GROWTH WITHOUT EXPECTATIONS: THE ORIGINAL SIN OF NEOCLASSICAL GROWTH MODELS

Documents de travail GREDEG
GREDEG Working Papers Series

Michaël Assous
Muriel Dal Pont Legrand

GREDEG WP No. 2018-30
https://ideas.repec.org/s/gre/wpaper.html

Growth without Expectations: The Original Sin of Neoclassical Growth Models[1]

Michaël Assous[2]
Université Lyon 2, CNRS, TRIANGLE

Muriel Dal Pont Legrand[3]
Université Cote d'Azur, CNRS, GREDEG

GREDEG Working Paper No. 2018-30

Abstract. *Early developments of growth theory are seen widely as the result of a two-step process – the first represented by Harrod's Essay in Dynaamic Theory, and the second by Solow's 1956 model. Harrod is considered to be the first to highlight the pervasive instability in macrodynamics, which Solow showed disappeared with the inclusion of flexible-coefficient production functions. It has been recognized since that this is a misreading (Besomi 1995, 1998, Bruno and Dal-Pont Legrand 2014). Hoover and Halsmayer (2016) examined how this "culture of misunderstanding" guided both Solow's modelling work and his reading of Harrod. Our paper pays attention to the specific issue of the introduction of an (independent) investment function in those early growth models. Using new archival material, we examine this complex issue and show how macroeconomists of that period dealt with problems related to incorporating expectations, an a priori unavoidable step in order to build robust investment functions. Those elements were indeed discussed at length, in the early 1960s, by economists such as Sen, Samuelson and Solow as shown in his correspondence with Hahn. Our paper sheds light on some hidden foundations of growth models and examines the nature of the break Solow's model introduced in the growth research program as initially defined by Harrod.*

Keywords: growth, expectations, investment function, (in-)stability.

JEL Codes : B2, B220, E1.

---

[1] A first version of this paper was presented at the the IV[th] Guggenheim Conference on the History of Economic Thought, Ben-Gurion University of the Negev, 18-19 December, 2017. A second version was presented at the HES annual conference, Chicago, 2018. The authors thank Arie Arnon, Mauro Boianovsky, Robert Dimand, Harald Hagemann, Esteban Perez and Anwar Shaikh for useful comments. The usual disclaimers apply.

[2] Université de Lyon 2, Triangle CNRS, Michael.Assous@univ-lyon2.fr.

[3] *Corresponding author*, Université Cote d'Azur, CNRS, GREDEG. muriel.dal-pont-legrand@univ-cotedazur.fr.

1. Introduction

The official (hi-)story of the early developments of growth theory is presented basically as a two-step process, identified by two major contributions: Roy Harrod's "Essay in Dynamic Theory" and Robert Solow's 1956 "contribution". Specifically, Harrod is considered as being the first to point to the pervasive instability in macrodynamics while Solow showed that this instability disappeared with flexible production function coefficients. Thus, Harrod's vision, based on the "principle of instability", was seen as if he would have hence developed a pessimistic vision of economic growth while Solow would have on the contrary produced an "optimistic" understanding of economic development[4].

However, such an interpretation is problematic for several reasons. First it leads to the neglect of a literature which emerged between 1948 and 1963, a period which is however identified by Young (1989) as progressive, characterized by an intensive cross fertilization of ideas[5]. Second, it drastically reduces the scope of growth theory and ignores most of the "solutions" and options proposed by their protagonists which though partial and fragile, might have contributed to re-defining the growth economics frontier.

There are already papers which have contributed to remove a few misunderstandings that may have otherwise subsisted. Besomi (2000) demonstrates that Harrod's initial project was to model business cycles not economic growth [6] while Bruno and Dal Pont Legrand (2014) show that the possibility of cyclical growth is supported

[4] In fact, many textbooks, although making some efforts to present Harrod's view correctly, adopt "a linear" interpretation of the connection between Harrod and Solow.

[5] Young (1989) provides an analysis of Harrod's Trade cycle group. He then investigates how Harrod went from *The Trade Cycle* to the '*Essay*'. Investigating this long period, Young identifies (p. 174) three distinct stages in the growth research program: a formative period (1924-1939), a 'take off' or 'progressive' period (1948-1963) and finally, 'degenerative' period from 1964 onwards.

