinkin Papers, Box 25, Rubenstein Rare Book and Manuscript Library.

an incompatibility between Walrasian microfoundations and Keynes' income analysis. This result was the heart of the 1965 paper.

In the letter, Clower used this criticism of Walrasian macroeconomics to question Patinkin's integration of monetary and value theory:

> We all have our hobby horses, to be sure, but this one [the utility theory foundations of monetary theory] does not really fit too well with some of your other ideas – particularly the ideas adumbrated in the second half of your book on disequilibrium systems. […] The very fact that you take initial money stocks as given, and income as given also, means that you are working with potential disequilibrium states for the consumer since, if you put factor services into the utility functions, and allow money balance to adjust over time, making balances a variable also, you immediately lose parameters and have to start dealing with more variables. But these variables are damned hard things to fit into general equilibrium models without getting classical conclusions (i.e., full equilibrium conclusion about full employment sales of factor services and full employment holdings of money balance). Then what can you say about the real balance effect? Note, in particular that you cannot legitimately put income into your demand functions in Part II of your book, if you suppose that individuals earn income from inside the system – for then income is not an independent variable.

The articulation between the 1965 argument and the criticism of Patinkin's integration of monetary and Walrasian value theory is not self-evident. Hence it is helpful to explain the quotation step-by-step. Clower accused Patinkin of focusing too much on the development of his foundations of monetary theory because that would not be in line with his disequilibrium interpretation of the *General Theory*. To explain why, Clower stressed a formal analogy

between the integration of income and real balances as additional independent variables in individuals' demand functions. Clower probably considered that there would be undesired variations of the level of real balances in situations of disequilibrium. Thus, just as income, real balances would have to act as constraints on workers' consumption plans. But this was not possible under the tâtonnement hypothesis. Without rejecting this assumption, the introduction of these variables would entail accepting full equilibrium conclusions. Accordingly, the real-balance effect would not properly account for the transmission of disequilibria from the monetary sector to the real sector of the economic system. Clower inferred that one fundamental pillar of Patinkin's monetary theory was faltering.

Later, Clower found a more decisive way to challenge Patinkin's integration of monetary and value theory. The criticism was presented in the 1967 article. It stressed the possibility of barter exchanges in Patinkin's framework. The analysis of the preliminary versions of the 1967 article suggests that this criticism was a side effect of Clower's charge against tâtonnement economics:

> For we found the ultimate source of anomaly in contemporary monetary theory […], *the failure of the traditional trading constraint to impose any restriction whatever on means of payment used to discharge trading obligations.* This is, after all, the economic meaning of 'tâtonnement', 'recontract', 'synchronized trading' to convert all forms of market trading into particular species of the genus *barter.*[16]

In the drafts, Clower pointed out that in tâtonnement models, "a market authority [was] presumed to synchronize purchases and sales to ensure continuous multilateral coincidence of wants between market participants". Individuals transmitted information on their consumption

[16] R.W. Clower Papers, Box 2, Rubenstein Rare Book and Manuscript Library.

and production plans. The market authority ensured the coordination between those plans and then facilitated the realization of transactions. Under these assumptions, it was as if the market authority acted as a "bargaining agent" and a "distribution center" for all the individuals of the economic system. According to Clower, this conception of trading activity implied that individuals could either sell their labor or their money balances to buy goods. Yet, a model in which goods were indistinguishable from money as a source of purchasing power portrayed a barter economy, not a monetary economy. Therefore, tâtonnement models could not be used to account for the functioning of monetary economies.

2.2 The 1967 article as part of Clower's disequilibrium program of microfoundations

Clower came to conclude that just like the integration of Keynes' income analysis and value theory, the integration of monetary and value theory required rejecting the tâtonnement hypothesis and providing a choice-theoretic basis for disequilibrium systems. From there, it is a short step to show that the 1967 article was part of Clower's (1965) disequilibrium program of microfoundations. First, the 1967 article can be viewed as the result of Clower's search for disequilibrium microfoundations to monetary theory. During the Royaumont conference, Clower claimed that the introduction of money as a new variable would have been a second step in his disequilibrium program of microfoundations. He explained that he decided not to introduce money in his model to facilitate the exposition of the "dual-decision" hypothesis and of its implications. According to Clower, such a strategy was also adopted by Keynes (1936):

> The essential character of the dual-decision process would come out more clearly if one did not get into asset-holding problems at the outset. Naturally, one must get into this kind of things in order to make sense of the complete Keynesian system […] A model that included money without including income as an independent variable would hardly qualify as a Keynesian model, whereas a

> model with income and without money could be called Keynesian (as Keynes' argument in chapter 2 of the *General Theory* so clearly indicated (1965a: p. 305).

In 1964, in a review of Milton Friedman and Anna Schwartz's (1964) *Monetary History of the United States 1867-1960*, Clower repeated the need to shape disequilibrium foundations to monetary theory. This would have been a way to account for the kind of correlations between the stock of money and monetary income described in this statistical work (1964: p. 65). In that respect, Clower regretted that Friedman and Schwartz did not try to sketch the analytical framework underlying their statistical study:

> But alas, except that Friedman and Schwartz display a moderate antipathy to Keynesian economics and nowhere worry seriously about possible direct effects of current market transactions on current demand and supply conditions, this line of argument cannot be sustained either – except by gross prejudice. The *shading* of the argument is in the direction claimed, but the *substance* is not (1964: p. 76).

Finally, in the preliminary drafts of the 1967 article, Clower explained that the dichotomized budget constraint emerged as a solution to explain how individuals behaved in a non-market clearing context:

> There is just one way to rid ourselves of the [contemporary monetary] theory, and that is to reformulate established microeconomic analysis. Following Keynes, I shall consider an economy in which trading takes place more or less continuously whether or not demand is equal to supply in all markets. Moreover, I shall assume that just one commodity in the economy, namely money, can be traded for all other commodities. These specifications force us to regard buying and selling as essentially independent (even if simultaneous) activities […]

> Desired earnings appear not as an element of purchasing power in (1) [the "expenditure constraint"] but simply as a possibly unrequited demand for income in (2) [the "income constraint"].[17]

In "contemporary monetary economics", individuals were supposed to make optimal decisions on the quantity of goods to purchase (d_i) and sell (s_i), and on the quantity of money to transfer to the next market period $M_j - \underline{M_j}$ (with M_j and $\underline{M_j}$, the desired and initial quantities of cash) under the following constraint:[18]

$$\sum_{i=1}^{n} p_i(\, d_{ij} - s_{ij}) + \, M_j - \underline{M_j} = 0 \qquad (1)$$

According to Clower, the form of this budget constraint implied that the capacity of individual *j* to sell the good *i* was granted. In other words, individuals formulated their consumption plans by considering desired receipts as an element of purchasing power. However, when disequilibrium trading took place, such an assumption was no longer relevant. Individuals may not be able to sell what they had planned at the prevailing market prices. Accordingly, standard budget constraint had to be reformulated so as to break the direct link between prospective sales and prospective purchases. Clower's idea was to consider buying and selling activities as independent activities. This resulted in the dichotomized budget constraint:

$$\begin{cases} \sum_{i=1}^{n} p_i(\, d_{ij} - s_{ij}) + \, M_j - \underline{M_j} = 0, \quad if\ d_{ij} - s_{ij} \geq 0 & (2) \\ \sum_{i=1}^{n} p_i(\, d_{ij} - s_{ij}) + \, m_j = 0, \qquad if\ d_{ij} - s_{ij} < 0 & (3) \end{cases}$$

[17] R.W. Clower Papers, Box 2, Rubenstein Rare Book and Manuscript Library.

[18] Both in the drafts and in the 1967 article, Clower used the label "contemporaneous monetary theory" to refer "specifically to O. Lange, *Price Flexibility and Employment* and Don Patinkin, *Money, Interest, and Prices*; but also to certain portions of Hicks's *Value and Capital* and Samuelson's *Foundations*" (1967: p. 81).

The "expenditure" branch of the budget constraint (2) asserted that in a monetary economy, demand was "effective if it [involved] a combination of desire with money purchasing power"; the "income" branch of the budget constraint (3) asserted that "intra-period receipts" (m_j) were a demand for monetary income.[19]

From there, analytical arguments can be raised to emphasize the disequilibrium features of the 1967 microfoundations. First, the dichotomized budget constraint aimed to reproduce the logic of the "dual-decision" hypothesis. Assume that some individuals fail to sell the quantity of goods planned at the prevailing market prices. The "intra-period receipts" would be lower than the one planned. Because of that, the money balances that individuals sought to hold to finance their expenditures and to transfer money purchasing power from one market period to another would be also lower than the ones planed. Individuals would be therefore forced to recalculate new consumption plans, on the basis of their realized monetary income. This is the dual-decision process expounded in the "Counter-Revolution" paper. The only difference is that income constraints would appear after a delay depending on the quantity of money initially held by individuals.[20] Second, the way Clower sought to close his 1967 model aimed to leave room for involuntary unemployment.[21] This intention appears clearly in the preliminary drafts of the 1967 article:

> To say that an unemployed man has an unsatisfied desire for money income makes sense. To suggest (as does traditional theory) that the same man has an

[19] R.W. Clower Papers, Box 2, Rubenstein Rare Book and Manuscript Library. The quotations can be found also in the 1967 article (p. 87).

[20] Clower supported this view in the course of the discussions held at the Royaumont Conference: "But if one had assets, the dual decision hypothesis would be relevant since, unless one supposed that assets somehow got replenished without getting purchased, a chronic gap between desired and actual factor sales would sooner or later force all assets to the zero level unless the gap was reflected instead in reduced demand for commodity flows" (1965a: p. 308).

[21] "As in established theory, the money value of the sum of all excess demands, including the excess demand for reservation money balances and for money income, is identically zero; hence a proposition analogous to what has come to be known as Walras' law applies to transactor in a money as well as to transactors in a barter economy" (1967: p. 88).

> unsatisfied desire for money seems not only senseless but silly. The point to emphasize is not verbal but substantive: transactors in a money economy are directly responsive to changes in actual as distinct from virtual income flows. This is *not* true in a money economy as it is in a barter system that $p_1x_1 + p_2x_2 + p_3x_3 = 0$ for all admissible values of the variables, i.e., Walras' law does not hold. What is true is the very different proposition $p_1x_1 + p_2x_2 + p_3x_3 - (\bar{y} - \underline{y}) = 0$, i.e., commodities, valued at prevailing market prices, is identically equal to his unsatisfied desire for income. This proposition might be called Keynes' law to distinguish it from Walras' law, or Say's law, neither of which is valid for a money economy. Keynes of course does not state this proposition explicitly, but his discussion of involuntary unemployment in chapter II of the *General Theory* implies it. For the term differs from zero only if there is involuntary unemployment in Keynes' sense of the term.[22]

A charge against Lange's theory underlined the presentation of "Keynes' law". In Lange's (1945) perspective, depression was viewed as a long tâtonnement process during which both the labor market and the market for goods would have been in a situation of excess-supply because of an excess-demand in the money market (Goulven Rubin, 2011). In Clower's (1965) disequilibrium model, such a scenario could not happen. Since the tâtonnement hypothesis was rejected, it was necessary to make a distinction between "effective" demands (deduced from constrained optimization plans) and "notional" demands (deduced from standard optimization plans). For a purchase decision to be effective, individuals had to sell before. They needed to have a purchasing power. Thus, workers could not even express a demand for money if they

[22] R.W. Clower Papers, Box 2, Rubenstein Rare Book and Manuscript Library.

did not have sold their labor before. They could express only an unsatisfied demand for monetary income in situation of involuntary unemployment.

To conclude, there are strong grounds for believing that the 1967 "Reconsideration" of Patinkin's microfoundations of monetary theory is rooted in Clower's (1965) disequilibrium interpretation of the *General Theory*. The results of the "Counter-Revolution" article can be used to explain both the 1967 criticism and the main features of the 1967 microfoundations. This raises the following issue. Since Clower (1965) required rejecting the Walrasian macroeconomics of Hicks (1939), Lange (1944), and Patinkin (1956), to what extent the 1967 proposals remained in Patinkin's program to integrate monetary and value theory?

3. An original reorientation in Patinkin's program to integrate monetary and value theory

Since Clower (1967) criticized the monetary theory developed in *Money, Interest, and Prices* and paved the way for an alternative class of models, it is often considered that his approach was part of an alternative tradition. Yet, in *Monetary Theory: Selected Readings* (1969), Clower never mentioned the alternative tradition allegedly embodied by Robertson (1933), Brunner (1951), and Tsiang (1966). Besides, analytical arguments show that Clower sought to reorient Patinkin's program, not to break with it. To make this point, it is necessary to outline the monetary theory contemplated by Clower. This reconstruction is based on the analysis of published and unpublished materials. Most of these materials were written by Clower after the 1967 article.

First, Clower (1969) inserted the "Reconsideration" article in the section devoted to the program opened by Patinkin (1956):

> The selections of Part two sketch the story of this [Classical] dichotomy from its very origins to very recent times. The end – or apparent end – of the story is unfolded in the selections appearing in part three [in which both an extract from *Money, Interest, and Prices* and the 1967 paper are presented] and part four [titled "Monetary Theory and Keynesian economics" in which the 1965 paper is presented] (1969: p. 19).

Clower (1969) suggested that the reason why *Money, Interest, and Prices* and the "Reconsideration" paper took part in the same tradition was that the same kind of monetary theory was sought:

> Looking at the problem of price behavior from a theoretical point of view, however, one finds it difficult to see how any significant role can be assigned to money in the long-run unless money is also assumed to play an important role in short-run events; and if money is assigned an important role in short-run economic analysis, then a *separate* long-run theory of money should not be necessary. Long-run conclusion should follow from short-run assumptions. However that may be, the fact is that until the appearance in 1936 of John Maynard Keynes' *General Theory of Employment, Interest, and Money*, most professional economists took it for granted that all economic problems of any practical importance could be adequately handled using established techniques of demand-and-supply analysis, thereby presupposing that money was as such a 'veil' in the short-run as it was in the long-run – for at no stage in pre-Keynesian economics was any serious attempt made to build peculiarly monetary assumptions into the micro-foundations of economic analysis (1969: p. 19).

Following in Keynes' footsteps, the goal would have been to formulate a non-dichotomous model, built from microeconomic behavior, and able to explain the dynamic of actual monetary economies so as to show the non-neutrality of money in the short-run without abandoning the neutrality proposition in the long-run.

Second, Clower kept advocating for a money-in-the-utility-foundation to monetary theory. In *Money, Interest, and Prices*, Patinkin considered that money displayed positive utility because of a stochastic payment system. It was assumed that individuals received their income and made their expenditure at different times during the Hicksian week. Therefore, individuals would have sought to hold money to make their payments. Clower rejected Patinkin's random payment process. In the preliminary drafts of the 1967 article, he argued that it "[involved] synchronization [of exchange] and [gave] completely artificial rationale to the theory of money". To explain the monetary nature of the market system, Clower assumed the existence of organized markets and considered that the activity of exchange was costly:

> Widespread acceptance of a definition of money that emphasizes its role as a means of payment would be of little consequence were this changed perspective not associated with important advances in the theoretical understanding of market exchanges processes in the real world. Perhaps, the best way to approach this subject is to observe that the existence of organized markets in which certain commodities play an exclusive role as means of payment does not permit us to assert that there will exist a positive demand for such commodities for purposes of exchange. The most obvious way to get around this difficulty is to suppose that it costs each individual something in terms of time and efforts to engage in the activity of exchange (1971: p. 111).

