

Romero, João P.

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Mr. Keynes and the neo-Schumpeterians: Contributions to the analysis of the determinants of innovation from a post-Keynesian perspective

João P. Romero

Department of Land Economy, University of Cambridge, UK

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Abstract

The purpose of this paper is to discuss the importance of knowledge, both tacit and codified, in the formation of the state of long-term expectations that drive firms' decisions to search for innovation and to investment in R&D. The paper takes the post-Keynesian theory as reference, associating it with the neo-Schumpeterian analysis of innovation dynamics. First, it is argued that knowledge plays a crucial role in building agents' confidence, emphasizing that radical innovations are more dependent on the accumulation of codified knowledge, given the higher degree of uncertainty associated with this type of innovation, while incremental innovations are more dependent on tacit knowledge about the current market conditions and technological trajectory. Second, it is argued that the accumulation of knowledge and the constant introduction of innovations foster the creation of a convention to innovate, which facilitates the decision to pursue innovations by influencing long-term expectations.

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Resumo

O objetivo desse artigo é discutir a importância do conhecimento, tanto tácito como codificado, para a formação do estado de expectativas de longo prazo que orienta as decisões das firmas quanto à busca de inovações e ao investimento em P&D. O artigo toma a teoria Pós-Keynesiana como referência, associando-a à análise Neo-Schumpeteriana da inovação. Primeiro, argumenta-se que o conhecimento desempenha um papel crucial na elevação da confiança dos agentes, enfatizando que as abordagens Pós-Keynesiana e Neo-Schumpeteriana são complementares, uma vez que a primeira coloca maior ênfase no conhecimento tácito e a segunda coloca maior ênfase no conhecimento codificado. Segundo, argumenta-se que que a acumulação de conhecimento e a constante introdução

E-mail address: jpr49@cam.ac.uk

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de inovações contribuem para a criação de uma convenção a inovar, a qual facilita a decisão de busca de inovações ao influenciar as expectativas de longo prazo.

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Palavras chave: Inovação; Teoria Pós-Keynesiana; Abordagem Neo-Schumpeteriana; Tecnologia

1. Introduction

The main branch of post-Keynesian theory emphasizes the role of money and banks in determining the level of investment, which in turn determines the levels of employment, production and income. By contrast, the neo-Schumpeterian theory emphasizes the importance of technological progress in the determination of the levels of production, employment and income.

Although innovation is rarely addressed in Keynes' works, it is possible to identify at least four channels through which the post-Keynesian theory can be combined with the neo-Schumpeterian theory to better understand the dynamics of innovation.¹ Firstly, several studies have sought to combine these traditions to understand the relationship between innovation and financial system dynamics, since both approaches consider money and banks as non-neutral (e.g. Gerschenkron, 1962; Zysman, 1983; Christensen, 1992; O'Sullivan, 2005; Henriques, 2007; Crocco et al., 2008; Raposo and Resende, 2012; Romero and Jayme Jr., 2012). Secondly, post-Keynesians have also sought to use Keynes' models of asset choice and of formation of expectations to understand the determinants of innovation (e.g. Crocco, 2003, 2008), given that both approaches stress the role of uncertainty in shaping firms' decisions (e.g. Dosi, 1982; Cimoli and Dosi, 1995; Dequech, 1999a). Thirdly, studies of Keynesian–Kaldorian orientation have combined the two insights investigating the impacts of demand growth (via specialization and division of labour *a la* Kaldor, 1966), technological diffusion and innovation effort on productivity growth (e.g. Oliveira et al., 2006). Fourthly, studies have also attempted to establish a relationship between innovation and trade, using the Keynesian–Kaldorian balance-of-payments constrained growth models as benchmark (e.g. Fagerberg, 1988; Resende and Raposo, 2008; Jayme Jr. and Resende, 2009; Romero et al., 2011). However, much remains to be explained within each of these research topics.