[6] Besomi (2000) explains that influenced by Keynes, Harrod revised his seminal 1939 paper to focus on the stability of his proposed equilibrium and moving away gradually from business cycles analysis.

by the arguments developed by Harrod in 1939. Hoover and Halsmayer (2016) examine how a "culture of misunderstanding" guided Solow's reading of Harrod and his (Solow's) own modeling strategy. We want to point out that this "culture" was exacerbated by problems related to the incorporation of expectations into his growth models and the building of robust investment functions which aspects were discussed at some length in the early 1960s by economists such as Sen (1963), Hahn (1960), Hahn and Matthews (1964), as well as by Solow himself. In addition, we want to stress that the modeling choices implemented subsequently were implicitly based on the disconnection between expectations and growth. For instance, unpublished papers and correspondence between Sen and Samuelson and between Solow and Hahn show that those economists were perfectly aware of the limitations of their work and the fragility of their respective models - elements that seem to have been overlooked by economists who contributed subsequently to the field. How did expectations come to be ignored, and what have been the consequences for analyses of growth stability? What kind of issue(s) could growth models address without the integration of expectations? How can they describe short-run and long-run dynamics? Our paper also sheds new light on little known aspects of neoclassical synthesis (see Arrow 1967) to which from the 1960s, Samuelson (1963)[7] decided to anchor Neo-classical growth models.

The paper is organized as follows. The first section discusses the debates triggered by Harrod's 1939 paper and show how the instability issues were tackled by his contemporaries. It pays special attention to growth analysis[8] and to Solow's growth model which on the assumption that whatever is saved is invested, makes any treatment of expectations redundant. Section 2 examines published and unpublished papers and less formal exchanges among the macroeconomists of that period. A review of the contributions (and sometimes also of the reactions) of various economists from Sen - who questioned the internal consistency of the so-called neoclassical growth model, to Hahn - who explicitly addressed the question of stability in relation to expectations, and even Meade, contributes to our understanding of the process involved in building the so-

[7] See Assous, Dal Pont Legrand and Manseri (2018).

[8] Recall that Harrod's instability principle was used also to build business cycles models (Hicks, 1950). We deliberately restrict the scope of this paper to the analysis of early growth models.

called neo-classical growth model. The paper sheds light on the nature of the compromises made which *in fine* led to the disconnection of expectations from growth analysis[9].

2. Stumbling toward instability: Harrod's attempt to incorporate expectations

Harrod's concerns over expectations emerged initially in 1936 when he wrote *The Trade Cycle*. It was then that he explicitly introduced[10] the terms "realization" and "disappointment". Entrepreneurs have expectations about additional effective demand and determine the level of investment; in turn, investment *via* the multiplier, affects the level of effective demand. Then the revision of expectations following a disappointment based on a multiplier-accelerator effect, gives rise to a cumulative mechanism which leads to further deviations. In 1939, cumulative dynamics were still present and Harrod developed arguments to show that instability played a key role.[11] In his "Essay on dynamic theory", Harrod emphasized several issues. First, he examined the possibility of steady growth in a model with fixed capital-output and fixed savings-output ratios. Second, he introduced a sort of investment function[12] before examining possible sources of the instability of this steady growth path. More precisely, he analyzed under what conditions entrepreneurs' expectations are verified, and what type of dynamics emerges if they are not. In addition, he defined G_w (the warranted growth rate) as a moving equilibrium.

> (…) as actual growth departs upwards or downwards from the warranted level, the warranted rate itself moves, and may chase the actual rate in either direction. (...) Indeed, there is no unique

[9] Indeed, these debates show that the scope of the neo-classical growth model can be questioned, as can and more concretely, its meaning and the message in Samuelson's synthesis (see on that point Assous, Dal Pont Legrand and Manseri (2018)).

[10] In Chapter 2.

[11] See also on that point Harrod (1948) and (1960).

[12] This sort of investment function was interpreted by Sen (1970) as an accelerator type and by Yoshida (1999) as an accelerator-multiplier type.

> warranted rate; the value of warranted rate depends upon the phase of the trade cycle and the level of activity' (ibid: 29–30).