Both in the 1969 book and in published papers, Clower (1968; 1970; 1971) stressed that the realization of transactions presupposed a degree of organization of trading activity. Clower assumed the existence of organized markets where individuals could acquire goods against money. Previously, individuals would have accepted to use money in transactions to reduce the costs of exchange. Because of the double coincidence of wants, Clower considered that it was costly to find a trading partner. The use of money would lower these costs. Accordingly, money yielded utility and so, could be introduced in utility functions.[23]

Third and final point, Clower intended to modify, not to reject Patinkin's technology of exchange. In *Money, Interest, and Prices*, Patinkin used the Hicksian week. He assumed that individuals formulated their plans on Monday. Before midnight, a tâtonnement process ensured the coordination between individuals' plans. The rest of the week was devoted to the realization of transactions. In an unpublished manuscript written in 1971 "The Keynesian Paradigm: An Attempt at Reconstruction", Clower referred to an institutional apparatus close to the temporary equilibrium period. The differences with respect to Patinkin's technology of exchange were due to the rejection of the tâtonnement hypothesis:

> The representative market specialist is assumed to act as a broker in exchange transactions among individuals. Specifically, the specialist is assumed to post at the end of each hour a money price at which he proposes to execute trades during the next hour. Individuals who wish to buy and sell units of any particular commodity then communicate unconditional purchase or sale orders to the specialist that are to be executed, if possible, at the price already posted. In general, quantities offered for sale at the posted price will not be equal to quantities demanded for purchase, so the specialist will not be able to execute all

[23] Note that when Clower (1967) expounded his optimization plan, real balances were introduced in the utility function (1967: p. 88).

> orders that are communicated to him during any given hour. If demand exceeds supply, he executes all sale orders. If supply exceeds demand, he executes all purchase orders. He then informs transactors of trades that have been completed, debits and credits appropriate cash accounts, and adjusts price in accordance with familiar rules (p.8).[24]

Clower had to rationalize the organization of exchanges in a non-tâtonnement framework. To do so, he assumed that individuals dealt with "market specialists" (i.e., traders), on independent markets. Each trader had to find the equilibrium price on his respective market without having information on the economic situation prevailing in other markets and without seeking to coordinate the economic activities of the entire system. Beyond this decentralization, Clower's technology of exchange was very close to the Hicksian week. On the one hand, Clower maintained a time slicing within the market period. Traders were supposed to set monetary prices at which transactions would take place thereafter. Of course, the posted price had no reason to clear the market. Under these circumstances, the short side of the market always dominated and traders modified the monetary price to remove discrepancies between supply and demand. On the other hand, traders were supposed to execute transactions. They gave information on the quantities effectively exchanged, ensured the deliveries of goods, and were supposed to debit and credit individuals' cash accounts.

To conclude, Clower reoriented Patinkin's (1956) integration strategy to provide microfoundations to monetary theory. Money was introduced in utility functions. But the procedure was not justified by the existence of a random payment process. Money yielded utility since there were transaction costs. Then, an institution set prices and rationalized the organization of exchange. But it was not the Walrasian auctioneer, who was supposed to know

[24] Robert W. Clower's Papers: Box 2, Rubenstein Rare Book and Manuscript Library.

the set of individuals' excess-demands, to adjust the economy-wide price vector, and to authorize transactions only when all markets cleared. Clower assumed the existence of independent markets where traders set prices and organized monetary exchange in a non-tâtonnement context. This resulted in an original framework. From the beginning, Clower wanted to use "it to investigate U.S and British experience with problems of structural unemployment and inflation".[25] According to Clower, this required formalizing his disequilibrium monetary model and studying its stability properties. Next section discusses the theoretical challenges posed by this project.

4. Disequilibrium or the challenges posed by Clower's microfoundations of monetary theory

The formalization of Clower's disequilibrium model was challenging. Clower identified a first challenge in "The Keynesian Paradigm: An Attempt at Reconstruction" (1971a): to model individuals' behavior out of equilibrium. As a reminder, individuals were supposed to decide on the quantity of stocks of commodities and money to hold as well as on the quantities purchased and sold. Under these circumstances, when disequilibrium trading took place, undesired variations of stocks would have implied that the choice-theoretic model "set additional side constraints relating changes in actual stocks of various commodities to realized purchases and sales" (p. 10). This would have resulted in "an extremely complex model of individual behavior" (p. 10). In "Reflections on the Keynesian Perplex" (1975), Clower identified a second challenge: to model traders' behavior, and in turn, market adjustment processes. Each trader was supposed to set prices "in response to his own conception of the adequacy of his existing stocks in relation to present and prospective sales" (1975: p. 201). This

[25] This quotation is taken from a research proposal written circa 1965. Its title was "Structural Unemployment and Inflation: A Study of Some Disequilibrium Properties of a Market Economy". R.W. Clower Papers, Box 5, Rubenstein Rare Book and Manuscript Library.

resulted in a twofold difficulty: to consider a large quantity of variables including the "costs of holding inventories, costs incurred in adjusting prices, and expectations of future market conditions." (1975: p. 201); and to account for the variety of price behavior occurring in markets (1975: p. 201).

Besides, Clower discussed the challenges posed by the study of money-type non-tâtonnement processes. In the 1971 manuscript, he argued that stability analyses:

so far proved to be almost impossibly difficult, partly because the analytical problems involved are so complex, partly because so few people have been working at the task and those few have not found it easy to decide just what kind of model specifications should be adopted (p. 12).

To study the functioning of disequilibrium systems, it was necessary to account for spillover effects. Typically, in situation of involuntary unemployment, workers' inability to sell the quantity of labor desired implied revisions of consumption plans. This was the scenario expounded in the "Counter-Revolution" paper. When money was introduced, there was an additional difficulty. Clower (1971a) stressed that undesired variations of stocks and the resulting effects on the quantity purchased and sold had to be taken into account. This would make the formal study of non-clearing market dynamics too complex to be carried out. Beyond this technical difficulty, Clower (1971a) pointed out the lack of interest for disequilibrium dynamics. He argued that economists were much more interested in studying the equilibrium properties of the economic system than in analyzing its behavior out of equilibrium.[26] Accordingly, it was difficult to make any progress in the study of the dynamics of non-clearing markets. Clower added that it was all the more difficult to make progress since the dialogue

[26] Hahn expressed a similar position to justify the development of non-tâtonnement models. In his presidential address to the Econometric Society, he stressed that "the study of equilibria alone [was] of no help in positive economic analysis. Yet, it [was] no exaggeration to say that the technically best work in the last twenty years [had] been precisely that" (Hahn, 1970: p. 12).

between the few economists interested by disequilibrium issues was complicated.[27] There was too much diversity in the modeling of disequilibrium systems, or more generally, of decentralized economies. For instance, Clower (1971a) argued that he did not want to follow the approach of "Ostroy, Veendorp, Starr and others [that consisted in dealing] with marketless models in which trade [took] place between pairs of individuals on terms that [were] decided by individual bargaining" (p. 5). Moreover, in private correspondence, Clower repeatedly stressed the differences between "the disequilibrium models […] of Negishi, Hahn and Uzawa [and] his own contribution [which implied] a redefined budget constraint that makes money enter the demand equations in a manner quite different from any other commodity".[28]

In the end, Clower stuck to a stationary equilibrium analysis. Typically, he acknowledged that "transactions and other costs of market exchange should be introduced into microeconomic analysis via the formulation of an explicit dynamic model in which holdings of commodity and money inventories at any given point in time [were] a function of market purchases and sales" (1970: p. 427). But "conceptual and mathematical difficulties [were considered to be] too great, for it to be regarded as a practical possibility at the present time" (1970: p. 427). Therefore, he studied only the properties of "stationary solutions to implicit dynamical systems" (1970: p. 427). Besides, Clower's approach remained informal when he sketched his disequilibrium model. Either in the 1971 manuscript or in "Reflections on the

[27] Note that Clower closely followed the literature on non-tâtonnement models. In the archives, one can find repeated references to the models developed by Hirofumi Uzawa (1960), or Hahn and Negishi (1962). Besides, in a footnote of "Theoretical Foundations of Monetary Policy", Clower (1971) accumulated few other references: "Thus far only limited progress has been made in this direction [the formal study of the dynamic of non-clearing markets]. Cf. Herschel Grossman, 'Theories of Markets without Recontracting' […], Herschel Grossman, 'A General Disequilibrium Model of Money and Income' […]; and Peter Frevert, 'Disequilibrium in a Macroeconomic Model' […] Reference should also be made to recent (but as yet unpublished) work by Richard W. Ruppert and Robert Russel ('Intermarket Spillover of Excess Demand and the Stability of Non-Tâtonnement Adjustment processes'), and by John Ledyard ('Growth, Stability, and a Disequilibrium Action Process')" (1971: p. 112). Unfortunately, these papers were not published and I did not find them in Clower's archives.

[28] Letter from Clower to an unidentified recipient (11/05/1968): Robert W. Clower's Papers, Box 1, Rubenstein Rare Book and Manuscript Library.

Keynesian Perplex" (1975), there was no formal description of traders' behavior and of the market adjustment rules.

Conclusion

My chapter aimed to provide a detailed study of Clower's (1967) project for monetary economics. The 1967 article seemed to come out of the blue. It was preceded by a few published contributions to monetary theory. And in none of them did Clower clarify his own conception of the foundations of monetary economics. Moreover, Clower never completed the monetary theory related to his 1967 microfoundations. To overcome these difficulties, the solution was to characterize the intellectual context from which Clower's (1967) contribution emerged and to rebuild his project.

Clower's 1967 microfoundations outlined a reorientation in Patinkin's program to integrate monetary and value theory. Initially, Clower was involved in Patinkin's controversy. In this context, he defended the validity of the "Classical" theory. Yet, Clower considered that Patinkin had identified the major gaps of "Classical" monetary economics as well as the proper framework for understanding the functioning of actual monetary economies. At that time, in a way, Clower had nothing to say about monetary economics that had not already been said by Patinkin (1956). The situation changed when Clower realized that Walrasian microfoundations were incompatible with Keynesian macroeconomics. This result led Clower to challenge the monetary theory expounded in *Money, Interest, and Prices*. In particular, Clower stressed that the model developed by Patinkin (1956) portrayed a barter economy because of the tâtonnement hypothesis. Since this assumption was a source of anomalies, its rejection and the formulation of a choice-theoretic basis for disequilibrium systems became the *sine qua non* of monetary theory. The 1967 article was the result of Clower's search for disequilibrium microfoundations to monetary theory. This search did not lead to the formulation of a complete model. Yet, the

monetary theory contemplated by Clower was identified. Two results followed. First, Clower retained Patinkin's approach to monetary theory. Like Patinkin, Clower sought to provide a non-dichotomous monetary theory, based on sound microfoundations, and able to demonstrate the quantity propositions. To do so, Clower maintained the two pillars of Patinkin's integration, namely the introduction of money into utility functions and the real-balance effect. In this context, Clower dissociated himself from Patinkin because of his disequilibrium perspective. For instance, the Walrasian auctioneer was no longer supposed to perform the coordination of economic activities. Instead, Clower assumed the existence of "market specialists" who set prices and organized disequilibrium trading on independent markets. In short, Clower (1967) redirected Patinkin's program. There was no break with it. Second, the formalization of Clower's disequilibrium monetary model and the study of its stability properties posed challenges. On the one hand, Clower had to model how individuals revised their choices about the stocks to hold and the quantity to produce or consume in situation of disequilibrium, and how they interacted with "market specialists" on each market. On the other hand, Clower needed to face the technical difficulties posed by the formal study of disequilibrium dynamics. In the end, he did not meet these challenges. Consequently, he never completed his project to provide disequilibrium microfoundations to monetary theory.

Despite this failure, Clower's reconsideration of the integration of monetary and value theory found an echo. The need to formulate a decentralized model in which money mattered because of its role as a medium of exchange was inspiring for Ostroy. Ostroy acknowledged that "[Clower] was responsible for [his] interest in monetary theory"[29] while he was just a PhD candidate at Northwestern University.[30] Later, Ostroy played a decisive role in the emergence

[29] Letter from Ostroy to Clower, (12/02/1965): Robert W. Clower's Papers, Box 1, Rubenstein Rare Book and Manuscript Library.

[30] Ostroy received his PhD in economics at Northwestern University. His dissertation *Exchange as an Economic Activity* was defended in 1970.

of search models, one of the most widely used approaches to monetary theory since the 1980s. Clower (1967) was also inspiring for Leijonhufvud, when he was a PhD student at Northwestern University.[31] In the book based on his dissertation *On Keynesian Economics and the Economics of Keynes* (1968), Leijonhufvud welcomed Clower's (1967) "preliminary attack" on the "transaction structure", an "important" problem for monetary theory (1968: p. 90). Finally, Clower influenced the development of the field of money-type non-tâtonnement economics. In *General Competitive Analysis*, Arrow and Hahn (1971) introduced money in a non-tâtonnement framework whilst acknowledging that "the discussion when a medium of exchange [was] present [owed] its point of departure to Clower" (p. 346). Therefore, Clower's (1967) influences extends well beyond Lucas (1980) and the cash-in-advance literature. Such a large sphere of influences is the mark of seminal idea

[31] Clower was one of Leijonhufvud's PhD advisors.

Chapter IV: In Search for a "General" Theory of Adjustment Processes

Introduction

Like Patinkin (1956), Clower (1965) considered disequilibrium as a dynamic phenomenon. Firms' and/or workers' inability to realize their standard optimization plans generated pressures on wages and prices which, in turn, provoked market adjustments. This approach to disequilibrium economics was abandoned by Barro and Grossman (1971). When they elaborated the seminal fixed-price model, their analysis focused on the end-state of the adjustment process. The challenge became to demonstrate that equilibria with rationing could be obtained. As a result of this dynamic/static transition, two analytical problems dear to Clower were left aside: how to model the operation of exchange, and whether price and wage adjustments were stabilizing.

Between 1965 and 1975, Clower's position on the stability of the market system remained the same. In the 1965 article, he suggested that market adjustment processes were unstable. When individuals reacted to price and quantities, an excess-supply in one market implied revisions of the demand in other markets. As a result of this fall in effective demand, the economy may not converge towards the full employment equilibrium (1965: p. 55).[1] In 1975, this potential instability of the market system was stressed again. Clower and

[1] During the discussion at the Royaumont Conference, Clower suggested that his concern with the introduction of income in excess-demand functions reflected Keynes' concerns with the (in) stability of the market system: "The reason Professor Clower had worked with quantities, however, was simply that this was what worried Keynes. If wages were cut in a situation of less than full employment, then this had a direct impact on demand via reduced income. In traditional general equilibrium theory, it was only the last factor which was taken into direct account – and this seemed to be what Keynes was objecting to. Unless one worked with a model in which realized income entered the demand functions as an independent variable, there was no direct impact on household demand, and one could not discuss the problem that bothered Keynes" (Hahn and Brechling, 1965: p. 308).

Leijonhufvud argued that if "some rudimentary monetary and credit complications [were] introduced in [their] model […], then coordination failures [could] occur from time to time" (1975: p. 215). By contrast, his position on how to model the operation of exchange changed. In 1965, Clower referred to a "central market authority" charged to ensure the coordination among markets. It was supposed to set prices, to control the effectiveness of purchase orders, and to act as a clearing house. In 1975, while presenting his "neo-marshallian" program of microfoundations, Clower explained that "traders" ensured the coordination process in autonomous markets whilst following private interests (1975: p. 194). This move raises the issue of the evolution of Clower's disequilibrium program of microfoundations. Until now, historians have provided accounts of Clower's theoretical propositions in his "Counter-Revolution" article and in the 1975 articles without tracing the evolution of his research program (De Vroey, 2004 and 2016; Backhouse and Boianovsky, 2013). My chapter aims to fill this gap.