The purpose of this paper is to discuss the importance of knowledge, both tacit and codified, in the formation of the state of long-term expectations, which drives firms' decisions to search for innovation and to invest in R&D. The paper takes the post-Keynesian theory as reference, associating it with the neo-Schumpeterian analysis of innovation dynamics. First, it is argued that knowledge plays a crucial role in building agents' confidence, emphasizing that radical innovations are more dependent on the accumulation of codified knowledge, given the higher degree of uncertainty associated with this type of innovation, while incremental innovations are more dependent on tacit knowledge about the current market conditions and technological trajectory. Second, it is argued that the accumulation of knowledge and the constant introduction of innovations foster the creation of a convention to innovate, which facilitates the decision to pursue innovations by influencing long-term expectations. Thus, knowledge influences both immediate determinants of the *state* of long-term expectations, confidence and expectations, providing strong incentives to pursue innovation.

The paper is divided into five sections. Section 2 discusses the post-Keynesian theory, which represents the main framework of the paper. Section 3 briefly discusses the neo-Schumpeterian theory related to innovative dynamics. Section 4 discusses how the post-Keynesian theory can contribute to improve the understanding of the innovation process. Finally, Section 5 presents the paper's concluding remarks.

2. The post-Keynesian theory: an overview

The purpose of this section is to discuss the foundations of the post-Keynesian theory. The first part of this section introduces the fundamental axioms of this theory, which guides the more careful analysis of this tradition carried out in the subsequent parts of this section. It is worth noting, however, that this section is not intended to establish an exhaustive discussion of the controversies related to the post-Keynesian theory. Rather, following some of Keynes'

¹ See Paula (2011) for a more general analysis on the compatibility of Keynes and Schumpeter's ideas.

post-Keynesian interpreters, this section's analysis seeks to provide a review of Keynes' central ideas and connect the various aspects of the post-Keynesian theory, taking into account the central objective of the paper, which is to analyse the contributions of this theory for understanding innovative dynamics.

2.1. Fundamentals

According to [Carvalho \(1989\)](#), the post-Keynesian theory can be summarized in five fundamental axioms: (i) the axiom of production; (ii) the axiom of decision; (iii) the axiom of absence of pre-reconciliation of plans; (iv) the axiom of irreversibility of time; and (v) the axiom of the properties of money.

The first axiom postulates that firms produce aiming to accumulate money. Since agents must produce before consume, production is the starting point of economic processes. The decision to produce, in turn, is made by *firms*, which are economic agents not reducible to their owners, given that the goal of firms is to profit, while the goal of their owners is to consume. This means that the firm seeks wealth in its most general form, i.e. monetary wealth, given that it always seeks to invest this wealth where it is most profitable. To paraphrase [Carvalho \(1989: 183\)](#), although to produce with efficiency is a goal, an even more important goal is to be able to sell the production in the market. Hence, this axiom stresses that firms' decisions about the level of production are guided by the possibility of obtaining monetary profits.

The second axiom postulates that firms decide about the levels of production, employment and income in the economy. This derives from the fact that firms are the agents who decide when, where, and how much capital should be used. According to [Carvalho \(1989: 183\)](#), the second axiom is equivalent to saying that the economy is subordinated to the firms' goal of multiplying monetary wealth, so that although consumption may be the ultimate goal of production, it must be subordinated to firms' immediate objective of obtaining profits.

The third axiom postulates that in a monetary production economy, the existence of money allows the factors of production not to decide *a priori* when and in what products to convert their monetary income. This results directly from the institution of cash payments, which implies a mismatch between production and consumption *a priori*. The existence of money, therefore, makes imbalances between aggregate supply and demand possible (i.e. deficiencies of effective demand – [Keynes, 1970, Chapter 3](#)), given that it allows part of the income to be retained in the form of money. Hence, the non-pre-conciliation of plans makes market performance uncertain. However, since production precedes consumption, the decision of how much to produce must be made based on *expectations* about the future level of consumption.²

The fourth axiom postulates that after an investment is made, it cannot be undone without bearing certain costs. In other words, time is unidirectional ([Carvalho, 1989: 185](#)).³ According to the third axiom, investment decisions must be made based on expectations, since there is no guarantee that expected demand will be *effectively* verified. Thus, the fact that expectations might be unfulfilled and that it is not possible to reverse realized investments exacerbates the uncertainty involved in firms' decision-making. In the post-Keynesian approach, uncertainty refers to the impossibility of knowing the possible future scenarios and of assigning correct probabilities to each expected future scenario.