G_w as a moving equilibrium implies a dynamic approach to the warranted ICOR. It has been shown (Bruno and Dal Pont 2014) that this along with Harrod's suggested introduction of corrections to both short-term (depending on the different phases of the cycle) and long-term expectations (comparing G to G_n, respectively the effective and natural rates of growth), makes it possible to dampen the instability[13]. Harrod coined the term "instability principle" to describe possible adjustments between effective accumulation (i.e. that realized by entrepreneurs) and warranted accumulation. The incorporation of expectations then raises two issues: i) Under what conditions are the entrepreneur's expectations realized? ii) What happens if these expectations are not realized? Although Harrod deals with the first question in detail, his treatment of the second is superficial and opened the way to numerous interpretations. Baumol (2000: 1039), for instance, concludes that "the main achievement of his [Harrod's] model lies in the ideas it inspired in those who did not fully understand it". Among the many different interpretations, most textbooks privilege Solow's view that due to the rigidity of the warranted rate of growth, the economy faced a so-called "razor problem" which vanishes with the assumption that technology is flexible[14]. Harrod persistently rejected that interpretation[15], and never considered the warranted growth rate G_w, as fixed but instead, times and again, insisted on the fact that G_w was a moving

[13] In fact, in line with Harrod's own comments, the model (Bruno and Dal Pont Legrand 2014) shows that different types of dynamics patterns, including cyclical convergence to the steady state, growth cycle and corridor of stability can emerge.

[14] Note that at that time, many economists interpreted Harrodian instability very 'negatively' and were always keen to dampen it (cf. Bruno and Dal Pont Legrand 2014: 467-468).

[15] He found the razor edge interpretation unpalatable; it was spread not only by neoclassical economists but also by Joan Robinson. Harrod never ceased to contest this interpretation, and in 1973, when he published his *Economic Dynamics*, he referred to the corridor concept proposed that same year by Axel Leijonhufvud in an article on effective demand failures, as being more appropriate. Bruno and Dal Pont Legrand (2014) follow this line of research and show that Harrod's dynamics was indeed compatible with the corridor concept in the context of growth cycles dynamics.

equilibrium over the different phases of the business cycle. Few contemporaries were aware that Harrod[16] was relying heavily on how entrepreneurs form and adapt their expectations (Baumol 1951; Hahn and Matthews 1964), and ultimately on the dynamics of investment. Nevertheless, it was not that road which was privileged. By introducing perfect substitutability between labor and capital in a world where whatever was saved was automatically invested, Solow proposed a model that was interpreted as a solution to Harrod's instability analysis. This functional approach determined the rate of growth of the economy and eliminates the need for an investment function. However, this modeling choice transformed Harrod's initial problem. Indeed, as pointed out by Hahn and Matthews (1964), it was necessary (Hagemann 2009:85) to "[distinguish]clearly … between two different notions of knife edge problem, the inequality between the warranted and the natural rates of growth and the instability of the warranted rate itself but also observed that Solow, in focusing exclusively on the first, had missed Harrod's emphasis on the second." (Hagemann 2009: 85)[17].

3. Getting rid of expectations: The original sin of neo-classical growth models

The neoclassical approach was understood as a double departure from Harrod's initial contribution. The first departure can be summarized as rejection of Harrod's knife-edge which led macroeconomists to assume permanent equality between full employment saving and full employment investment. To "solve" Harrod's instability problem, Solow assumes full-employment.

In addition, because his model ignored the demand side, it was at the origins of the dichotomy which emerged in modern macroeconomics between business cycles and growth theories, i.e. again between short

[16] More precisely, the instability was interpreted as an obstacle to growth and as a possible opportunity for business cycles; however, in both cases, it was considered excessive and requiring of dampening. The (only) person who seems properly to have understood Harrod's project was Jacob Marschak who made a clever comment in his 1939 article. For a more detailed analysis see Sember (2010).

[17] In a private conversation with Muriel Dal Pont Legrand in 2009, Solow said that the real challenge was the investment function, and unfortunately, no one so far had come up with a satisfactory answer to this issue.

and long run dynamics[18]. Solow confessed later that at the time, he had not realized that in building this model he was redirecting the growth research program substantially and had contributed to its definitive disentangling from business cycles analysis:

> it is clear to me that I oversimplified matters in 1956. The model was new, and I didn't understand all its implications. Some of what Harrod called instability is, of course, a matter of the behavior of the effective demand, off equilibrium paths. Harrod never specified clearly what he had in mind, and indeed there is very little literature even now that marries the theory of growth with effective demand. What I was getting at in 1956 was this: the special character of Harrods' model rests in the fact that the natural and warranted rates of growth are independent numbers… That characteristic of the model rests on fixed proportions. (it is immaterial whether Harrod believed that factor proportions are technically fixed or simply never change.). In turn, at least some aspects of "instability" arise because the economy is always being pulled away from the warranted path because it differs from the natural path. (Solow 1966[19], cited by Boianovsky and Hoover and 2009: 6)