This raises three difficulties. The first one is to clarify the aim contemplated in Clower's disequilibrium research program. The second difficulty is to reconstruct the disequilibrium theory sketched in the "Counter-Revolution" article. On the one hand, Clower only provided a choice-theoretic basis for a theory of demand adapted to market disequilibrium. The supply side of the theory was not even mentioned. On the other hand, although Clower referred to the dynamic of non-clearing markets at the end of his article, he did not clarify the behavior of the economic system out of equilibrium. The third difficulty is to account for the development of a research program while no related contribution was published for more than ten years.[2] To overcome these difficulties, I characterize the intellectual context in which Clower evolved and

[2] There is no published contribution to disequilibrium economics between 1963 and 1975. Clower's article "The Keynesian Counter-revolution: A Theoretical Appraisal" was originally published in a Swiss journal in 1963 – it was published thereafter by Hahn and Brechling in *Theory of Interest Rates; Proceedings of a Conference held by the International Economic Association* (1965). New contributions appeared in 1975, when Clower and Leijonhufvud outlined their disequilibrium program of microfoundations.

analyze carefully all the published and unpublished documents written over the period 1958-1975. Particular attention will be paid to two unpublished manuscripts: "Keynes and the Classics: A Reinterpretation" (1958) and "The Keynesian Paradigm: An Attempt at Reconstruction (1971a). Their analysis will be complemented by referring to research proposals written circa 1965, to letters written during the sixties, and to the notes prepared by Clower for a conference held in Italy, in 1973.

Clower sought to lay the foundations of a "general" theory of adjustment processes. Concretely, this meant shaping a choice-theoretic basis for a market model able i) to account for the determination of prices and income in a monetary framework; ii) to include Walrasian economics as a special case, valid under full employment conditions; and iii) to address disequilibrium phenomena such as involuntary unemployment and inflation. Three market structures were elaborated in view of meeting this challenge. The first one was sketched in the "Counter-Revolution" article, the second one in "The Keynesian Paradigm: An Attempt at Reconstruction", and the third one in two articles published in 1975. The modifications made are analyzed in light of two intellectual contexts. In the first case, I identify a small group of economists including Crouch (1972), Frevert (1968; 1970), Grossman (1969; 1971), Leijonhufvud (1968), Rader (1972), and Tucker (1968). All these economists attracted Clower's attention because they sought to develop the kind of dynamic disequilibrium theory outlined in the "Counter-Revolution" article. Frevert's formal stability analysis of the dynamic model contemplated by Clower (1965) turns out to be particularly important to understand the first modifications. In the second move, particular attention is given to Arrow and Hahn's perception of the field of money-type non-tâtonnement economics. In the early 1970s, these two authors came to conclude that the existing foundations of economics were inappropriate for analyzing how actual market economies worked. This viewpoint was decisive in Clower's decision to base macroeconomics on Marshallian foundations.

1. A “general” theory of adjustment processes

Between 1958 and 1967, Clower was engaged in a search for microfoundations adapted to disequilibrium systems. His final proposition was to combine the “dual-decision” process with the monetary behaviors described by the optimization plan of the 1967 article. The aim contemplated was to lay the foundations of a “general disequilibrium theory”. Beyond its alleged capacity to address the determination of prices and income in a monetary framework, this theory was supposed to include Walrasian economics as a special case and to account for market adjustment mechanisms in disequilibrium situations such as involuntary unemployment and inflation. Clower claimed that the elaboration of this framework was possible because he had managed to devise “general” market adjustment mechanisms. From there, the project was to formulate a dynamic model composed of “general” adjustment rules, to set the related technology of exchange, and to study its stability properties. Each part of the project is rebuilt on the basis of published and unpublished materials written by Clower over the period 1958-1967. This rational reconstruction yields three results. First, Clower formulated a dynamical system in which the variation of prices in each market was a function of the excess demand in the market considered and of the quantity effectively exchanged in all other markets. Second, Clower based this dynamical system in a non-tâtonnement framework. Third, Clower sought to feature unstable market adjustment processes in order to portray scenarios of persistent involuntary unemployment and persistent inflation. The challenge was to provide a formal stability study to demonstrate these dynamic properties. Unfortunately, Clower failed to overcome the technical difficulties raised by his dynamical system and left opened the issue of its stability properties.

1.1 Microfoundations of a "general disequilibrium theory"

Over the period 1958-1967, Clower was looking for a choice-theoretic basis adapted to disequilibrium systems. He shaped his first disequilibrium microfondations in "Keynes and the Classics: A Reinterpretation", an unpublished manuscript written in 1958. But they were abandoned and replaced by the "dual-decision" hypothesis expounded in "The Keynesian Counter-Revolution: A Theoretical Appraisal" (1965). This behavioral hypothesis justified the process by which workers revised downwards their consumption plans in situation of involuntary unemployment. It was associated with an optimization plan which took into account the income effectively earned by workers in the labor market. In correspondence, Clower suggested that the "dual-decision" process was also adapted to the behaviors of entrepreneurs in situations of disequilibrium. In a letter sent to Meyer L. Burstein before the Royaumont Conference, Clower evoked the generalization of the "dual-decision" process arguing that "if the real wage [gave] us demand for labor greater than supply, the supply of goods [would have been] restricted by this limitation".[3] Unfortunately, Clower never formalized the resulting theory of the firm. After the Royaumont Conference, he focused on the integration of money in disequilibrium systems. He proposed a solution to address this issue in "A Reconsideration of the Microfoundations of Monetary Theory" (1967). Clower assumed that individuals should have money to consume and receive money in return of their selling. He deduced an optimization plan in which the budget constraint was separated into "expenditure" and "income" branches. The combination of this behavioral hypothesis with the "dual-decision" process constituted Clower's final proposition to model individuals' choices in disequilibrium systems.

[3] Undated letter from Clower to Burstein: R.W. Clower Papers, Box 8, Rubenstein Rare Book and Manuscript Library.

Clower never clearly expounded the project underlying his search for disequilibrium microfoundations. Yet, decisive clues on the aim contemplated are contained in two archival documents written circa 1965. The first document consists of the drafts of an unpublished book titled *Pricing and Disequilibrium*. In the introduction, Clower explained that the book "intended to contribute to the development of a general disequilibrium theory [capable of unifying] modern price theory, income analysis, and the theory of money".[4] The second document is a research proposal that Clower wrote to obtain a visiting position at the University of Essex.[5] Whilst referring to *Pricing and Disequilibrium*, Clower claimed that he sought to provide microfoundations to a "general disequilibrium theory" in order to rigorously address phenomena such as structural unemployment and inflation:

> As indicated in the accompanying account of the background for this proposal, I am currently writing a book on the theory of income, employment, money, and prices in which value theory and income analysis are treated as special cases of a general disequilibrium model of the economic system. The argument of the book rests on a straightforward dynamic generalization of established theories of household and business behavior. The end result is a synthesis of value theory and income analysis that permits the powerful analytical techniques of contemporary microeconomic theory to be brought to bear directly on problems that have hitherto been reserved almost exclusively for discussion in terms of *ad-hoc* macroeconomic models. To test the factual merit of this synthesis, I

[4] R.W. Clower Papers, Box 5, Rubenstein Rare Book and Manuscript Library.
[5] Clower obtained the position of "Keynes Visiting Professor of Economics" at the University of Essex from 1965 to 1966.

> propose to use it to […] investigate U.S. and British experience with problems of structural unemployment and inflation during the period 1946-1962.[6]

In the preceding quotations, Clower invoked three reasons to justify the generality of his disequilibrium theory. First, it could be used to address various "disequilibrium phenomena" such as persistent involuntary unemployment and persistent inflation. Second, it could provide a unified treatment of the determination of prices and income, in a monetary framework. Third, it could include the "Walrasian price theory perfected by Hicks, Samuelson, and Patinkin" as a special case because of dynamic extensions of standard microeconomics.

The key to fully identify Clower's project is to explain what made his approach to disequilibrium economics "general". An explanation can be found in "Keynes and the Classics: A Reinterpretation" (1958). In this unpublished manuscript, Clower began his analysis of the Keynes-Classics divide with a "restatement of the foundations of the Classical and Keynesian doctrines" (1958: p. 2). Then, he deduced two different dynamic models arguing "that the market adjustment mechanisms as seen by Keynes [differed] in an essential way from that contained in the Classical model" (1958: p. 9). Clower (1958) ended his "reinterpretation" of the Keynes-Classics divide with the formulation of a "General Classico-Keynesian model" (1958: p.13) mixing "Classical" and Keynesian adjustment rules (1958: p. 14). In that process, Clower (1958) suggested that the ultimate aim of his discussion was to provide microfoundations to "general" market adjustment mechanisms and, in turn, to a "general" theory of adjustment processes.

It turns out that this ambition underpinned Clower's disequilibrium program of microfoundations. Indeed, it explains the prior assertions regarding the "general disequilibrium

[6] This quotation is taken from a research proposal titled "Structural Unemployment and Inflation: A Study of Some Disequilibrium Properties of a Market Economy". R.W. Clower Papers, Box 5, Rubenstein Rare Book and Manuscript Library.

theory" and transpires in the "Counter-Revolution" article. First, Clower considered that the formulation of a dynamic model composed of "general" adjustment rules allowed addressing various disequilibrium phenomena. In "Keynes and the Classics: A Reinterpretation" (1958), Clower claimed that "ordinary circumstances" (i.e., economic situations near equilibrium) and scenarios of "wage-price deflation" could be portrayed on the basis of his "General Classico-Keynesian model" (1958: p. 15).[7] Though less explicitly, Clower (1965) also considered that different dynamic scenarios could be addressed thanks to the "general" adjustment processes that he deduced from his "dual-decision" hypothesis. The processes were "general" because they encompassed "traditional" and Keynesian market adjustment mechanisms. Clower argued that when workers' and entrepreneurs' "current income [was] not less than notional current income […] the notional functions $\overline{d_G}$ and $\overline{s_G}$ [demand and supply for goods] constitute[d] relevant market signaling devices" (1965: p. 49). But if workers were involuntary unemployed and yet entrepreneurs sold the quantity of goods that they had planned, the "constrained demand functions $\widehat{d_G}(P, Y)$ and the notional supply functions $\overline{s_G}$ [were] the relevant providers of market signals" (1965: p. 50). Since markets were supposed to adjust according to excess-demand conditions (1965: p. 54), the dynamic of the economy would have been different whether or not the income effectively earned by individuals was taken into account.[8] Second, Clower argued that the formulation of a dynamic model composed of "general" adjustment rules allowed integrating price theory and income analysis, in a monetary framework. To make this point,

[7] Note that the dynamic of inflationary states was not mentioned in this manuscript. But Clower raised this issue in "Keynes and the Classics: A Dynamical Perspective" (1960: p. 24). In the afterword of *Money and Markets*, Clower explained that this article was an "expurgated version" of "a much longer paper on Keynesian microdynamics that made use of various mechanical price and quantity adjustment rules" (1984: p. 260). Clower (1984) certainly referred to "The Keynes and the Classics: A Reinterpretation" (1958). Because of that, one can infer that Clower believed in the possibility to address the dynamic of inflationary states on the basis of the general adjustment rules set in 1958.

[8] "The point of the example is merely to illustrate that, *when income appears as an independent variable in the market excess-demand functions – more generally, when transaction quantities enter into the definition of these functions – traditional price theory ceases to shed any light on the dynamic stability of a market economy*" (1965: p. 55).

Clower focused on the choice-theoretic basis underlying his "general" market adjustment mechanisms. In the "Counter-Revolution" paper, the "dual-decision" hypothesis was the founding stone of a "Keynesian model of market price formation" able to account for "factor unemployment" (1965: p. 55). In other words, the "dual-decision" hypothesis allowed modifying the excess-demand functions so as to portray situations of involuntary unemployment at the individual and market levels of analysis. Following the same logic, the combination of the "dual-decision" process with the 1967 optimization plan would have generated market excess-demand functions taking into account the monetary structure of exchange. Clower might have inferred that he had found the way to simultaneously address the determination of prices and income in a monetary framework. Third and final point, Clower considered that his "general" dynamic model could include Walrasian price theory as a special case. Starting from the idea that Walrasian economics was mainly concerned with equilibrium situations, Clower raised two arguments to explain the generality of his model. On the one hand, Clower (1958) considered that "the equilibrium problem [was] a special case of a more general dynamical problem" (1958: p. 3). This was because equilibrium issues could be addressed by setting the conditions under which the economy was in a state of rest, i.e., when "all time derivatives [were] zero" (1958: p. 14). On the other hand, Clower claimed that he had formulated a microeconomic framework including the Walrasian price theory as a special case, valid under full employment conditions. In the "Counter-Revolution" paper, the "dual-decision" hypothesis was viewed as general because it included Walrasian preference analysis at the full employment equilibrium, and was valid in disequilibrium. Moreover, thanks to the "dual-decision" hypothesis, Clower explained that Walras' law was the limit case of a more general relation, valid in situation of involuntary unemployment as well as in full employment

(1965: p. 53).[9] Therefore, "price theory with Walras' law was just a special case" (1965: p. 56) of the "general" theory of adjustment processes that Clower contemplated.

1.2 Modeling the "general" theory of adjustment processes

The elaboration of the "general" theory of adjustment processes raised the issue of how to model the dynamics of non-clearing markets. The approach adopted by Clower is clarified by a letter sent to his mathematician colleague Bushaw, by a discussion held at the Royaumont Conference with Malinvaud, and by the "Counter-Revolution" article.

1.2.1 The dynamical system

In a letter sent to Bushaw before the Royaumont Conference, Clower presented the dynamical system that he had in mind while writing the "Counter-Revolution" article. The "usual" price adjustment function was replaced by another mechanism connected to the "dual-decision" process:

> My problem is naturally mathematical in character. Consider a price system $\dot{p}_i = F_i\left[\overline{d}_\iota(P) - \overline{s_\iota}(P)\right]$ (P a price vector $(p_1 \dots p_{n-1}, 1)$, $i = 1, \dots, n-1$, $\sum_{i=1}^{n} p_i x_i = 0$, where $p_n \equiv 1$, as indicated above. The functions $\overline{d}_\iota$ and $\overline{s_\iota}$ satisfy the usual economic conditions for demand and supply functions, and $x_i = \overline{d}_\iota - \overline{s_\iota}$. Now, I want to consider the difference between this system and one in which the demand and supply functions depend not only on prices, but on quantity actually

[9] Clower changed his mind regarding the formal aspect of this relation. In the "Counter-Revolution" article, Clower argued that the value of the sum of excess demands was not equal to zero but less than equal zero. This was because in situation of involuntary unemployment, the "notional" demand for goods was replaced by the "constrained" demand for goods in the sum of excess-demands. In the preliminary drafts of the 1967 article, Clower formulated another relation. His proposition was to introduce an excess demand for monetary income in a sum including the excess demands for labor, goods, and money to hold. On that basis, an excess supply in the labor market would have been balanced by an excess demand for monetary income. Thus, the sum of all constrained demand was equal to zero even when there was a situation of involuntary unemployment.

> exchanged, this being defined as quantity demanded if there is excess supply in any market, as quantity supplied if there is excess demand (the short side of the market governs it). Denote these quantities by q_i; then $q_i = d_i$ if $x_i \leq 0$, $q_i = s_i$ if $x_i > 0$, but the demand and supply functions, instead of being defined as above, are now given by, say, $\widehat{d_i}(P, Q)$ and $\widehat{s_i}(P, Q)$, P the same vector as before, but $Q = (q_1, \ldots, q_n)$ […] I have worked out a complete theory of individual behavior underlying systems of this kind.[10]

In a model based on a generalized "dual-decision" process, market excess demands took into account the income that individuals (entrepreneurs and workers) managed to earn thanks to what they actually sold in markets. More generally, individuals' ability to buy and sell was supposed to depend on the transactions realized in various markets. This resulted in a new price adjustment mechanism. Clower's suggestion was that the variation of a price in one market depended on the excess demand in that market and on the quantity effectively exchanged in all other markets.[11]

[10] Undated letter from Clower to Bushaw: R.W. Clower Papers, Box 4, Rubenstein Rare Book and Manuscript Library. Note: to stick to the logic of the "dual-decision" process exposited in the "Counter-Revolution" article, *Q* should be replaced by *PQ*. When individuals revised their plans, what mattered was not the physical transaction but the value of what was effectively exchanged. See below and 2.1 for more details about this dynamical system.