Finally, the fifth axiom refers to the fundamental *characteristics* of money: (i) that money has null or negligible elasticity of production and (ii) that money has null or negligible asset in a monetary production economy.⁴ Having a null or negligible elasticity of production indicates the impossibility of expanding the production of money when its demand increases. In other words, the response of employment in the production of money to increases in the demand for money is null, since the production of money is a monopoly of the monetary authority and cannot increase freely. Thus, given that the money supply is relatively fixed, its value is more reluctant to fall.⁵ Having null or negligible elasticity substitution, in turn, indicates that money is not easily replaceable. According to [Keynes \(1970: 231\)](#), "this

² [Carvalho \(1989: 184–185\)](#) points out that in neoclassical economics, disappointment of expectations can only occur in terms of *sectoral* allocation of resources, since it is assumed that all income must be consumed. In the post-Keynesian approach, however, the verification of losses in some sectors may not correspond to extraordinary gains in other sectors. Paraphrasing [Carvalho \(1989: 185\)](#), in monetary production economies there is nothing ensuring that disappointment of expectations generates a process of gravitation around a fixed point of resource allocation.

³ [Amado \(2000\)](#) provides a good review of conceptions of time and non-ergodicity in the post-Keynesian tradition.

⁴ The functions of money are not discussed here. See [Keynes \(1970\)](#) and [Carvalho \(1989\)](#).

⁵ According to [Carvalho \(1989: 188\)](#), the restricted supply of money imposes a limit on the expectations about the future purchasing power of the monetary unit.

follows from the peculiarity of money that its utility is solely derived from its exchange-value, so that the two rise and fall *pari passu*, with the results that as the exchange value of money rises there is no motive or tendency, as in the case of rent-factors, to substitute some other factor for it". Thus, this axiom indicates that money becomes an asset due to its relatively stable value and due to the difficulty in replacing it with another asset.

These five axioms summarize the basic post-Keynesian interpretation of the mode of operation of a monetary production economy. The level of production is determined by profit-seeking firms (axiom of production), which decide when, where and how much to produce based on expectations about future economic activity (axiom of decision), given that there is no pre-conciliation of plans compelling agents to spend all income earned (axiom of no pre-conciliation of plans). The non-existence of pre-conciliation of plans makes the volume of sales uncertain, making possible for expectations to be disappointed.⁶ Moreover, the irreversibility of investments exacerbates the problem of deciding the appropriate production levels (axiom of irreversibility of time). Hence, in face of uncertain outcomes, agents often prefer to hold money rather than risk investing (axiom of the characteristics of money). This creates the possibility of deficiencies in effective demand that affect the levels of employment, production and income. The existence of money, therefore, is not neutral to the economic activity neither in the short nor in the long term. In the short term, the existence of money may harm the sales of current production (with the existing capital stock) due to deficiencies of effective demand. In the long term, the existence of money influences investment decisions that determine the levels of production, employment and income through its impact on the short term economic results, which guide long-term expectations.

To sum up, the post-Keynesian approach represented by the five axioms discussed above rests on three pillars: (i) uncertainty; (ii) expectations; and (iii) money. The existence of *uncertainty* implies the formation of *expectations* to guide firms' decisions about production and investment, which introduces subjectivity into resource allocation decisions and makes disappointments possible.⁷ According to Keynes (1937a: 213), disregarding this issue is a major shortcoming of the neoclassical theory. Finally, the existence of *money*, which is the asset demanded in situations of high uncertainty (given its stable value and high liquidity), creates the possibility of persistent unemployment and low production due to deficiencies of effective demand.

It is crucial to note, however, that the concept of uncertainty used in the post-Keynesian theory refers not only to the uncertainty about the probabilities associated with each possible future event, but also to the uncertainty about the list of possible future events. Dosi and Egidi (1991: 145) differentiate substantive uncertainty, which refers to "the lack of all the information which would be necessary to make decisions with certain outcomes", and procedural uncertainty, which refers to "limitations on the computational and cognitive capabilities of the agents to pursue unambiguously their objectives, given the available information". Dequech (2000), in turn, distinguishes between ambiguity, which is the uncertainty about the probabilities associated with each future event, and fundamental uncertainty, which is the uncertainty about the list of possible future events. Using these definitions, therefore, the concept of uncertainty adopted here encompasses both (substantive) ambiguity and fundamental uncertainty. Moreover, following Dequech (1999a,b, 2000), Amado (2000) and Crocco (2003, 2008) the discussion presented in this paper considers that there are different *degrees* of uncertainty, optimism and confidence.