Solow was not alone in proceeding this way. In fact, neoclassical growth theory and its so-called Solow-Swan-Meade type model relied on a plausible scenario explaining how the "economy" could be on the long-term equilibrium path. Swan (1963 [1970], 205) decided to assume "either that the authorities have read The *General Theory* or that they are socialists who did not need to." Meade made a similar assumption in the introduction to his 1961 book where he points out that his analytical framework was "based on the assumption of an ideally successful Keynesian policy which at every point of time manages to keep the value of investment at the desired level" (ix). Meade (1961) is even more explicit in adding:

> We desire to watch this system grow through time (…) But in this book we shall confine ourselves to watching this process of growth on the assumption that the growing system remains in equilibrium. We must explain (…) and this explanation can perhaps best be made in terms of the monetary system which we shall be assuming" (ibid: 3).

He even provides a more detailed justification: "(…) we shall assume that there is banking system with a central bank and that the rate of interest is thereby always set at such level as to preserve a constant cost-of-

[18] Cf. Bruno and Dal Pont Legrand (2014).

[19] Boianovsky and Hoover (2009) quote a letter from Solow to Ernst Helmstädter, dated February 11, 1966, from the Duke University Rare Book, Manuscript and Special Collections Library, Durham, N.C.

living index… we assume that full employment of labor and land available at any moment of time is achieved by adjustment of the money wage per worker and the money rent per acre of land." (ibid: 3)

Finally, Meade appears to be expressing some annoyance in confessing that by proceeding this way "we (they) are ignoring all the dynamic problems involved in ensuring that our economy does not leave the path of equilibrium growth" (fn. 1, p. 4). Setting aside short-run rigidities does not mean that those growth models ignored the importance of short-run disequilibria[20] but it clearly is a non-neutral modelling strategy, i.e. it transformed how Harrod's (1939) definition of the line of steady advance was understood[21]. Clearly, business cycles were eliminated, and the research program focused on analysis of the long run equilibrium path.

The second departure from Harrod's initial contribution was that the introduction of perfect substitutability between capital and labor resulted in a perfect adjustment between the warranted and natural rates of growth. The direct consequence of this hypothesis was that while the equilibrium growth path was only a possible solution in Harrod's and Post-Keynesian models which was stressed also by Joan Robinson's

[20] This view was shared by Solow as evidence in his insistence on the fact that the absence of short-run disequilibria should not be interpreted as his willingness to neglect these issues: "It is not my contention that these problems don't exist, nor that they are of no significance in the long run" (Solow 1956: 91) but rather as an unavoidable distinction to clarify complex (and related) issues.

[21] The line of steady advance (i.e. the warranted rate of growth) appears in Harrod's 1936 book when he defines the line of steady advance as the growth path compatible with producer long-run equilibrium. However, at that time the "Harrodian cycle oscillates around the line of steady advance, it would appear that Harrod uses the steady growth path as a dynamic reference for his analytical framework and not as a medium which might formally link cycles and growth" (Bruno and Dal Pont Legrand 2014: 471). It was not until 1939 that the warranted rate of growth played a more active (dynamic) role.

"creeping platinum age"[22], it became the unique solution and direction in Solow's model i.e. in the so-called canonical neoclassical model.

However, it became obvious at a second stage that to complete the Solow-Swan approach required proof that the dynamic system was stable. Hahn (1960) analyzed the stability of the full employment growth equilibrium. The issue was revisited again by Hahn and Matthews (1964 [1972], p. 34) who thought that the dynamics needed to be based on the convergence process between G and G_w and needed also to show that the equilibrium path was stable both locally and globally. These proofs of stability were indeed seen as necessary conditions before one could be allowed to derivate implications for real life but also a more difficult task than the analysis of the equilibrium growth path properties (*ibid*. p. 41-42). The point is to ensure that whatever the initial condition, there was a mechanism that would guarantee that the system was able to define and then to achieve a full employment growth equilibrium. They came to the conclusion there are situations for which the system is unstable (ibid. p.42).