[11] In chapter 13 of *Money, Interest, and Prices*, Patinkin addressed the dynamic of non-clearing markets in much the same way. He combined the concepts of "spillover effect" with the one of "dynamic intermarket pressures" ([1956] 1965: p. 319) to explain how the market system adjusted in situation of involuntary unemployment. The "spillover effect" and the "dual-decision" process rested on the same logic and the "dynamic intermarket pressures" was Patinkin's way to justify that price adjustment in a given market depended on the excess demands of all the market system ([1956] 1965: p. 235). It is very likely that Clower's reading of *Money, Interest, and Prices* led him to formalize his dynamical system. On the one hand, I argue elsewhere that Patinkin (1956) had a decisive influence on Clower's disequilibrium interpretation of the *General Theory* (Plassard, 2015). On the other hand, Clower (1965) referred to Patinkin's "spill-over effect" whilst stressing what that meant in terms of price adjustment mechanism: "[Patinkin] suggested the desirability of supposing that actual transactions exert a more or less direct influence on price adjustment via 'spillover' effects – changes in prevailing supply and demand conditions to reflect current discrepancies between planned and realized purchase and sales. […] His suggestion is to redefine the usual price adjustment function to make the rate of change of price in one market a function not of excess demand in that market alone, but also of excess demand in all other markets." (1965: p. 44).

In the course of a discussion with Malinvaud during the Royaumont Conference, Clower insisted on the originality of this dynamical system:

> Professor Clower said that he suspected that M. Malinvaud and he had different methodological views about economic dynamics […] He [Clower] wanted to analyze disequilibrium states without in any way committing himself to the assumption that the forces at work in the neighborhood of a given state would be qualitatively the same if we moved to a different neighborhood. [Clower claimed that] models of the sort used in classical physics were no doubt interesting from a mathematical point of view. But they might not be relevant in economics. Professor Clower's preference was for dynamical models [in which] one did not assume that equations of motion which were valid for one state of a system could be carried over without change to discuss motions which started from other states. The dynamical systems which were implied in a general equilibrium model of the sort he had in mind were not at all classical. They gave rise to non-linear systems in which the values of the relevant adjustment coefficients switched with changes in the state of excess-demands in various markets (Brechling and Hahn, 1965: p. 306).

The specificity of Clower's approach to dynamics was that the equations of motion were qualitatively different, depending on the kind of disequilibrium analyzed. According to him, this feature implied a modeling of dynamical systems alternative to the one inherited from physics and traditionally used in economics. In the preceding quotation, Clower referred to this characteristic through the idea of a switch in "relevant adjustment coefficients". To understand what he meant, it is helpful to recall the basics of economic dynamics. Assume a simple non-linear dynamical system composed of two equations of motions. They are supposed to describe

the evolution of prices (p) and wages (w) as functions (f_G and f_L) of the "notional" excess demand for goods ($\overline{x_G} = \overline{d_G} - \overline{s_G}$) and labor ($\overline{x_L} = \overline{d_L} - \overline{s_L}$):

$$\begin{cases} \dot{p} = f_G(\overline{d_G} - \overline{s_G}) \\ \dot{w} = f_L(\overline{d_L} - \overline{s_L}) \end{cases}$$

To study the stability properties of this system, it is necessary to express its linear approximation at the stationary equilibrium ($p^*; w^*$). It follows a coefficient matrix A composed of the partial derivatives of each function with respect to prices and wages, calculated in the neighborhood of the stationary equilibrium. The stability of the market system depends on the signs of the trace and the determinant of A.

$$A = \begin{matrix} \frac{\partial f_G}{\partial p} & \frac{\partial f_G}{\partial w} \\ \frac{\partial f_L}{\partial p} & \frac{\partial f_L}{\partial w} \end{matrix}$$

In the discussion with Malinvaud, Clower referred to these coefficients. With that in mind, there are two ways to explain why Clower considered that the coefficients switched "with changes in the state of excess demands in various markets". The first way is to compare the adjustment rules in equilibrium and disequilibrium situations. The equations of motion that Clower took into account in equilibrium were qualitatively different in disequilibrium. For instance, A would have been considered as relevant if all individuals satisfied their optimization plan but not if some of them were rationed. To be more specific, in the situation of involuntary unemployment considered in the 1965 article, a "constrained" demand function was supposed to be substituted to the "notional" demand function. Accordingly, the coefficients $\frac{\partial f_G}{\partial p}$ and $\frac{\partial f_G}{\partial w}$ would have differed from those given by A if there was an excess supply in the labor market. The second way to explain the modifications of the coefficients is to highlight their components. Assume that the "constrained" demand function is substituted to the "notional" demand function in the

market excess-demand for goods. It follows that the quantity effectively exchanged in the labor market appears in the expressions of $\frac{\partial f_G}{\partial p}$ and $\frac{\partial f_G}{\partial w}$. This is because instead of deriving $f_G[\overline{d_g}(P) - \overline{s_g}(P)]$ with respect to *p* and *w*, the theorist would have to derive $f_G'[\widehat{d_G}(P, w\overline{d_L}) - \overline{s_G}(P)]$ with respect to these variables. Since the quantity of labor effectively exchanged in the labor market was not supposed to be fixed, the values of $\frac{\partial f_G'}{\partial p}$ and $\frac{\partial f_G'}{\partial w}$ would have been different depending on the magnitude of the excess supply in the labor market.

1.2.2 The technology of exchange

In the "Counter-Revolution" article, Clower sought to formulate the technology of exchange adapted to his "general" theory of adjustment processes. On the one hand, he assumed that "actual transactions in any given market [were] always dominated by the 'short' side of the market" (1965: p.44). The quantities effectively exchanged were supposed to be equaled to the quantity demanded if there was an excess supply in a given market, to the quantity supplied in the contrary case. On the other hand, Clower (1965) proposed to rationalize the operation of trade in a non-tâtonnement framework:

> Here and elsewhere in the argument, it may be helpful if the reader imagines that a central 'market authority' is responsible for setting all prices (using the nth commodity as an accounting unit), and that this 'authority' maintains a continual surveillance over all sale and purchase orders communicated to it by individual transactors to ensure that no purchase order is 'validated' unless it is offset by a sale order that has already been executed (i.e., purchase orders are simply 'cancelled' unless the transactor has a positive balance of 'book credit' with the market authority sufficient to cover the entire value of the purchase order). It must be assumed that the market authority communicates continuously with each transactor to inform it of the precise level of its current credit balance, and further

> informs each transactor of the precise rate at which previously validated purchase orders currently are being executed. Sale orders are 'validated' automatically, but the rate at which such orders are executed is governed by prevailing demand conditions. It is implicit in this entire line of argument that, at some 'initial' state in the evolution of market trading arrangements, the market authority advances a nominal quantity of book credit to one or more transactors to set the trading process in motion (without such initial advances, no sale order could ever be executed since no purchase order would ever be validated) (1965: p.51).

Clower assumed the existence of a central market authority charged to set prices, to control the effectiveness of purchase orders, and to carry out transactions. On the basis of this technology of exchange, Clower broke down his non-tâtonnement process into three logical steps – each of which being suggested through his well-known example of the economic consultant in situation of involuntary unemployment. First, the central market authority was assumed to set a vector of prices at which exchange took place. Individuals communicated simultaneously their purchase and sale orders at these prices.[12] By assumption workers failed to sell the quantity of labor planed at the given real-wage and entrepreneurs sold the quantity of goods that they had planned. This stage was associated to the assumption that the economic consultant was "involuntarily unemployed in the sense of Keynes" (1965: p. 48). Second, the market authority cancelled the purchase orders of workers in situation of involuntary unemployment. Because of that, workers expressed an "effective" demand for goods instead of a "notional" demand for

[12] In the "Counter-Revolution" article, Clower was ambiguous regarding the operation of buying and selling activities. Whether these activities took place following a sequence or simultaneously was not specified. Yet, this issue was clarified in an archival document written circa 1965. In the course of formulating a disequilibrium monetary theory, Clower considered "buying and selling as essentially independent (even if simultaneous) activities". R.W. Clower Papers, Box 2, Rubenstein Rare Book and Manuscript Library.

goods.[13] This stage was associated to the formal presentation of the "dual-decision" process and the deduction of the "constrained" demand for goods (1965: pp. 49-50). Third, the market authority modified the set of prices in accordance with market excess-demand conditions, and exchange took place again. This stage was associated to Clower's emphasis of different dynamical scenarios, at the end of the article (1965: pp. 54-55).

1.3 Stability properties

Both in "Keynes and the Classics: A Reinterpretation" and in the "Counter-Revolution" article, Clower discussed scenarios of persistent involuntary unemployment. This implied that he wanted to build his "general" theory of adjustment processes on a result of instability of the full employment equilibrium. This may be surprising given the intellectual context in which he evolved. Clower was led to formulate his disequilibrium program of microfoundations under a twofold influence. The first influence was played by Hicks ([1939] 1946) and Patinkin (1956). Put simply, Clower inherited his microfoundational approach from Hicks and his disequilibrium interpretation of the *General Theory* from Patinkin. The second influence was exerted by Hahn and Negishi (1962). Clower (1965) insisted on the rejection of Walras' law partly because they recognized its validity as a necessary condition for ensuring the stability of non-tâtonnement processes. What is striking is that unlike Clower, all these authors considered that a relevant model had to feature a stable market adjustment process towards temporary equilibrium. The reason invoked by Hahn and Negishi was empirical. Considering that instability meant individuals' inability to exchange, they argued that an unstable dynamic did not provide a good picture of the functioning of the market system. Economic activities displayed coherence, not chaos.[14] The reasons invoked by Hicks and Patinkin were empirical

[13] Note that it was as if the "dual-decision" process was instantaneous.

[14] Note that Hahn and Negishi started developing non-tâtonnement models because they realized that it would not be possible to demonstrate that a tâtonnement process was stable in general. In "The Stability of the Competitive Economy: A Survey Article", Negishi drew on Herbert Scarf's (1960) examples of global instability to

and theoretical (Rubin, 2004; 2011). Whilst claiming that the instability of the temporary equilibrium was a possible scenario (associated to a "breakdown" of the economic system), Hicks and Patinkin considered that this result was not appropriate for analyzing the functioning of the market system. It was viewed as exceptional and too radical to constitute a relevant basis for a realistic theory. Then, since both Hicks and Patinkin sought to capture the dynamic of the market system through a sequence of temporary equilibria, they needed to formulate models that ensured the convergence of the exchange process on each Monday of the Hicksian week. It was for these two main reasons that Hicks and Patinkin eventually gave up the idea to build theories including a result of instability of the full employment equilibrium.

Thanks to the technology of exchange sketched in the "Counter-Revolution" article, Clower thought that he might capture the dynamic of market economies other than through a sequence of temporary equilibria. His approach to market dynamics would thus have been compatible with the instability of the full employment equilibrium. Therefore, the theoretical argument of Hicks and Patinkin could be eluded. Then, Clower wanted to model an unstable dynamic that had nothing to do with the radical conceptions displayed by Hahn, Hicks, Negishi, and Patinkin. As a reminder, Clower sought to use his "general disequilibrium theory" to portray scenarios of "structural unemployment" and "structural inflation". This meant that instability did not refer to a breakdown of the economic system. Instead, instability portrayed sequences of exchange in which some individuals repeatedly failed to realize their standard optimization plans. In other words, the market system would not have the forces to bring the

make this point: "Judging from these examples [Scarf's], we must admit that the tâtonnement process is not perfectly reliable as a computing device to solve the system of equations for general economic equilibrium. It is possible to interpret these instability examples as showing that the difficulty is essentially due to the assumption of tâtonnement (no trade out of equilibrium) and to conclude that the tâtonnement process does not provide a correct representation of the dynamics of markets. See Hahn (1960). The failure of the general stability of the tâtonnement process suggests the study of the stability of the non-tâtonnement process (1962: p. 659).

economy back to full employment equilibrium but it would have the forces to ensure the operation of economic activities.

To justify this conception of market dynamics, Clower proposed only one literary stability analysis. The analysis was exposited in the "Counter-Revolution" article and aimed to account for a scenario of persistent involuntary unemployment. It concerned a special case of Clower's dynamical system since only workers failed to realize their optimizing plan. His demonstration rested on various assumptions. First, the central market authority set all prices except the *numéraire*. Second, labor was the *numéraire*. Third, the effective demand for goods matched the notional supply of goods (1965: p. 54). Fourth, prices varied according to a rule including the "constrained" demand for goods and the "notional" supply of goods (1965: p. 54).[15] Under these assumptions, the price adjustment process was blocked and so was the situation of involuntary unemployment. The reason was that only prices were supposed to vary. They did not because the "constrained" demand for goods equaled the "notional" demand for goods. In the "Counter-Revolution" article, this dynamical scenario was described through the example of the economic consultant in situation of involuntary unemployment. The problem of defective market signals underlined the narrative. The economic consultant was unable to signal the demand for goods associated to his "notional" supply of labor. By virtue of the "dual-decision" hypothesis, the signal sent to the market was a "constrained" demand, not a "notional" demand (1965: pp. 49-50). If this demand satisfied the offer of goods, there would be no excess demand in the related market. Therefore, the price would not go up and there would be no stimulation of the supply.[16]

[15] All the assumptions made by Clower to leave room for involuntary unemployment in the Walrasian framework are identified by Michel de Vroey (2004).

[16] Clower expounded an analogous scenario in the preliminary drafts of the 1967 article. The sole difference was that when the "dual-decision" process was combined with the 1967 optimization plan, individuals could use their stock of cash to diminish the impact of a fall in income on the level of consumption. Thus, the new level of consumption could exceed for some time the one that would have been deduced from the realized income. In spite of this, Clower stressed that it was optimal for individuals to undertake a lower level of expenditure: "Since

It is frustrating that Clower did not further his analysis of system's behavior out of equilibrium.[17] But, in a way, this was not his priority. During his discussion with Malinvaud at the Royaumont Conference, Clower explained that "he did not say anything definite about stability in his paper" because of the absence of formal stability study (Hahn and Brechling, 1965: p. 306). The priority was to provide a mathematical treatment of his dynamical system. But Clower experienced difficulties to overcome technical issues. In the letter sent to Bushaw before the Royaumont Conference, Clower confided that the "switching mechanism [of the coefficient matrix] was driving [him] bats". He thus asked Bushaw whether or not he could "make any cleaver comments about this issue". Apparently, Bushaw accepted to address it and was "able to analyze the [dynamic] equations for simple special cases" (Hahn and Brechling, 1965: p. 306).[18] Unfortunately, there is no evidence of such studies either in published or in unpublished documents.[19] In the 1967 article, Clower once again put dynamic matters in the background. Worst, he focused only on the monetary behavior of individuals ideally situated in general equilibrium. Thus, beyond the technical difficulties raised by Clower's dynamical system, no stability study could be proposed since it lacked a formalization of the market excess demands (and so of the adjustment rules) taking into account explicitly the monetary structure

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the money economy budget constraint depends on realized income from the sale of C_2 [say labor], the immediate effect of a decline in $\underline{y}$ [income] is to reduce desired and realized consumption expenditures, the precise amount of the decrease depending on the income elasticity of demand for consumption. In general, however, expenditure on consumption will continue to exceed realized income, hence, real balances will decline over time, and consumption will move in the same direction". R.W. Clower Papers, Box 2, Rubenstein Rare Book and Manuscript Library.

[17] For instance, a stability analysis of unemployment situations in which both workers and entrepreneurs failed to realize their optimization plans or when prices and wages were supposed to adjust would have been welcomed.

[18] In the conclusion of his discussion with Malinvaud at the Royaumont Conference, Clower argued that "a friend of his (a professional mathematician) was working on his [dynamical] problem" (Hahn and Brechling, 1965: p. 306). Although Bushaw was not explicitly mentioned, he was certainly the mathematician to whom Clower referred.