2.2. Asset choice model

This section discusses Keynes' (1970) model of asset choice. According to Keynes (1970), the demand for consumer goods is a relatively stable proportion of national income (marginal propensity to consume). Thus, the volatility of aggregate demand and output are associated with the volatility of the demand for investment goods (Carvalho, 1994: 77–78; Amado, 2000: 69). To understand how allocation decisions are made, therefore, the starting point is the Keynesian asset choice model.

⁶ The impossibility of increasing employment in the production of money is crucial to understand why a rise in the demand for money affects the levels of employment, production and income. Demand for money discourages production and does not compensate the fall in employment with increased employment in the production of money. The demand for money, therefore, opens the possibility of deficiency of effective demand, creating situations of equilibrium with unemployment or underemployment (Keynes, 1970: 236).

⁷ For a deeper explanation about the post-Keynesian conceptions of time, uncertainty and money, see Amado (2000).

According to Keynes (1970, Chapters 11 and 17) the interest rate appears as a limit to the level of employment, given that for new investments to be made the marginal efficiency of capital must be above the interest rate.⁸ Keynes (1970) stresses that from the rate of interest on money it is possible to calculate specific interest rates for each asset in the economy (in monetary values), so that the comparison of these rates indicates the levels of demand for each asset.

“The money rate of interest – we may remind the reader – is nothing more than the percentage excess of a sum of money contracted for forward delivery, e.g. a year hence, over what we may call the ‘spot’ or ‘cash’ price of the sum thus contracted for forward delivery” (Keynes, 1970: 222).

Keynes’ (1970) asset choice model is based on the fact that decisions about the purchase of different assets are necessarily *forward-looking*, as they depend on the *expected* future returns of each asset in a given period. Thus, since the future is surrounded by uncertainties, expectations play a crucial role in the estimation of assets’ own-rates of interest.

Four attributes determine the own-rate of interest of each asset in monetary terms: (i) the expected yield (q); (ii) the carrying cost (c); (iii) the liquidity premium (l); and (iv) the expected appreciation (a). The sum of these attributes gives the assets’ own-rate of interest, which measures its total expected return: $a + q - c + l$.⁹ The term *liquidity* refers to the ability to quickly convert an asset into money without loss in its initial value. Thus, liquidity is a two-dimensional concept.¹⁰ From this definition it is possible to establish different levels of asset liquidity. The assets that need more time to be converted into money (without loss of value) are less liquid, while highly convertible assets are more liquid. Hicks (1967) proposed a classification of three levels of liquidity: (i) the first level (most liquid) consists of money and its substitutes; (ii) the second level consists of net assets supported by secondary markets without guarantees in selling prices (bonds); and (iii) the third level consists of illiquid assets without organized markets, which cannot be held as a store of value given the uncertainty surrounding their resale (capital goods). According to Keynes (1970), therefore, the basic difference between money and capital goods is that for the former, the liquidity premium exceeds the carrying costs, while for the latter (and other goods in general) the returns exceed the carrying costs in spite of its low liquidity premium.¹¹ Moreover, since the greater the risk (r) of an investment is, the lower its liquidity premium (l) is, then $r = -l$, and the previous formulation can be changed to: $a + q - c - r$ (Keynes, 1970: 240).

The asset choice model stresses that different expectations lead to different asset choices. Given that q and a are expected values, changes in agents’ perception of the degree of uncertainty of future results affects the prices of all assets. Thus, an increase in uncertainty not only reduces the expected returns (q) and the expected appreciation (a) of different assets, but it also increases the importance attributed to the liquidity premium (l) (Carvalho, 1994: 89; Paula, 1999).¹² Note that money is the most flexible form of wealth, and the demand for liquidity is associated with the demand for *flexibility* to adapt to unforeseen events, which is actually a demand for security (Keynes, 1970: 226; Carvalho, 1989: 180). This situation, therefore, is characterized by an increase in the liquidity preference. Hence, each state of long-term expectation is associated with a particular level of liquidity preference, which determines the expected values of each variable in the model.