In various published and unpublished papers (Sen 1963a, 1963b, 1964), Sen also paid attention to the stability issue. Sen (1963b) explored the possibility of price movements playing an equilibrating role in a context of a fixed money rate of interest. The neo-classical model appeared robust in that context, "the process does not make it possible to have warranted growth with full employment, but in the long run the warranted rate of growth gives a stable proportion of unemployment" (Sen 1963b:280). The second and more sensitive issue was how the neo-classical model behaves if the assumption of constant equality between the warranted and actual growth rates was relaxed. Sen (1963a) introduced an independent investment function based on an expected rate of growth in a Solow-Swan type model, and finally obtained "the old-fashioned Harrodian problem" (ibid: 278). Like Baumol[23] before him, Sen observed a clearly destabilizing effect emanating from lack of adaptation *via* entrepreneurs' expectations. Herein, for Sen (and others), lies the fundamental failure of the neo-classical growth theory:

> (…) the absence of an investment function and the consequent failure to assign a major role to entrepreneurial expectations about the future. It may be convenient at this point to recall that Harrod

[22] On this specific point, see Sen (1970: 21).

[23] 1959.

> was concerned with the instability problem in equilibrium growth precisely in this context. The balance between 'warranted growth' and 'natural growth' is only one of Harrod's problems, and this is the only one that the Solow-Swan model takes up, leaving out the question of balance between 'warranted growth' and 'actual growth' related to entrepreneurial expectations. Once an independent investment function is introduced, the instability problem of Harrod quickly reappears in the Solow-Swan model, in spite of replacing the assumption of a constant capital-output ratio by a neo-classical production function (see Eisner 1958; Hahn 1960; Sen reading 10). The assumption of substitutability does not seem to be a key difference between neo-classical and neo-Keynesian studies of growth, though it is sometimes thought to be so, and the main difference seems to lie in the investment function. (Sen 1970, p. 23)

In an unpublished paper, Sen (1964: 279) reiterates that "if growth theory is to have any relevance to policy, it cannot do without an investment function; and once that is given a fair play, it is easy to recognize that anything that reduces the 'knife-edge' balance between G_n, and G_w will tend to highlight the 'knife-edge' balance between G and G_w"[24]. So, fully aware of the two distinct (Harrodian) instability problems, Sen knew that they were not independent of each other. Sen (1963b: 277) confessed that what kind of investment function should be introduced was not clear to him since "this deals with one of the most untraceable elements in capitalist economy". Finally, he concludes: "The difficulty is usually concealed by doing without an independent investment function in the growth models, and thereby by eliminating the influence of expectations. It is a dodge, and like all clever dodges it has its usefulness, but it is easy to outlive that" (ibid. 280).

Samuelson had intensive exchanges with Sen on this issue. He was in quest of a consistent global view which would reconcile short-run Keynesian interventionism and long-run neo-classical growth analysis. Samuelson was convinced that the economy could not adjust automatically in a long-run equilibrium growth path, and that such a long-run equilibrium path could only be achieved through appropriate fiscal and monetary policies. He then explicitly refers to Harrod's dynamics issue as a problem which could "easily" be solved

[24] Sen (1963b) had observed that: "(…) anything that makes G_w move towards G_n will itself raise some questions about the equality of the actual rate of growth with G_w" (ibid. 280).

"(…) laissez faire harrodian discrepancies can lose much of their terror and relevance in a properly managed mixed economy » (1976: 754). In this way, he circumvented the difficulty related to introducing expectations[25].

This view (or strategy) was questioned by Arrow (1967)[26] who rightly pointed out that even if such a mechanism worked and allowed the economy to achieve a full-employment equilibrium path, there would be no guarantee that an economy which had achieved this path artificially would then behave like an economy which had reached it automatically, i.e. in the absence of economic policy. This was a crucial critique since it not only showed that the scope of growth analysis was reduced i.e. by focusing on the behavior of the full-employment equilibrium path, but it also had consequences for the significance and the consistency of Samuelson's Synthesis.

4. Conclusions

This paper shows that in not incorporating expectations, early growth models broke with Harrod's project. Specifically, unpublished papers and correspondence reveal how the difficulties experienced by economists such as Solow, Hahn and Sen in formulating an autonomous investment function based on analysis of expectations, led them to examine economic dynamics under the hypothesis of full-employment, and ultimately to admit that saving-investment coordination problem could be ruled out in the context of the long-run.