[19] Bushaw may have succeeded in providing some formal stability analyses. He and Clower were well-trained in economic dynamics. In *Stabilizing Dynamics: Constructing Economic Knowledge*, E. Roy Weintraub (1991) stressed that Bushaw and Clower (1954) pioneered the Lyapunov technique to study the stability properties of competitive equilibrium. In *Economic Dynamics* (2010), Giancarlo Gondolfo also acknowledged their advanced skills in dynamics by referring to their use of the Lyapunov technique in their dynamical study of 'stock-flow' models.

of exchange. In spite of this, Clower claimed that "a wholesale reconstruction of large areas of multiple market dynamics [was going to] be presented elsewhere in the near feature" (1967: p. 89). So what happened next?

2. Theoretical deadlock and dissatisfactions

By the late sixties, a small group of economists including Crouch (University of California Santa Barbara), Frevert (University of Kansas), Grossman (Brown University), Leijonhufvud (University of California Los Angeles), Rader (Washington University), and Tucker (Council of Economic Advisors) attracted Clower's attention. This was because all these authors developed models based on the "dual-decision" hypothesis with the ambition (at least initially) of addressing the effects of disequilibrium trading on the dynamics of the market system. While following their works, Clower realized that his dynamic model of non-clearing markets was a blind alley and that no solid alternative was about to emerge. To make this point, I analyze the models developed by these authors in the light of related comments that Clower made in private correspondences.

2.1 Frevert's formal stability studies or the deadlock of Clower's dynamical system

Frevert formally studied the stability properties of dynamic models based on the "dual-decision" process in "Disequilibrium in a Macro-Economic Model" (1968) and "On the Stability of the Full Employment Equilibrium" (1970). To "examine some of the implications of the dual-decision hypothesis for the stability of full employment equilibrium" (1970: p. 239), the "notional" system of the "Classics" served as the benchmark.[20] Frevert pointed out that according to the Routh-Hurwitz criteria, this system was stable when the trace of the coefficient matrix was negative and when its determinant was positive (1968: p. 363; 1970: p. 240). On

[20] See 1.2.1 for a formalization of a "notional" dynamic model.

that basis, the challenge was to "isolate [this] stable case [to] see how Clower's behavioral hypothesis [affected] the stability of the system" (1970: p. 239). To be more specific, Frevert modified the "classical" adjustment rules (via changes of market excess demands), deduced the new coefficient matrix, and discussed the conditions under which the "stable case" could be obtained again. The more the conditions were restrictive, the more the stability of the market system was considered to be affected by the absence of recontracting and the introduction of Clower's "dual-decision" hypothesis. Three theoretical scenarios were considered in a macroeconomic model with three markets – good, labor, and money.[21] First, Frevert (1968; 1970) introduced a "constrained" demand for goods instead of the "notional" demand for goods in the price adjustment function. This would correspond to the scenario exposited by Clower in the 1965 article (1968: p. 364; 1970: p. 245):[22]

$$\begin{cases} \dot{p} = f'_G(\widehat{d_G} - \overline{s_G}) \\ \dot{w} = f_L(\overline{d_L} - \overline{s_L}) \end{cases}$$

Second, Frevert (1970) assumed that "the demand for labor [was] constrained by the amount of goods that producers [could] currently sell" and so modified the wage adjustment function. This would "correspond to Patinkin's case of less than full employment" (1970: p. 247):[23]

$$\begin{cases} \dot{p} = f_G(\overline{d_G} - \overline{s_G}) \\ \dot{w} = f'_L(\widehat{d_L} - \overline{s_L}) \end{cases}$$

[21] By virtue of Walras' law, one market could be omitted. Frevert focused on the market for labor and the market for goods (1968: p. 360; 1970: p. 239). Frevert justified the use of Walras' law to simplify the formal stability study: "Clower bases his attack on the traditional micro-foundations of aggregate behavior, and his interpretation of Keynes' departure on the violation of Walras' law. For all its romantic appeal, this violation makes the logical structure of the model very unwieldy. It seems better to allow for a modified version of *The Law* to close the system and to incorporate any changes in behavioral postulates into the excess demand functions directly." (Frevert, 1970: p. 239)

[22] In fact, there was a difference with Clower's (1965) scenario: wages could vary.

[23] This dynamical system does not represent exactly the scenario of Patinkin (1956). In chapter XIII, Patinkin considered that both the demand for goods and the demand for labor were constrained ([1956] 1965: p. 322).

Third, Frevert (1970) studied the stability properties when Clower and Patinkin's "constrained" demands were substituted to the "notional" demands for goods and labor:

$$\begin{cases} \dot{p} = f'_G(\widehat{d_G} - \overline{s_G}) \\ \dot{w} = f'_L(\widehat{d_L} - \overline{s_L}) \end{cases}$$

In this dynamical system, the price adjustment function depended on the transactions realized in the labor market and the wage adjustment function took into account the quantities effectively exchanged in the market for goods (1970: p. 249).

Clower was one of the referees of Frevert's second article. In his report sent to John Green on April 2 1969, he claimed that "the paper [was] an important and original contribution to knowledge just as it [stood]" and, in turn, "strongly [recommended] publication". He added that the "paper [was] definitely the best thing [he had] seen in this area since [his] first introduction of the dual decision hypothesis in 1965, and [he doubted] if anyone did much better or [got] results that [could alter] significantly those obtained by Frevert."[24] But according to Clower, one of the strengths of Frevert's results was to demonstrate that his dynamical system was a blind alley. This viewpoint appears in another report – in which Clower had to decide on the publication of Tucker's article "Macroeconomic Model and the Demand for Money under Market Disequilibrium":[25]

[24] R.W. Clower Papers, Box 8, Rubenstein Rare Book and Manuscript Library.

[25] In the report, Clower signaled that Rader was also trying to provide a formal stability study of a model based on the dual-decision hypothesis: "Rader may come to it one day (he got tangled up with my IEA [1965] paper, and came a cropper – Frevert got into it and produced a beautiful paper that demonstrated that the model got one nowhere)". Rader's analysis eventually appeared in chapter seven of *Theory of General Economic Equilibrium* (1972). In the report, Clower maintained that "Rader had similar problems [as Frevert's]". As a result, there is no need to present his formal stability analysis.

> Does Tucker know anything about Frevert (KU)? Frevert has done about as much as can be done with the dual decision hypothesis and appears to have got nowhere. It is a bad model to work with.[26]

Two arguments might explain why Clower considered that Frevert's results highlighted the deadlocks of his dynamical system. First, a conclusion of his formal stability analysis questioned the intuitions put forward at the end of the 1965 article. In "Clower's case" (1970: p. 245), the market system remained self-regulating:

> The entry here [scenario I] of dual decision hypothesis does not appear, by itself, to affect the stability of full employment equilibrium as compared to the classical model (1970: p. 247).

To demonstrate the stability of market adjustment processes, Frevert studied the formal properties of the new coefficient matrix. This raised difficulties since the signs of the coefficients $\frac{\partial f_G{}'}{\partial p}$ and $\frac{\partial f_G{}'}{\partial w}$ were ambiguous (1968: p. 362; 1970: p. 246):

$$\frac{\partial f_G{}'}{\partial p} = \underbrace{\frac{\partial s_G}{\partial p}}_{+} + \underbrace{\frac{\partial \widehat{d_G}}{\partial p}}_{-} + \underbrace{\frac{\partial \widehat{d_G}}{\partial (ws_L)}}_{+} * w * \underbrace{\frac{\partial d_L}{\partial p}}_{+}$$

$$\frac{\partial f_G{}'}{\partial w} = \underbrace{\frac{\partial s_G}{\partial w}}_{+} + \underbrace{\frac{\partial \widehat{d_G}}{\partial (ws_L)}}_{+} * w \left(\underbrace{\frac{\partial d_L}{\partial (w)}}_{-} * \underbrace{d_L}_{+} \right)$$

This ambiguity in the signs of the partial derivative was mainly due to the presence of $\frac{\partial \widehat{d_G}}{\partial (ws_L)}$, i.e., the sensitivity of the "constrained" demand for goods with respect to the income earned by workers in the labor market (1968: p. 364; 1970: p. 245). This is striking when emphasis is

[26] Letter from Clower to an anonymous recipient (11/05/1968): R.W. Clower Papers, Box 1, Rubenstein Rare Book and Manuscript Library.

given to the second coefficient. If the size of $\frac{\partial \widehat{d_G}}{\partial (ws_L)}$ relative to other price elasticities is important, then the coefficient $\frac{\partial f_{G'}}{\partial w}$ will be negative and so the Routh-Hurwitz criteria for stability would not be met. In spite of this complication, Frevert argued that the stability of the market system was not affected because the "stable" coefficient matrix could be formulated without the need to impose further restrictions. He managed to sign the coefficients $\frac{\partial f_{G'}}{\partial p}$ and $\frac{\partial f_{G'}}{\partial w}$ so as to meet the Routh-Hurwitz criteria by referring back to the characteristics of entrepreneurs' optimization plan (1970: p. 246-247).

The importance that Clower may have attached to this result should not be overstated. On the one hand, Frevert's formal stability analyses of the two other scenarios confirmed Clower's intuition that the dual-decision process was a source of instability. Frevert needed to impose quantitative restrictions on the size of the partials and/or on the speed of adjustments to sign the coefficient matrices. This implied that the stability of the market system was affected by the introduction of Clower's behavioral hypothesis (1970: pp. 249-250). On the other hand, Frevert concluded his article by claiming that "more elaborate models [had to] be investigated in order to find out just what sort of states of the economy (other than full employment) [could] be 'predicted' under the dual decision hypothesis" (1970: p. 250). This conclusion had a Clowerian flavor. It suggested that Clower's dynamical system could be used to portray market systems that would ensure the operation of economic activities without ever reaching the full employment equilibrium. In view of this, it is clear that our first argument is not sufficient to understand why Clower realized that his dynamical system was a blind alley. A complementary argument lies in the tension between Clower's quest for a "general" theory of adjustment processes and the nature of Frevert's conclusions. In the drafts of *Pricing and Disequilibrium*, Clower sought to formulate "a general disequilibrium analysis which [would preserve] the

intellectual quality of established theory".[27] In the area of stability analysis, its quality was to account for the dynamic of the market system by limiting the number of quantitative assumptions to sign the coefficient matrix. Yet, Frevert (1968, 1970) demonstrated that it was necessary to add quantitative assumptions to study the stability properties of Clower's dynamical system. Otherwise, it would not be possible to sign the coefficients matrices.[28] Accordingly, the conclusions about the stability properties of the market system were necessarily less general than the one formulated in "established theory". This might explain Clower's claim that his dynamical system "got one nowhere" and was a "bad model to work with".

2.2 No satisfactory alternative

Whilst acknowledging that his dynamical system was a blind-alley, Clower maintained that his original idea [to base a dynamic model of non-clearing markets on the dual-decision process] was good, and that "he was eagerly awaiting *good* works by someone interested in [such] problems".[29] The list of candidates included Crouch, Grossman, Leijonhufvud and Tucker. It turned out that none of them managed to provide the "good" work that Clower expected. The reason was that none of their works met simultaneously three criteria: i) to provide a formal treatment of disequilibrium issues; ii) to address the dynamics of non-clearing markets; and iii) to impose a monetary structure of exchange. A clear exposition of the first criterion is found in the course of private discussions with Leijonhufvud. It can be used to explain why neither Leijonhufvud nor Crouch's works were considered as satisfactory. A clear exposition of the second criterion is found in the report of Tucker's article. It can be used to explain why Clower

[27] R.W. Clower Papers, Box 5, Rubenstein Rare Book and Manuscript Library.
[28] "This case [II] illustrated some of the kinds of *quantitative* information which would be needed to test for stability" (1970: p. 250).
[29] This quotation is taken from Clower's report of Tucker's article. R.W. Clower Papers, Box 1, Rubenstein Rare Book and Manuscript Library.

was not satisfied by Tucker and Grossman's disequilibrium models. Both economists eventually provided static approaches to disequilibrium economics. The last criterion was expressed in Tucker's report and in other private correspondences. It provides another basis for explaining why Clower was not convinced by the works of Tucker, Grossman, and Crouch.

2.2.1 A formal treatment of disequilibrium issues

The ambition to address the dynamics of non-clearing markets was central in the doctoral dissertation on which Leijonhufvud based *On Keynesian Economics and the Economics of Keynes* (1968). It was expressed in a letter sent to Clower in 1965:[30]

> As you note, I – like Keynes and others – start off assuming a situation in which all markets do, for the moment, clear at some given vector of money prices. I am then much preoccupied with trying to explain 'what happens' in the *very short interval of time* when the system stumbles into an income constrained process and begins to generate for itself information on prices, and quantities supplied and demanded, which make it increasingly difficult – and altogether unlikely – to get back on the beam again quickly. This problem I regard as very much part and parcel of what I am trying to do in my dissertation.[31]

Leijonhufvud intended to relate the "income constraint processes" discussed by Clower (1965) with informational problems occurring when the market system was out of equilibrium. In 1968, Leijonhufvud assumed away the auctioneer. Individuals had to find the equilibrium prices themselves. Since this process took time, disequilibrium trading would occur. Under these circumstances, Leijonhufvud considered that quantity adjusted more rapidly than prices. This

[30] Leijonhufvud wrote his doctoral dissertation under Clower and Burstein's supervision. For more information on the background of his PhD thesis, see Backhouse and Boianovsky (2013).

[31] Letter from Leijonhufvud to Clower, (10/18/1965): R.W. Clower Papers, Box 2, Rubenstein Rare Book and Manuscript Library.

idea served to explain why quantity constraints would arise in individuals' plans and constituted the basis of Leijonhufvud's dynamic study.

In *Macroeconomics*, Crouch (1972) followed in Leijonhufvud's footsteps to discuss the dynamic of non-clearing markets.[32] In the absence of auctioneer, individuals were supposed to search the equilibrium prices. This "searching [was considered as] a time consuming process during which transactions [occurred]" (1972: p. 385). Under these circumstances, Crouch argued that it was optimal for individuals to adjust prices after having adjusted quantities. Hence the Keynesian adjustment processes described by Leijonhufvud (1968):

> According to this [microeconomic] analysis efficient markets in which transactors are optimizing will not be characterized by prices that instantly fluctuate so as always to clear the market. We have then what we alluded to at the beginning of chapter 11 as a typically Keynesian phenomenon, namely, quantity adjustments emerging in a market which is out of equilibrium before price begins to adjust to the changed circumstances (1972: p. 387).

In Crouch's analysis, Leijonhufvud's adjustment rules referred back to entrepreneurs and workers' search for information when they failed to realize their optimization plans. Let us focus on entrepreneurs' behaviors whilst considering that a similar reasoning applied to workers (1972: p. 387). Crouch claimed that if there was a fall in aggregate demand, entrepreneurs would experience difficulties to know whether the depression was temporary or permanent (1972: p. 386). But they needed to get information of this kind to decide on their next move. In this context, it would not be optimal to reduce the prices at which they sold their production. This was because entrepreneurs would automatically make losses. At the same time,

[32] "A final chapter on Macroeconomic disequilibrium incorporates into a textbook (for the first time, I believe) Clower and Leijonhufvud's more recent reinterpretation of Keynes as a disequilibrium theorist. I would like to thank Professors William J. Baumol and Robert W. Clower, who read a preliminary version of the manuscript, in its entirety" (Crouch, 1972: p. ix).

entrepreneurs did not want to increase their stocks of goods. As a result, Crouch argued that their best option was to reduce their production by taking into account the quantities effectively sold in the market for goods. The reduction of prices would come thereafter if it turned out that the reduction of the aggregate demand was permanent (1972: p. 386). This would explain why prices did not adjust as fast as quantities.