The model of asset choice demonstrates that there is an interaction between the assets in the process of price formation, since variations in the demand for an asset (e.g. money) influence the demand for other assets (e.g. capital goods). As discussed in the previous section, Keynes (1970) puts especial emphasis on the importance of money as a highly liquid asset that is demanded when uncertainty rises. Taking into account the characterization proposed by Hicks (1967), high uncertainty leads to a contraction of the demand/production of capital goods at the expense of increased demand for money and securities. Consequently, the model demonstrates why money is non-neutral neither in the short nor in the long term.

⁸ The marginal efficiency of capital is given by the ratio between the *expected* yield resulting from the use of this capital and the costs of this capital (Keynes, 1970, Chapter 11).

⁹ Note that in order to compare the rates of different assets it is necessary to calculate the rates over equal periods of retention.

¹⁰ Market efficiency is another factor that influences the attribute of liquidity of an asset, since more efficient markets increase the agents’ confidence regarding the conversion of assets into money without significant loss. For a more detailed discussion of this topic, see Carvalho (1989).

¹¹ According to Carvalho (1994: 84), “it is the latter attribute that allows us to consider money as an asset and to compare its ‘return’ with the value returns offered by other assets”.

¹² The demand for security, therefore, is associated with the demand for *flexibility* to adapt to unforeseen events. According to Carvalho (1989: 180), money is the most flexible form of wealth.

2.3. Finance and the non-neutrality of banks

The asset choice model identifies the determinants of demand for investment. However, to understand what determines the level of investment in each economy it is also necessary to analyse other factors that make investment possible. Among these factors, the availability and form of investment finance is particularly important.

In neoclassical growth theory, investment is determined by savings (e.g. [Sollow, 1956](#)). Hence, fostering higher savings leads to higher investment. Thus, this approach assumes the neutrality (passiveness) of banks in relation to the investment process. In the neoclassical tradition, money supply is exogenous to the economic system, determined by the monetary authority, and banks work only as intermediaries between savers and investors ([Amado, 2000](#)).

Post-Keynesian theory describes the process of investment in a radically different form. For Keynes and the post-Keynesian, money supply is *partly* endogenous to the economic system, and although influenced by the actions of the monetary authority, it is also influenced by banks' decisions to lend.¹³ In post-Keynesian theory, banking firms have similar characteristics to other firms, being also subject to uncertainty ([Keynes, 1970: 158](#)). According to [Dow \(1993\)](#), therefore, the asset choice model and the theory of liquidity preference apply to the decisions to demand for all assets, whether by banks or by other agents.¹⁴ Thus, as every firm working in a monetary production economy, banks decide how to allocate the money they hold following expectations and the asset choice model.

The level of liquidity preference (expectations) of banks, therefore, directs their decisions about asset allocation, determining how much they lend (i.e. demand less liquid assets) and how much they demand financial assets (i.e. more liquid assets). These decisions, produce a crucial impact on the level of economic activity. Banks' decisions can either follow the same direction of the central bank's policy, or follow an opposite direction. Hence, different banking strategies can magnify or reduce the objectives of the policy adopted by the monetary authority. Consequently, due to banks' influence on the determination of money supply (credit) and of interest rates, banks have direct impacts on the levels of investment, output and employment ([Keynes, 1970: 158; Paula, 1999: 177](#)).¹⁵ This highlights the crucial role of banks in determining the pace of capital accumulation in a monetary production economy.

2.4. The finance–investment–savings–funding circuit (FISF)

In the previous section it was argued that the level of investment finance depends on banks' decisions regarding the allocation of their resources, so that money supply is partly endogenous. In this framework, *ex ante* savings are not necessary to generate investment, given that it is banking finance that enables investment.