This watershed moment which occurred in the 1960s reduced the scope of dynamics quite drastically. Following Solow's 1956 contribution, the literature had focused mostly on the behavior of equilibrium paths

[25] See Assous, Dal Pont Legrand and Manseri (2018) for a more detailed investigation of that literature, based on journal articles and enriched by archival material.

[26] Arrows' comments (1967) were written at the occasion of the publications of Samuelson collected papers edited by Joseph Stiglitz.

with business cycles analysis clearly disconnected from growth. Though partly responsible for it, Solow regretted that turn. In his Nobel Prize lecture, he stressed this explicitly:

> it is impossible to believe that the equilibrium growth path itself is unaffected by the short – to medium-run experience. In particular the amount and direction of capital formation is bound to be affected by the business cycle… So a simultaneous analysis of trend and fluctuations really does involve an integration of long run and short run of equilibrium and disequilibrium. (1987, 311-12)

There is no doubt that this separation between cycles and growth dynamics most likely contributed much to the success of Solow's growth model: " (…) theoretical attention shifted from fluctuations with growth to growth without fluctuations" (Punzo 2009, p. 101).

Building a growth model which was distinct from business cycles dynamics and without an independent investment function led Sen to think that the neo-classical growth research program needed to be redefined. He saw it necessary to consider three possible options (Sen 1970: 23-24): (i) the model describes the (real) working of the economy in which thanks to judicious government intervention "ex ante investment and ex ante savings are brought in line with each other" (ibid 23); (ii) it provides "a description of the consequences over time of maintaining full employment, rather than a causal model which may have explained what would actually happen"(ibid); and, finally, (iii) the model is more useful "to trace a full employment path rather than describe what would in fact happens in a capitalist economy, with or without control" (ibid, 23-24). Sen concludes with the words: "This is less heroic but also less objectionable" (ibid: 24).

References

Arena R. and Porta P.L. (2012), Structural Dynamics and Economic Growth, Cambridge University Press.

Arrow K. (1967), "Samuelson collected", *Journal of Political Economy*, 75(5), pp. 730-7.

Assous M., Dal Pont Legran, M. and Mansieri S. (2018), "Walking a tightrope: the neoclassical synthesis in action", GREDEG Working Paper (forthcoming).

Assous M., Bruno O. and Dal Pont Legrand M. (2014), “The law of diminishing elasticity of demand in Harrod's trade cycle”, *Cahiers d'Economie Politique / Papers in Political Economy* 2/2014 (No 67) , pp. 159-173 DOI : 10.3917/cep.067.0159.

Assous, M. (2015), “Solow's struggle with medium-run macroeconomics: 1956–1995”, *History of Political Economy*, 47 (3), 395–417.

Baumol W. (1959), *Economic Dynamics*, 2nd Ed, MacMillan Company, New York.

Baumol W.J. (2000). Book review of D. Besomi. *History of Political Economy*, 32(4): 1037–9.

Besomi D. (2000). On the spread of an idea: the strange case of Mr. Harrod and the multiplier. *History of Political Economy*, 32(2): 347–79.

Boianovsky M. and K. Hoover (2014), "In the Kingdom of Solovia: The Rise of Growth Economics at MIT, 1956-1970," E. Roy Weintraub, editor. *MIT and the Transformation of American Economics, History of Political Economy*, 46 (supplement), December 2014, 198-228.

Boianovsky M. and K. Hoover (2009), “The Neoclassical Growth Model and 20th century Economics”, Introduction of the special issue *Robert Solow and the Development of Growth Economics, History of Political Economy*, 41 (Annual Suppl.): 1-23.

Bruno O. and M. Dal Pont Legrand (2014), “The instability Principle revisited: an Essay in Harrodian Dynamics”, *European Journal of the History of Economic Thought*, June 2014, 21(3): 467-484.

Hagemann H. (2009), "Solow’s 1956 contribution in the context of the Harrod-Domar model”. *History of Political Economy*, 41 (Annual Suppl.): 67–87.

Hahn F. (1960), "The stability of growth Equilibrium." *The Quarterly Journal of Economics* 74 (2): 206-226.

Hahn F. and Matthews, B. (1964), “The Theory of Economic Growth: A Survey.” *The Economic Journal*, 74 (296).

Harrod R. (1939), “An essay in dynamic theory”. *Economic Journal*, 49: 14–33.