Although Clower showed interest in Leijonhufvud and Crouch's ways to address the dynamic of non-clearing markets, he was not satisfied by their works.[33] This was because no formal model was used to support their analyses. Such a criterion to judge the relevance of disequilibrium models was formulated by Clower while commenting Leijonhufvud's chapters of his dissertation. When Leijonhufvud replied to Clower in the letter previously quoted, he referred to this criterion:

> I will say one thing for the dreary length of the thesis: it must seem a monument of random verbosity on your formal criteria, *but* much of the space *is* devoted to discussing the 'next' […] 'plausible argument' about the 'nature of the world'.[34]

Clower justified the need to provide formal analyzes with a methodological argument. Because of the absence of formal model, Leijonhufvud would take the liberty to draw conclusions about the economic effects of disequilibrium trading by resorting to logical arguments and to observations of the real world. According to him, Leijonhufvud was thus "unconcerned with the oil-and-water-mixing problems that [arose] from trying to work induction and deduction

[33] In a letter sent to Leijonhufvud on October 4, 1964, Clower found particularly interesting the idea to consider that quantities adjusted more rapidly than prices: "I am returning the copy of Chapter III with marginal comments. I found the discussion very rewarding. I must say that I had never thought particularly about the possibility of connecting Keynesian type of adjustment with the sort of short-run quantity adjustments discussed by Marshall – but your discussion on the matter convinces me that there is something in what you say". Axel Leijonhufvud Papers, Box 2, Rubenstein Rare Book and Manuscript Library.

[34] Letter from Leijonhufvud to Clower, (10/18/1965): R.W. Clower Papers, Box 2, Rubenstein Rare Book and Manuscript Library.

both ends against the middle".[35] This was not rigorous. When trying to capture the effects of the dropping of the tâtonnement hypothesis, emphasis had to be given on the deduction of the logical properties of models. Clower considered that the best way to secure this procedure was to provide a formal analysis. Leijonhufvud (1968) and Crouch (1972) failed to do so.

2.2.2 A dynamic approach to disequilibrium economics

In contrast to Leijonhufvud and Crouch, Grossman and Tucker provided formal treatments of disequilibrium issues. On top of this, they addressed the dynamic of non-clearing markets in their early works.[36] The problem with these two authors was their shift towards a static approach to disequilibrium economics. According to Clower, a relevant disequilibrium model had to address the dynamic of non-clearing market. This criterion was set in the report of Tucker's paper:

> It is only the dynamic adjustment process that is interesting in [disequilibrium] models […] Tucker should go read Hahn and Negishi again. They *deal* with the transactions rules in a sensible and complete way – and so does Uzawa. And until this matter is discussed one has done nothing but pose a problem.[37]

[35] Letter from Leijonhufvud to Clower, (10/18/1965): R.W. Clower Papers, Box 2, Rubenstein Rare Book and Manuscript Library.

[36] In "Credit Rationing, Interest Lags, and Monetary Policy Speed" (1968), Tucker sought to account for the effectiveness of monetary policy when there was a "situation of excess demand or supply for long periods of time in the bank loan market" (1968: p. 54). To support this analysis, Tucker based his model on the "principle that the existence of excess demand or supply in one market influence[d] the magnitude of effective demands expressed in other markets" (1968: p. 61). The "principle" was related to Clower's "dual-decision" hypothesis and served to derive an effective demand for investment (1968: p. 62) and an effective demand for loans (1968: p. 63). According to Tucker, such transformations were "essential" to provide "an adequate treatment of disequilibrium dynamics" (1968: p. 60), and, in turn, to explore the effects of "financing constraints" in the transmission of monetary policy. At the end of his paper, Tucker discussed these effects though a formal study of a dynamic model describing the evolution of income, of the rate of interest, and of money supply. Grossman's propositions to elaborate a dynamic disequilibrium theory are better known. See "Theories of Markets without Recontracting" (1969) and "Money, Interest, and Prices in Market Disequilibrium" (1971).

[37] R.W. Clower Papers, Box 1, Rubenstein Rare Book and Manuscript Library.

By distinguishing Tucker's works from Hahn, Negishi, and Uzawa's, Clower drew a line between two approaches to disequilibrium economics. The first one was concerned with the static properties of disequilibrium systems. It was adopted by Tucker in "Macroeconomic Model and the Demand for Money under Market Disequilibrium". In the published version of this article, Tucker (1971) focused on the determination of the effective excess demands and postponed the analysis of disequilibrium dynamics.[38] By contrast, there would be the approach to disequilibrium economics adopted by Uzawa (1960) or Hahn and Negishi (1962). According to Clower, this approach would get the essence of the problem related to disequilibrium trading because the dynamic of non-clearing markets was addressed. In view of this distinction, it is clear that the seminal fix-price model developed by Robert Barro and Grossman (1971) constituted for Clower nothing but a superficial proposal to address disequilibrium issues.

2.2.3 A monetary structure of exchange

The last criterion on the basis of which Clower judged the relevance of disequilibrium models concerned the structure of transactions. Money had to be the only medium of exchange. This criterion was suggested in the report of Tucker's article:

> No mention is made of what is exchanged for what. It is clear from the budget equation that money holds no special position in [Tucker's] model: it is no more a medium of exchange than any other commodity (all are admissible as means of payment for commodities).[39]

Following an idea already exposited in his 1967 article, Clower stressed that money was not the only source of effective demand in Tucker's model. This was because money entered into

[38] "An interesting extension of this analysis in a different direction would be to apply this model to a stability question raised by Patinkin. Does the introduction of what he calls 'dynamic intermarket pressures', the property that the excess demand in one market influences the demand expressed in other markets, render unstable an economic system that would be stable in their absence" (1971:p. 82).

[39] R.W. Clower Papers, Box 1, Rubenstein Rare Book and Manuscript Library.

the model just like any other commodities. Yet, according to Clower, nothing would ensure its use in transactions if its intermediary role in the exchange process was not formally specified.

With the exception of Leijonhufvud (1968), none of the authors that we have mentioned imposed monetary restrictions in line with the 1967 budget constraint. That was another reason why Clower was not satisfied by their disequilibrium models. Clower made this point in a letter sent to Bernt P. Stigun in 1970:

> Grossman and others (Tucker at C.E.A, Crouch at Santa Barbara, and Frevert at Kansas) have tried to make something of this beginning – the dual-decision hypothesis – but I am not impressed by that work. […] What these writers (and I also) would like to do is to capture some of the effects of trading at 'false price' that we seem to discern occurring in the real world, but they have failed to work monetary restrictions into the analysis in a way that would permit them to argue that their analyzes actually have some bearing on observed market processes.[40]

To conclude, none of the models previously analyzed met simultaneously three criteria: to be formal, dynamic, and based on an explicit monetary structure of exchange. In view of this, Clower considered that no satisfactory alternative to the disequilibrium theory sketched in his 1965 and 1967 articles was about to emerge. At the same time, he realized in the light of Frevert's stability analyzes that his conception of market adjustment processes was a blind-alley. Hence the question: what did Clower propose to complete his "general disequilibrium theory"? Let us remind where he stood in 1967. Clower intended to combine the "dual-decision" process with the 1967 optimization plan to address disequilibrium dynamics. But he did not manage to move away from an equilibrium analysis. Clower (1967) only formalized the

[40] Letter from Clower to Stigun (06/29/1970). R.W. Clower Papers, Box 1, Rubenstein Rare Book and Manuscript Library.

monetary choices of individuals ideally situated in a market-clearing context. Besides, he did not model the market structure in which individuals were supposed to evolve.

3. New model, same situation

Between 1968 and 1971, Clower outlined a new disequilibrium model. He had the conviction that it was a promising way to complete his "general" theory of adjustment processes. Unfortunately, the situation of his project remained nearly the same as in the 1967 article. On the one hand, Clower failed to move away from a stationary equilibrium analysis. On the other hand, a complete formalization of his disequilibrium model was missing.

3.1 A new disequilibrium model

In a series of articles published in 1968, 1970, and 1971, Clower addressed the issue of why individuals sought to hold and use money in their transactions.[41] In each article, Clower was concerned with the justification of these choices in equilibrium. Nonetheless, he repeatedly signaled that his goal was to provide the microeconomic foundations of a monetary theory valid both in equilibrium and in disequilibrium situations (1970: p. 427; 1971: p. 112, p. 116). Such an articulation between the search for a satisfactory monetary framework and the elaboration of disequilibrium systems became clear in an unpublished manuscript, "The Keynesian Paradigm: An Attempt at Reconstruction" (1971a). There, Clower outlined a disequilibrium model alternative to the one sketched in the 1965 and 1967 articles. Three differences deserve to be noted. The first one concerned the choice of agents. Whilst maintaining the combination of the "dual-decision" process with the 1967 budget constraint, Clower introduced transactions costs in individuals' plans:

[41] See also Clower's introduction of *Monetary Theory: Selecting Readings* (1969).

> We introduce transaction costs (in terms of time and effort) that depend on such things as search and bargaining time rather than quantities traded. […] It is then a simple matter to show that individual will find it advantageous to trade at discrete points in time in lots of finite size rather than to trade continuously in arbitrarily small lots; hence that individuals will hold positive average of all commodities trade, and, in particular, positive average inventories of C_0 [money]. Moreover, the budget equation of conventional theory is replaced by two separate constraints one of expenditure (offers to buy goods are simultaneously offers to sell money), another on income (offer to sell goods are simultaneously offer to buy money). A set of additional side conditions relating changes in actual stocks of various commodities to realized purchases and sales to round out the picture (p.9).[42]

By assumption, individuals took time to find a trading partner and to decide on the quantities to exchange. This time could be allocated to leisure or directly used to produce. As a result, the trading activity was costly for individuals. Under these circumstances, individuals would find convenient to hold stocks of commodities and money. Despite storage costs, individuals would seek to hold commodities to avoid engaging in trade too often. Then, despite the absence of interest payments, individuals would seek to hold money to avoid the problem of the double coincidence of wants. From there, Clower inferred that individuals preferred trading lots of goods at discrete point in time instead of exchanging small quantities continuously. Now the question is how Clower articulated these choices with the behavioral hypotheses exposited in the 1965 and 1967 articles. On the one hand, Clower imposed the 1967 budget constraint to preclude barter exchanges. Although individuals sought to hold money in his model, Clower "[did] not (and [could] not) show that the [trading] costs [were] lower for *all* trades" (p. 7).

[42] R.W. Clower Papers, Box 2, Rubenstein Rare Book and Manuscript Library.

Therefore, the 1967 constraint would have been necessary to prevent individuals from exchanging goods against goods. On the other hand, Clower sought to account for the modifications of individuals' behaviors when there was disequilibrium trading. He pointed out that alongside the choices regarding the stocks to hold, individuals had to decide on the flows of consumption and production. The "dual-decision" process would serve as a basis to account for the effects of undesired variations of stocks on the quantity consumed or produced.

The second modification in the model concerned the market structure. In 1965, Clower had taken a first step towards the decentralization of exchange by dropping the tâtonnement hypothesis. Yet, he maintained the existence of a "central market authority" setting the vector of prices and acting as a clearing house for all the individuals in the economic system. In 1971, Clower went further in the decentralization process:

> Given a set of $n + 1$ commodities $C_0, C_1, C_2, \dots, C_n$, we associate with each of the commodities $C_1, C_2, \dots, C_n$ a distinct market and designate the remaining commodity, C_0 [money], as the only commodity units of which can be traded in all markets. Thus the only trades that are feasible in organized markets are represented by the $n - 1$ collection of two-element sets of the form $(C_0; C_i)$, of which one element is C_0. We then suppose that trading in each market is conducted in accordance with rules established by a market specialist, each specialist acting as a bargaining agent and clearing house for transactions involving C_0 and one other commodity (p.6).

The economic system was portrayed by "organized" and "distinct" markets. On one side, markets were considered as "organized" because "traders" were assumed to set prices, to act as a clearing house, and to allow transactions involving only money with another commodity. On the other side, markets were viewed as "distinct" since each trader set the exchange rules on his

own market without having information on the economic situation prevailing in other markets and without seeking to coordinate the economic activities of the entire system.

This trading organization leads to identify the third and final modification of Clower's disequilibrium model. In contrast with the complexity of the market adjustment mechanism underlying the 1965 article, Clower (1971a) proposed to use the "familiar" law of supply and demand:

> The next stage in the argument introduces explicit rules governing market exchange. [The] specialist is assumed to post at the end of each hour a money price at which he proposes to execute trades during the next hour. Individuals who wish to buy and sell units of any particular commodity then communicate unconditional purchase or sale orders to the specialist that are to be executed, if possible, at the price already posted. In general, quantities offered for sale at the posted price will not be equal to quantities demanded for purchase, so the specialist will not be able to execute all orders that are communicated to him during any given hour. If demand exceeds supply, he executes all sale orders; if supply exceeds demand, he executes all purchase orders. He then informs transactors of trades that have been completed, debits and credits appropriate cash accounts, and adjusts price in accordance with familiar rules. Orders that are unexecuted in one period are carried over the next period – being placed at the head of the queue in relation to orders that are placed during the coming hour. Most of this is fairly standard, except that trades take place at other than market-clearing prices – and that all trades involve a transfer of money from buyer to seller (p. 9).

Clower (1971a) considered that "market specialists" set prices at which trade would take place thereafter. Of course, nothing ensured that a posted price cleared the corresponding market. Under these circumstances, the "market specialist" was charged to control the effectiveness of purchase orders. Besides, the quantities effectively exchanged would be determined by the short side of the market. The question was: if the posted price did not clear the market, what was the adjustment rule? In the 1965 article, Clower considered that the price adjustment mechanism took into account the excess demand in the given market and the quantities effectively exchanged in all other markets. In 1971, Clower suggested that the relevant force governing the variation of prices were unexecuted orders. If sales orders were cancelled, the "market specialist" would record this information and lower the price. Conversely, if purchase orders were cancelled, the "market specialist" would increase the price. With this conception of price adjustment processes, Clower kept maintaining that there existed defective market signals. Typically, if workers "run out of cash, they [would have been] able to buy nothing at all" (p. 11). Thus, no purchase order would be transmitted to the "market specialist". As a result, prices could remain blocked following the same logic as in the 1965 article. Clower (1971a) inferred that "the system [could] depart from equilibrium over finite time intervals and so [displayed] characteristics that might sensibly be interpreted on one side as signs of chronic tendencies towards depression and on the other side as chronic tendencies towards inflation" (p. 10). By evoking the possibility to account for such dynamic properties, Clower suggested that his new disequilibrium model was a promising way to complete his original project.

3.2 Statu quo

Unfortunately, the situation of Clower's project remained nearly the same as in the 1967 article. On the one hand, Clower failed to move away from a stationary equilibrium analysis. Except in the 1971 manuscript, Clower (1968; 1969; 1970; 1971) always put disequilibrium issues in the background. On the other hand, when Clower (1971a) sketched his disequilibrium

model, his approach remained informal. In particular, there was no formal description of the market structure in which individuals were supposed to evolve. The same was true for the behaviors of the "market specialists" and so, of the market adjustment rules.

To conclude, once again Clower failed to meet the challenges posed by his project. He expressed frustration in a letter sent to Stigum, in 1970:

> The problem as I now see it is to provide an explicit monetary framework for general equilibrium analysis and to work from this to a treatment of decision behavior in other than equilibrium states. As you may know (or have guessed), I'm not able to set out what I would consider to be a minimally satisfactory description of a monetary economy except for special cases where my sole concern is with stationary state problems.[43]

This frustration found an echo in the 1971 manuscript. After almost ten years of research, Clower was forced to admit that his "present problem [was still] to elaborate the Keynesian paradigm (i.e., Keynes' vision of the economic system) in terms of appropriate formal models" (1971a: p. 12). Faced with this situation, Clower felt the need to reflect on his own difficulties, and more generally, on the inability of economists to provide a satisfactory account of the disequilibrium adjustment processes occurring in monetary economies. This reflection shaped the fate of his project.

4. Diagnosis and future prospects

Over the period 1971-1975, Clower sought to diagnose why a satisfactory formalization of money-type non-tâtonnement processes was missing. Initially, he explained that this was due

[43] Letter from Clower to Stigun (06/29/1970). R.W. Clower Papers, Box 1, Rubenstein Rare Book and Manuscript Library.

to the complexity of analytical problems and to the absence of a significant and organized research community interested by disequilibrium dynamics. But thereafter, Clower identified a much deeper cause. He realized that *whatever* the modifications made to the Walrasian framework (rejection of the tâtonnement hypothesis, introduction of income constraints, of transactions costs…), the entire apparatus would remain unable to capture the functioning of monetary systems. As a result, its rejection was imperative. Instead, Clower proposed to elaborate a "neo-Marshallian" framework. This proposition outlined prospects for his original project.

4.1 A diagnosis in two steps

Clower's first diagnosis appears in "The Keynesian Paradigm: An Attempt at Reconstruction" (1971a). In the conclusion of the manuscript, Clower raised analytical and contextual arguments to explain why economists (including himself) did not manage to offer a satisfactory formal treatment of the disequilibrium adjustment processes occurring in monetary economies:

> This task has so far proved to be almost impossibly difficult, partly because the analytical problems involved are so complex, partly because so few people have been working at the task and those few have not found it easy to decide just what kind of model specifications should be adopted (p. 12).

Let us give flesh and blood to the points made by Clower. To this end, they will be documented by discussing his position as well as Arrow and Hahn's, two economists who introduced money in a non-tâtonnement framework at the same period. Clower's first point stressed the complexities of the analytical problems. In the 1971 manuscript, he discussed the difficulties raised by his own disequilibrium model. They were essentially due to the amount of variables that had to be taken into account. As a reminder, individuals were supposed to decide on the

quantity of stocks of commodities and money to hold as well as on the quantities purchased and sold. Under these circumstances, when disequilibrium trading took place, undesired variations of stocks would have implied that the choice-theoretic model "set additional side constraints relating changes in actual stocks of various commodities to realized purchases and sales" (p. 10). This resulted in "an extremely complex model of individual behavior" (p. 10), one which made the interactions with the "market specialists" and the resulting effects on the dynamic path of the economic system hard to model (p. 12). Whilst developing different models, Arrow and Hahn (1971) also asserted that the introduction of money in a non-tâtonnement context raised important difficulties. This was due to the resulting speculative dimension. Individuals would exchange goods against money in view of obtaining different goods thereafter. If some individuals failed to realize the transactions desired, their utility would decrease in the exchange process. Yet, in Arrow and Hahn's (1971) models, the stability of the market adjustment processes was ensured only if the level of utility was never declining for any individuals and increasing for some. It followed that the introduction of money was a potential source of chaos, not of coherence (1971: p. 338). In view of this, Arrow and Hahn acknowledged that the presence of money entailed "perplexing problems" (1971: p. 338).[44] The second point made by Clower was that few economists were concerned with the formalization of the non-tâtonnement processes occurring in monetary systems. In the light of the 1971 manuscript and other archival documents, three arguments justified this viewpoint. First, Clower (1971a) argued that economists mainly focused on the equilibrium properties of the economic system. Hahn (1970)

[44] "The results of the last section [stability of a non-tâtonnement process in a barter model] depend entirely on the assumptions that ensure that at every stage of the process, the utilities of households are non-decreasing and those of some households are increasing, as long as equilibrium has not been attained. […] In the world in which we live, however, most acts of exchange are exchanges of goods for money and money for goods, and one feature of this arrangement is that it cannot sensibly be argued that every such act of exchange increases the utility of at least one of the participants and diminishes that of no participant. A real household, if constrained to the mediation of money, may be willing to exchange something of one good for money on the supposition that the money so acquired will be used in exchange for some other good. Should the second leg of this transaction fail to materialize, then it may well be that had the household anticipated this it would never have embarked on the first leg; in other words, the first transaction by itself leads to a fall in utility. Some rather perplexing problems now come up" (Arrow and Hahn, 1971: p. 338).

shared this concern. In his presidential address to the Econometric Society, Hahn regretted that "the technically best work in the last twenty years" concerned "the study of equilibria alone" (1970: p. 12). Second, in various correspondences, Clower stressed that most of the formal studies of disequilibrium adjustment processes concerned barter systems, not monetary systems. In the report of Tucker's article, he considered that "all general results using barter models [were already provided] in Negishi, Hahn, and Uzawa articles". But "the field of money-type non-tâtonnement models [had] yet to be attacked seriously".[45] Third, Clower acknowledged that an economist like Leijonhufvud (1968) did have a disequilibrium monetary theory but its formalization was missing. Hence another proof that few economists were concerned with the formalization of the working of monetary economies. The last point made by Clower emphasized the lack of organization in the small community of economists interested by this issue. In that respect, Clower (1971a) regretted the absence of a common way to address the introduction of money in non-tâtonnement frameworks. According to him, money had to be formally distinct from the other commodities in the system. By contrast, money entered in Arrow and Hahn's (1971) model like all the other goods (1971: p. 339). To conclude, the three points structuring Clower's (1971a) diagnosis served to deliver one message. Economists failed to provide a satisfactory account of the disequilibrium adjustment processes occurring in monetary economies because the analytical problems involved were complicated and that the intellectual context was not favorable to their resolution.

Such a diagnosis contrasts with the one formulated two years after in a series of lectures given by Clower at "the seminar of the research staff of the Bank of Italy and the Institute of Economics of Florence (October 22-27, 1973)".[46] In one of the lectures titled "Retrospect on the Keynesian Counter-Revolution", Clower explained that economists remained incapable of

[45] R.W. Clower Papers, Box 1, Rubenstein Rare Book and Manuscript Library.
[46] R.W. Clower Papers, Box 5, Rubenstein Rare Book and Manuscript Library.

formulating a satisfactory representation of the working of monetary economies because their framework was inappropriate. According to him, whatever the modifications made, Walrasian general equilibrium models could not be used to account for the disequilibrium adjustment processes occurring in monetary systems:

> Since [the writing of the "Counter-Revolution" article"] many interesting attempts have been made to develop within the existing framework in certain directions – new constraints and so forth – but what really needs to be done, as I suggested earlier, is to rethink the conceptual scheme because one way or another, what we have discovered as a result of the Keynesian revolution and the very deep investigation into foundations that has followed it, is that we need to get rid of the neo-walrasian interpretation of the world altogether.[47]

Clower (1973) justified his diagnosis during the first lecture, "The Present Crisis in Economic Theory". Thomas S. Kuhn's (1970) analysis of scientific revolutions supported his argumentation. At the start of his speech, Clower claimed to use the "term crisis in the sense of Kuhn to refer to a situation in which widespread and increasing awareness of serious anomalies associated with adherence to an established theoretical tradition [had] induced a state of acute intellectual insecurity among qualified practitioners of science." In view of this definition, Clower emphasized that after "having dedicated much of their professional lives to general equilibrium analysis", eminent economists such as Arrow, Hahn, and Hicks, came to criticize the "existing framework of formal theory", arguing that it was "inadequate for analyzing the actual going of a capitalist economy".[48] To make this point, Clower repeatedly referred to

[47] R.W. Clower Papers, Box 5, Rubenstein Rare Book and Manuscript Library.

[48] Hicks and Paul Davidson attended the seminar. In a letter sent to Weintraub on 31 October 1973, Davidson told him that Hicks was convinced by Clower's (1973) diagnosis: "Just last week, I attended a conference in Perugia, Italy. Clower and Hicks were there also and we discussed A-H [Arrow and Hahn's book *General Economic Analysis*] at length and *even* Hicks agreed that the Walrasian system could not provide the proper microfoundations for monetary theory. […] Moreover we ended up the conference by agreeing that a different axiomatic microtheory underlies Keynes' system – and that a Walrasian-Debreu approach was never going to get

Hahn's (1970) presidential address to the Econometric Society and to Arrow and Hahn's book, *General Equilibrium Analysis* (1971).[49] This was because in both cases, the authors questioned the very possibility of representing the market system through Walrasian general equilibrium models. The central argument was that whether the recontracting assumption was made, it was not possible to prove that the pursuit of private interest produced coherence and not chaos in general. While referring to Scarf's (1960) examples of global instability, Hahn "admitted that the study of the Walrasian tâtonnement process has not been very fruitful" (1970: p. 2). Except under very special assumptions, it was not possible to prove that individuals found common grounds to exchange. The same was true in a non-tâtonnement context once production (1970: p. 3), money (1970: p. 3), or expectations (1970: p. 5) were introduced. In each case, the stability of the exchange process became precarious. Restrictive assumptions were therefore necessary to ensure that trade took place. According to Clower, these results demonstrated that the Walrasian framework provided inappropriate foundations for economic theory. Since there was growing recognition among "qualified practitioners" of its inadequacy, Clower concluded that its complete rejection was imperative.

4.2 Prospects for Clower's original project

The positive side of Clower's (1973) diagnosis was the elaboration of a "neo-Marshallian" framework. He revealed this proposition during the second lecture, "Retrospect on the Keynesian Counter-Revolution":

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the story straight, no matter what elaborations, constraints were put in". We found this letter thanks to Weintraub. He gave us access to archival documents hold in his office at the Center for the History of Political Economy, Duke University.

[49] A beautiful evidence of the "intellectual malaise" described by Clower (1973; 1975) is found in Hahn's presidential address to the Econometric Society, "Some Adjustment Problems" (1970). In the conclusion, Hahn claimed: "I apologize for the mixture of rather negative criticism and small theorems that I have produced. But I fear that I, like the Victorian parson of old, am assailed of 'Doubts' and this seemed the appropriate moment for expressing them" (1970: p. 12).

> I think that we need to go back and ask what are the proper criteria for [elaborating] a theory of money economy. What kind of things do we want to build into it – and here, I think what happens to us is that we find ourselves turning back more and more to Marshall, but not to Marshall the partial equilibrium theorist […] but to a kind of generalization of Marshall which I think can only be constructed by going back and rethinking the entire conceptual framework of economic activity.[50]

Whilst turning back to Marshall, Clower left aside the partial equilibrium approach. The challenge was to elaborate a Marshallian general-equilibrium theory. Clower set out its main features during the 1973 lectures and in "Reflections on the Keynesian Perplex" (1975). The analytical structure was the same as in the 1971 manuscript. First, individuals would seek to hold stocks of commodities and money to minimize the costs of exchange (1975: p. 199). It followed decisions on "the levels of inventories [and on the] levels of consumption or production flows" (1973). Second, information about those plans was transmitted to "middlemen" whose role was to ensure the operation of trade in their respective markets.[51] Third and finally, no institution was concerned with the coordination of economic activities among markets. The dynamic of the economic system was determined by the adjustment rules set by each "middleman" on his own market, without having information on the economic situation prevailing in other markets (1975: p. 193). In "Reflections on the Keynesian Perplex", Clower (1975) explained that the Marshallian flavor of this framework mainly lay in the conceptualization of economic activities. On the one hand, "individuals [were supposed to]

[50] R.W. Clower Papers, Box 5, Rubenstein Rare Book and Manuscript Library.

[51] During the 1973 seminar, Clower substituted the term "middlemen" to the term "market specialists" or "traders" to stress the Marshallian flavor of his analytical framework: "if you think in Marshallian terms of the world where economic agents are currently producing and consuming goods and they are able to engage in trade at any moment at their own discretion, […] we need middlemen. [In this context] we have markets defined and elaborated formally in our theory."

fumble and grope rather than optimize" (1975: p. 194). On the other hand, "the focus of theoretical analysis [ceased to be] upon isolated actions of primary agents (households, firms…) but rather on the average or representative behavior of groups of primary agents as perceived by dealers" (1975: p. 193). Under these circumstances, "dealers" became the central analytical figure. It became crucial to discuss their behaviors, i.e., to set their objective function, to determine how they established exchange contracts (price, quantities, transaction fees), and to account for their reactions in situations of disequilibrium. This was because the coordination processes ceased to be mechanistic in a Marshallian context.

This set of propositions outlined prospects for Clower's original project. During the 1973 lectures, emphasis was given to the generality of the "neo-Marshallian" framework. Clower argued that it was built so as to "maintain as explicit special cases all of the recognizably significant contributions that have a long history in economics […] though they may not appear to be mutually consistent". Then, Clower suggested that scenarios of structural unemployment and structural inflation could be portrayed. According to him, there was "plenty of instability" once the economic model accounted for "inventory adjustments in a world where price setters [were] not in direct communication with other price setters". Consequently, despite his previous failures and the long road that still lay ahead before offering a formal treatment of a "neo-Marshallian" framework, Clower continued to believe in his ability to lay the foundations of a "general" theory of adjustment processes.

Conclusion

My chapter aimed to provide a detailed study of Clower's disequilibrium program of microfoundations. This posed three difficulties: to identify the aim contemplated in his microfoundational program; to rebuild the disequilibrium theory sketched in the "Counter-Revolution" article; and to account for the development and perspectives of a research program

while no related contribution was published for more than ten years. These difficulties were overcome thanks to a characterization of the intellectual context in which Clower was involved and to a careful examination of archival documents written over the period 1958-1973.

Clower sought to lay the foundations of a market theory able i) to account for the determination of prices and income in a monetary framework; ii) to include Walrasian economics as a special case, valid under full employment conditions; and iii) to address disequilibrium phenomena such as involuntary unemployment and inflation. Over the period 1958-1967, Clower outlined a first proposition to elaborate such a "general" theory of adjustment processes. The key idea was to construct a dynamic model composed of "general" adjustment rules. These rules were deduced from the "dual-decision" hypothesis. They were "general" because "Classical" and Keynesian types of adjustments were encompassed. When individuals managed to realize their standard optimization plans, the "notional" magnitudes remained relevant market forces. Yet, if some individuals (workers or entrepreneurs) were rationed, "constrained" functions were substituted to "notional" functions. As a result, the variation of a price in one market depended not only on the excess demand in that market but also on the quantity effectively exchanged in all other markets. According to Clower, this "general" price adjustment mechanism was a source of instability in the economic system. He inferred that it could be used to portray scenarios of persistent involuntary unemployment and persistent inflation. Then, in the "Counter-Revolution" article, Clower argued that the "dual-decision" hypothesis allowed transforming the market excess demands so as to integrate value theory and income analysis. Following the same logic, he eventually proposed to combine the 1965 and 1967 behavioral hypotheses in a unique choice-theoretic model to address the determination of prices and income in a monetary framework. Finally, Clower pointed out that equilibrium issues could be addressed by studying the stationary solutions of his dynamical system. Hence the inclusion of Walrasian economics as a special case of his model, valid in

stationary equilibrium. Clower's challenge was to formalize this "general" theory of adjustment processes and to study its stability properties. However, he never completed this task. Initially, this was because of analytical difficulties. But thereafter, Clower decided not to explore further his first theoretical avenue. His decision was explained in the light of the intellectual context. At the end of the sixties, a small group of economists developed models based on the "dual-decision" hypothesis to address the dynamic of non-clearing markets. The important figure was Frevert. In two articles, Frevert studied formally the stability properties of the dynamical system underlying the "Counter-Revolution" article. While following his works, Clower realized that his dynamic model was a blind alley. At the same time, Clower considered that no satisfactory alternative was about to emerge from the works led by Crouch, Leijonhufvud, Grossman, and Tucker. Hence the necessity to find another avenue to construct his "general" theory of adjustment processes. It was outlined over the period 1968-1971. Several modifications of the first disequilibrium model were made. First, Clower introduced transaction costs in individuals' plans. Second, he went further in the decentralization process by considering the existence of "distinct" markets in which "traders" substituted the 1965 "central market authority". Third, Clower considered that prices were adjusted following the "familiar" rule of supply and demand. A given price was supposed to increase when there were unexecuted purchase orders, and to decrease when there were unexecuted sale orders. To justify the generality of this new framework, Clower resorted to the logic previously expounded. The introduction of transaction costs in a choice-theoretic model combining the 1965 and 1967 behavioral hypotheses would consolidate the possibility to address the determination of prices and income in a monetary framework. Then, Walrasian economics was presented as a special case of his disequilibrium model, valid in stationary equilibrium and when economic activities were costlessly coordinated by an auctioneer. Finally, Clower considered that his theory could feature unstable market adjustment processes. He inferred that scenarios of persistent involuntary

unemployment or persistent inflation could be obtained. Once again, the formalization of this "general" theory of adjustment processes and the study of its stability properties was the priority. Unfortunately, Clower failed to move away from a stationary equilibrium analysis and his approach remained mainly informal. This new failure led Clower to reflect on his own difficulties, and more generally, on the inability of economists to provide a satisfactory formalization of the disequilibrium adjustment processes occurring in monetary economies. Clower came to the conclusion that whatever the modifications made to the Walrasian framework, it would remain inappropriate for analyzing the working of monetary systems. Therefore, an alternative conceptualization of economic activities had to be set out. Clower proposed to construct a "neo-Marshallian" framework. This proposition outlined his third and final avenue to lay the foundations of a "general" theory of adjustment processes.