Harrod R. (1948). *Towards a Dynamic Economics*. London: Macmillan.

Harrod R. (1960). Second essay in dynamic theory. *The Economic Journal*, 70: 277–93.

Harrod R. (1973), *Economic Dynamics*. London: Macmillan.

Harrod R. (2003), The Collected Interwar Papers and Correspondence of Roy Harrod. Vol. 1: Correspondence 1919–35; Vol. 2: Correspondence 1936–39; Vol. 3: Essays and Press Items, edited by D. Besomi, Cheltenham: Elgar The papers of Roy Harrod. Available from: https://www.researchgate.net/publication/228646011_The_papers_of_Roy_Harrod [accessed Jun 18, 2017].

Hicks J. (1950). A Contribution to the Theory of the Trade Cycle. London, Oxford: Clarendon Press.

Hoover K. and Halsmayer V. (2016), "Solow's Harrod: Transforming Cyclical Dynamics into a Model of Long-run Growth," *European Journal of the History of Economic Thought*, 23(4): 561-596.

Kaldor N. (1955), "Alterative Theories of Distribution", *Review of economic Studies*, 23(2) (1955 – 1956): 83-100.

Leijonhufvud A. (1973). Effective demand failures. The Swedish Journal of Economics, 75(1): 27–48.

Meade J. (1961), *A Neo-Classical Theory of Economic Growth*, New York, Oxford University Press, Pp. ix+ 146.

Punzo L.F. (2009), "A Nonlinear History of Growth and Cycle Theories", *History of Political Economy*, , 41 (Annual Suppl.): 88-106.

Samuelson P. (1955), *Economics*, 3rd Ed. New York: MacGraw-Hill.

Samuelson P. (1963a), "A Brief Survey of Post-Keynesian Developments" in Keynes' General Theory: Reports of Three Decades, Robert Lekachman (Ed.)

Samuelson P. (1963b), "Inconsistent and Incomplete Theories of Distribution" (mimeographed).

Samuelson P. (1964), *Economics*, 6th Ed. New York: MacGraw-Hill.

Samuelson P. (1976), *Economics*, 10th Ed. New York: MacGraw-Hill.

Samuelson Paul A. and Modigliani F. (1966), "The Pasinetti Paradox in Neoclassical and More General Models", *The Review of Economic Studies*, 33(4): 269-301.

Sember F. (2010), "Closing the model? The Harrod–Marschak correspondence on the draft of the "Essay in dynamic theory", *Journal of the History of Economic Thought*, 32(4): 583-608.

Sen A. (1963a), "Neo-classical and Neo-Keynesian Theories of Distribution", *Economic Record*, 39 (85), March 1963, 53–64

Sen A. (1963b), “The Money Rate of Interest in the Pure Theory of Growth,” In: Hahn F, Brechling F Theories of the Rate of Interest. London: MacMillan.

Sen A. (1964), “Full employment, Perfect Foresight and the Neo-Keynesian Distribution Theory”. Unpublished.

Sen A. (1970), *Growth Economics, Selected Readings*, “Introduction”, Edited by Amartya Sen. Penguin Books.

Solow R. M. (1956), “A Contribution to the Theory of Economic Growth” *Quarterly Journal of Economics*, Vol. 70, Issue 1, 65-94. 30p.

Solow R. M. (1957), “Technical Change and the Aggregate Production Function », *The Review of Economics and Statistics*, 39(3): 312-320.

Solow R. M. (1988), "Growth Theory and After," *American Economic Review*, American Economic Association, 78(3), 307-317, June.

Swan, T. W. (1956), “Economic growth and capital accumulation. *Economic Record*, 32 (63):334-61.

Swan, T. W. (1963), "Growth models: of Golden ages and production functions" in Economic Development with special reference to East Asian, ed. By K.E. Berrill London: MacMilan.

Tobin J. (1955), “A Dynamic Aggregative Model”, *Journal of Political Economy*, 63(2): 103-115.

Yoshida, H. (1999), Harrod’s ‘knife-edge’ reconsidered: an application of the Hopf-bifurcation theorem and numerical simulations. *Journal of Macroeconomics*, 21(3): 537–62.

Young, W. (1989). *Harrod and his Trade Cycle Group: the origins and development of the growth research program*, Macmillan, London and New York University Press, USA.