The construction of a "neo-Marshallian" framework was rooted in Clower's belief that a deep transformation of economic theory was about to happen in the 1970s. Clower diagnosed an "intellectual malaise" among "eminent practitioners" specialized in general equilibrium analysis. In particular, economists like Arrow and Hahn (1971) expressed serious "doubts" about the possibility to use the Walrasian framework to capture the coordination processes occurring in capitalist economies. Such "doubts" announced a change in "paradigm", and Clower wanted to play a key role in its emergence.[52] To this end, he engaged into collaborations. The publication of "The Coordination of Economic Activities: A Keynesian Perspective" (1975) formalized his partnership with Leijonhufvud. Together, they attempted to develop the "neo-marshallian" program of microfoundations (1975: pp.213-217).[53] Peter Howitt as well as

[52] The term "paradigm" was repeatedly used during the series of lectures given by Clower in 1973. This is not surprising given his references to Kuhn's analysis of scientific revolutions.

[53] Clower and Leijonhufvud already planned to write a textbook (*The Coordination of Economic Activities*) in 1972. At that time, there was no reference to the elaboration of a "neo-Marshallian" framework. See the description of the table of contents in Axel Leijonhufvud Papers, Box 3.

a group of mathematicians including Bushaw joined this effort.[54] Clower insisted on the need to address the "neo-Marshallian process analysis" in "precise and mathematically rigorous terms in keeping with the fruitful tradition established by Hicks, Arrow, Debreu and other leading contributors to the neo-Walrasian literature" (1975: p. 202). Unfortunately, the problems encountered during the sixties resurfaced. On the one hand, Clower and Leijonhufvud did not manage to provide a full-fledged formalization of the decentralized economy portrayed in 1975 (De Vroey, 2004; 2016). On the other end, Clower and Howitt (1978) stuck to a stationary equilibrium analysis of individuals' trading activity. Disequilibrium issues were put in the background, arguing that the results obtained in dynamic were too ambiguous to be of any theoretical value.[55] In short, it proved highly difficult to give flesh and blood to the "neo-Marshallian" program of microfoundations in the 1970s. At the same time, the deep transformation of the theoretical landscape that Clower expected did happen. Lucas (1972, 1976) imposed his rational-expectation-equilibrium approach to the microfoundations of macroeconomics. On that basis, the coordination of economic activities ceased to be addressed through disequilibrium dynamics. It became a matter of selection of equilibria under assumptions of informational imperfections (Howitt, 2001). The consequence was to sweep under the rug an analytical issue that was central in the 1950s and 1960s, i.e., the working of the coordination process. Addressing this issue is yet central to understand the large market failures that sometimes occur in capitalist economies.

[54] See Clower and Howitt (1978: p. 167).

[55] "A nonstationary version of the problem analyzed here was studied by D.W. Bushaw and five other mathematicians during a summer institute in applied mathematics at Washington State University in 1972. The difficulty of the problem is reflected in the paucity of unambiguous results obtained by this group (which included some leading specialists in dynamical polysystems)" (Clower and Howitt, 1978: p. 167).

General Conclusion

My dissertation intended to study Clower's contributions to the microfoundations of macroeconomics and monetary theory, over the period 1949-1975. The challenge was to bring his scattered and elusive theoretical propositions together into a well-defined, coherent, and comprehensive picture. In this purpose, I explored carefully the published and unpublished documents written by Clower in the context under analysis, I characterized the intellectual milieu in which he was involved, and I established the influences from which he benefited. The information collected allowed to clarify the logic underlying the evolution of Clower's thought and to reconstruct his theoretical projects.

My account of Clower's intellectual journey started in 1949, at Oxford. While preparing a PhD thesis under Hicks' supervision, Clower adopted the microfoundational approach expounded in *Value and Capital* (1939). Then, he acquired the conviction that the general-equilibrium theory developed by Hicks (1939) was not appropriate to analyze the logical properties of macroeconomic phenomena. Lastly, he considered a research strategy that consisted of formulating general frameworks, able to include existing theories as special cases. This resulted in an original approach to economics. Its three components (methodology, conviction, and research strategy) characterized Clower's thought until 1975. Put simply, there is a before' and an after' "Counter-Revolution" article. The reason is that this article, first presented at the Royaumont Conference in 1962, marked a triple inflexion. First, it revealed Clower's *volte-face* regarding the Keynesian Revolution. Until 1957, Clower considered that Keynesian macroeconomics could be rooted in an equilibrium framework, compatible with Walrasian microfoundations. But he moved away from an equilibrium explanation of unemployment in 1958. Thereafter, he came to the conclusion that Walrasian microfoundations had to be partly rejected to leave room for Keynes' insights in a general-equilibrium framework.

These two ideas appeared together for the first time in the "Counter-Revolution" article. They may reflect the influences exerted on Clower by Patinkin's (1956, 1958) disequilibrium interpretation of the *General Theory* and by Hahn and Negishi's (1962) non-tâtonnement economics. Second, the writing of the "Counter-Revolution" article contributed to settle Clower's thought. Before 1962, Clower scattered his efforts. Typically, he developed his 'stock-flow' general-equilibrium program of microfoundations and, in parallel, intended to formulate a "general" price theory purporting to unify all forms of competition. After 1962, most of his attention was devoted to one issue: the construction of a "general" framework capable of analyzing the disequilibrium adjustment processes occurring in capitalist economies. In particular, he posed the problems of how to integrate money in his disequilibrium theory and how to model the coordination process of economic activities. Third, the "Counter-Revolution" article constituted an act of emancipation within the microfoundational program of Hicks (1939). While insisting on the rejection of the tâtonnement hypothesis and on the formulation of a choice-theoretic basis adapted to disequilibrium systems, Clower reoriented the reflections not only on the microfoundations of Keynesian macroeconomics but also on the integration of monetary and value theory. This emancipation was notably marked by the formulation of the dichotomized budget constraint and by the project to construct a general-equilibrium model in which "traders" substituted the Walrasian auctioneer, in autonomous markets. Clower completed his emancipation while proposing to reject the Walrasian theory developed by Hicks (1939) or Patinkin (1956), and to replace it by a "neo-Marshallian" framework. This proposition, first formulated in 1973 and taken up with Leijonhufvud in 1975, constituted the point of arrival of my account of Clower's intellectual journey.

By tracking the evolution of Clower's thought, three theoretical projects were brought to light. The first one was to provide microfoundations to a Keynesian theory of the trade cycle. This theory, inspired by Keynes (1936), was supposed to include Harrod's (1939) and Hicks'

(1950) as special cases. Such a capacity to unify the treatment of the trade cycle was due to its 'stock-flow' architecture. Clower (1952) considered that the relation between the stocks and the flows of capital assets was the essence of capital accumulation processes in Keynesian models. From there, the aim was to incorporate this relation into individuals' plans, to deduce the market structure, and to study its logical properties so as to know whether it could be used to ground Keynesian business cycle models. These three steps outlined the 'stock-flow' general-equilibrium program of microfoundations. Already in his dissertation, Clower devised a choice model (the "producer-consumer" theory of the firm) in which entrepreneurs were supposed to decide on the quantity of input and output to hold alongside with the flow of output. This constituted the choice-theoretic basis of the 'stock-flow' market models. During the 1950s, Clower studied their static and dynamic properties with the help of his mathematician colleague Bushaw. Together, they sought to prove that Keynesian macroeconomics could be deduced from the 'stock-flow' market theory. Lloyd (1960) and Baumol (1962) also attempted to do so. In light of their studies, it was concluded that under Bushaw and Clower's assumptions (1957), the 'stock-flow' general-equilibrium models could hardly be a relevant interface with Keynesian macroeconomics. Despite this result, Clower remained convinced of their theoretical value. Two reasons explained why. On the one hand, they could be used under alternative assumptions, e.g., with trade out of equilibrium (Clower, 1968). On the other hand, they would offer a structure appropriate for clarifying the properties of cyclical fluctuations and economic growth, at the market level of analysis (Clower and al., 1992).

The second theoretical project was to integrate monetary and value theory. To address this issue, Clower adopted the approach expounded in *Money, Interest, and Prices* (1956). The introduction of money in utility functions and the real-balance effects were viewed as essential pillars to formulate a microeconomic framework coherent with observed monetary economies. At the same time, Clower dissociated himself from Patinkin's integration. This was due to his

ambition to elaborate a disequilibrium monetary theory. First, Clower rejected Patinkin's random payment process. His rationale for the theory of money was that the activity of exchange was costly. Second, Clower rejected the tâtonnement hypothesis and introduced a dichotomized budget constraint in individuals' optimization plans. The separation between "income" and "expenditure" branches was supposed to ensure the use of money in transactions and to account for the constraints imposed by the monetary income in situation of disequilibrium. In view of this, the real-balance effect became the mechanism through which individuals' inability to earn a monetary income implied downwards revisions of consumption plans. Third, Clower formulated a technology of exchange adapted to a non-tâtonnement context. He substituted "traders" to the Walrasian auctioneer, and assumed that they set monetary prices, controlled the effectiveness of purchase orders, and carried out the transactions in autonomous markets. Clower's objective was to provide a full-fledged formalization of the resulting 'stock-flow' disequilibrium model and to study its stability properties. This was challenging. On the one hand, Clower had to model how individuals revised their choices about the stocks to hold and the quantity to produce or consume in situation of disequilibrium, and how they interacted with "market specialists" on each market. On the other hand, Clower needed to face the technical difficulties posed by the formal study of disequilibrium dynamics. In the end, he did not meet the challenges posed by his project. Consequently, he never completed his project to provide disequilibrium microfoundations to monetary theory. However, his reconsideration of the integration of monetary and value theory found an echo. Clower's insights were particularly inspiring for Leijonhufvud (1968), Ostroy (1970), and the money-type non-tâtonnement economics *à la* Arrow and Hahn (1971).

The third and final project was to provide microfoundations to a "general" theory of adjustment processes. To be "general", the theory had to address the determination of prices and income, in a monetary framework; to include standard general-equilibrium theory as a

special case; and to account for the market adjustment mechanisms occurring in situations of involuntary unemployment and inflation. Over the period 1958-1975, Clower outlined three frameworks purporting to meet these conditions. Their differences concerned the choice-theoretic basis, the organization of exchange, and the price adjustment mechanism. The first model was formulated between 1958 and 1967. Its choice-theoretic basis combined the 1965 and 1967 behavioral hypothesis; the exchange process was organized by a "central market authority" charged to set prices, to control the effectiveness of purchase orders, and to act as a clearing house; and the variation of a price in one market was supposed to depend on the excess demand in that market and on the quantity effectively exchanged in all other markets. The second model was outlined between 1968 and 1971. Clower added transaction costs in individuals' plans; replaced the "central market authority" by "traders" in autonomous markets; and proposed a new price adjustment mechanism in which unexecuted orders were the driving force. The third and last model was sketched between 1973 and 1975. The preceding structure was maintained. But the rationality of individuals was now bounded, and the "traders" were supposed to ensure the coordination of economic activities whilst following private interests. The first move was the occasion to stress Clower's influences. Economists like Crouch (1972), Frevert (1968; 1970), Grossman (1969; 1971), Leijonhufvud (1968), Rader (1972), and Tucker (1968) attempted to construct the kind of dynamic disequilibrium theory outlined in the "Counter-Revolution" article. Yet none of their works met simultaneously three criteria dear to Clower: to be formal, dynamic, and based on an explicit monetary structure of exchange. Neither did Clower succeed in constructing such a model. Faced with this situation, Clower felt the need to diagnose why a satisfactory formalization of money-type non-tâtonnement processes was missing. This triggered his last move. His conclusion, also shared by Arrow and Hahn (1971), was that the existing foundations of economics were inappropriate for analyzing the disequilibrium adjustment processes occurring in capitalist economies. On that basis,

Clower decided to reject entirely the Walrasian framework and to replace it by a "neo-Marshallian" general-equilibrium theory.

At the same time, Lucas (1972; 1976) was about to transform macroeconomics in-depth by imposing his rational-expectation-equilibrium program of microfoundations. My study enriches the analysis of this episode. First, it provides a detailed picture of the emergence of the search for disequilibrium microfoundations, and by extension, contributed to highlight the background of the Lucasian revolution. The context is notably characterized by close interactions between the concerns to find a theoretical structure adapted to Keynesian macroeconomics, and the developments of general-equilibrium theory. As evidence of that: i) Clower considered the rejection of Walras' law as the *sine qua non* of Keynesian macroeconomics partly because Hahn and Negishi (1962) recognized that its validity was a necessary condition for ensuring the stability of non-tâtonnement processes; ii) Clower's attempt to elaborate a disequilibrium monetary theory was instrumental in the emergence of the money-type non-tâtonnement models developed by Arrow and Hahn (1971: p. 346); iii) Arrow and Hahn acknowledged that they were "concerned with relating certain features of [the Keynesian] model to what has gone before in [their] book [devoted to non-tâtonnement economics]" (1971: p. 347); iv) Frevert's (1968; 1970) and Arrow and Hahn's (1971) formal stability studies faced a common problem: the need to make ad-hoc assumptions on markets' or individuals' behaviors to provide an account of the coordination process of economic activities. Second, our study stressed that central analytical problems in the 1950s and 1960s were swept under the rug in the process of transformation of macroeconomics initiated by Lucas. The integration of monetary and value theory and the issues raised by the coordination processes were cases in point. Lucas assumed away the former issue by considering that the introduction of a cash-in-advance constraint in individuals' plans was enough to model

monetary economies. The same was true with the latter issue since Lucas and his followers assumed that markets always cleared.

There is one lesson to learn and one remark to make on the basis of the two preceding observations. The lesson is that the co-evolution of Keynesian macroeconomics and general-equilibrium theory should be explored further to tell the story of modern macroeconomics. The analyses of Patinkin-Clower type spillover effects in non-tâtonnement models would be an avenue to explore. Negishi and Grossman discussed this issue in correspondence in the early 1970s. While reacting to a manuscript sent by Grossman, Negishi argued that the "Patinkin-Clower type spillover effects [were] important [to understand] the realistic [and] imperfect process of exchange". As a result, Negishi recognized the need to "provide further studies in this area".[1] Grossman did not take this direction but economists such as Franklin Fisher (1972; 1978) and Emiel Veendorp (1975) did. It is an issue to know whether their studies influenced the fix-price theorists who, at about the same time, sought to dynamize their models.[2] The remark concerns the penetration of Clower's insights in the field. It is true that the way he approached the issues related to the modeling of monetary systems and to the coordination processes fell out of fashion with the emergence of the Lucasian macroeconomics. Yet, the problems posed by Clower remained objects of inquiries. Recently, the agent-based computational economics opened up the possibility to simulate trajectories of economies in situation of disequilibrium and, in turn, to account for the properties of the coordination process. This shows that Clower left us with penetrating insights that keep influencing contemporary macroeconomics.

[1] Undated letter from Negishi to Grossman: R.W. Clower Papers, Box 9, Rubenstein Rare Book and Manuscript Library.

[2] During the 2016 ESHET Conference, I had the opportunity to discuss with Richard Arena. He told me that in the early 1980s, French economists including Benassy, Pascal Picard, Philippe Michel, Claude Fourgeaud, and Pierre-Yves Hénin were part of a research team whose goal was to explore the stability properties of non-Walrasian models. According to Arena, their works are archived at Paris I Pantheon-Sorbonne.

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