DOCUMENTS DE TRAVAIL GREDEG PARUS EN 2018
GREDEG Working Papers Released in 2018

2018-01 Lionel Nesta, Elena Verdolini & Francesco Vona
Threshold Policy Effects and Directed Technical Change in Energy Innovation

2018-02 Michela Chessa & Patrick Loiseau
Incentivizing Efficiency in Local Public Good Games and Applications to the Quantification of Personal Data in Networks

2018-03 Jean-Luc Gaffard
Monnaie, crédit et inflation : l'analyse de Le Bourva revisitée

2018-04 Nicolas Brisset & Raphaël Fèvre
François Perroux, entre mystique et politique

2018-05 Duc Thi Luu, Mauro Napoletano, Paolo Barucca & Stefano Battiston
Collateral Unchained: Rehypothecation Networks, Concentration and Systemic Effects

2018-06 Jean-Pierre Allégret, Mohamed Tahar Benkhodja & Tovonony Razafindrabe
Monetary Policy, Oil Stabilization Fund and the Dutch Disease

2018-07 Pierre-André Buigues & Frédéric Marty
Politiques publiques et aides d'Etat aux entreprises : typologie des stratégies des Etats Membres de l'Union Européenne

2018-08 Jean-Luc Gaffard
Le débat de politique monétaire revisité

2018-09 Benjamin Montmartin, Marcos Herrera & Nadine Massard
The Impact of the French Policy Mix on Business R&D: How Geography Matters

2018-10 Adrian Penalver, Nobuyuki Hanaki, Eizo Akiyama, Yukihiko Funaki & Ryuichiro Ishikawa
A Quantitative Easing Experiment

2018-11 Lionel Nesta & Stefano Schiavo
International Competition and Rent Sharing in French Manufacturing

2018-12 Melchisedek Joslem Ngambou Djatche
Re-Exploring the Nexus between Monetary Policy and Banks' Risk-Taking

2018-13 Dongshuang Hou, Aymeric Lardon, Panfei Sun & Theo Driessen
Compromise for the Per Capita Complaint: An Optimization Characterization of Two Equalitarian Values

2018-14 Gérard Mondello & Evens Salies
The Unilateral Accident Model under a Constrained Cournot-Nash Duopoly

2018-15 Stéphane Gonzalez & Aymeric Lardon
Axiomatic Foundations of a Unifying Concept of the Core of Games in Effectiveness Form

2018-16 Claire Baldin & Ludovic Ragni
François Perroux : Echange pur contre échange composite - Controverses et enjeux de justice

2018-17 Guilhem Lecouteux
What Does 'We' Want? Team Reasoning, Game Theory, and Unselfish Behaviours

2018-18 Ludovic Dibiaggio, Benjamin Montmartin & Lionel Nesta
Regional Alignment and Productivity Growth

2018-19 Nicolas Brisset
L'organe comme marchandise fictive : une mise en perspective

2018-20 Dongshuang Hou, Aymeric Lardon, Panfei Sun & Hao Sun
Procedural and Optimization Implementation of the Weighted ENSC Value

2018-21 Frédéric Marty
Intelligence Artificielle et Organisation Industrielle : quels enjeux pour l'économie numérique

2018-22 Michele Pezzoni, Reinhilde Veugelers & Fabiana Visentin
Is This Novel Technology Going to be a Hit? Antecedents Predicting Technological Novelty Diffusion

2018-23 Jacques Mairesse & Michele Pezzoni
Novelty in Science: The Impact of French Physicists' Novel Articles

2018-24 Giuseppe Attanasi, Laura Concina, Caroline Kamate & Valentina Rotondi
Firm's Protection against Disasters: Are Investment and Insurance Substitutes or Complements?

2018-25 Nicolas Brisset
Bourdieu, neo-smithien ? À propos d'Anthropologie économique

2018-26 Agnès Festré & Alain Raybaut
Colonial Banks, Credit, and Circulation: The Example of Martinique 1848-1871

2018-27 Frédéric Marty
The Unspeakable One. De l'activation de la théorie des facilités essentielles dans l'économie numérique

2018-28 Agnès Festré
Hayek on Expectations: The Interplay between Two Complex Systems

2018-29 Lauren Larrouy & Guilhem Lecouteux
Choosing in a Large World: The Role of Focal Points as a Mindshaping Device

2018-30 Michaël Assous & Muriel Dal Pont Legrand
Growth without Expectations: The Original Sin of Neoclassical Growth Models