In post-Keynesian theory, it is investment that generates savings, while the accounting equality between them is only verified *ex post*. After an investment is made, the income multiplier operates, and given that consumption is a fixed proportion of income, at the end of the process the sum of the savings of all agents equals the initial investment. According to [Keynes \(1937b\)](#), the process of investment unfolds in two steps. In the first step, planned (*ex ante*) investment, realized when savings have not yet been created via the income multiplier, corresponds to the short-term credit demanded by firms to initiate the investment – demand for money due to the *finance motive*. In the second step, the actual (*ex post*) investment, which corresponds to aggregate savings that arise via the income multiplier at the end of the process, is carried out. According to [Keynes \(1937b\)](#), *ex ante* investment is justified by the fact that investment finance must occur before the investment is effectively made. There is no plausible explanation justifying the equality between *ex ante* savings and *ex ante* investment. Firstly, it is not necessary for people to decide beforehand about how much they will save in the future, as they often do not know how much will their future income be. Secondly, and more importantly, “the *ex ante* saver has no cash, but is cash that the *ex ante* investor requires” ([Keynes, 1937b: 665–666](#)).

Liquidity preference determines both the level of *ex ante* investment (finance) and the level of the interest rate ([Keynes, 1937b: 664–665](#)). Most importantly, it is banks' liquidity preference that determines the amount of credit

¹³ For a deeper discussion on the endogeneity of money in the post-Keynesian theory, see [Carvalho \(1993\)](#).

¹⁴ It must be noted that liquidity preference is not the same as demand for money, given that the demand for money due to the *finance* motive actually refers to the demand for loans to purchase capital goods, representing, therefore, low liquidity preference.

¹⁵ According to [Minsky \(1986\)](#), banks do not administrate their liabilities passively, but actively seek to introduce financial innovations that allow them to escape regulation, raise credit and expand their liabilities. Banks, therefore, are active (not passive) agents that dynamically manage their assets and liabilities ([Paula, 1999: 173](#)).

granted in the economy. This occurs because bank finance does not necessarily employ savings.¹⁶ The conclusion derived from the process described is obvious: “this means that, in general, the banks hold the key position in the transition from a lower to a higher scale of activity” (Keynes, 1937b: 668).

According to Keynes (1937b), however, at the end of the investment process, the savings that result from it can be used to transform investors’ short-term debt into long-term liabilities. This transformation happens through the issuance of stocks, i.e. through firms’ *funding*, which completes the *finance–investment–savings–funding* (FISF) circuit. The existence of organized financial markets, therefore, not only allows *funding* to take place, but it also influences firms’ disposition to invest and banks disposition to finance such investments.

For Keynes (1970, Chapter 12: 151), the fundamental function of financial markets is to facilitate exchanges, increasing the liquidity of long-term assets (for individual stock-market investors) and thereby reducing the uncertainty associated with these assets. Nonetheless, financial markets are also particularly important for information dissemination, given that these markets collaborate to: (i) signal prices of new stocks; (ii) reduce underwriting risk due to the presence of specialized financial institutions; and (iii) enable investors’ assessment of the profitability of new stocks (Stuart, 1995). Hence, well organized secondary markets encourage investment by allowing periodic reviews of investment decisions.

However, the speculative nature of financial markets generates instability as well, which can lead to crises and curb economic growth (Keynes, 1970: 145, 158; Minsky, 1986).¹⁷ While speculative investors seek to predict market psychology, enterprise investors seek to predict the expected returns of investments (Keynes, 1970: 158). Nonetheless, as Keynes (1970) argues, the same mechanism that generates crises generates growth as well, given that:

“The liquidity of investment market often facilitates, though it sometimes impedes, the course of new investment. For the fact that each individual investor flatters himself that his commitment is “liquid” (though this cannot be true for all investors collectively [as one’s gain is another’s loss]) calms his nerves and makes him much more willing to run a risk” (Keynes, 1970: 160).

For Keynes, therefore, the absence of financial markets constrains economic growth, as it limits the process of *funding*, which allows firms to equate the terms of their obligations to the maturity of their investments.¹⁸ Moreover, the characteristics of each country’s financial system (Gerschenkron, 1962; Zysman, 1983), the degree of its development (Dow, 1993), and the form it is regulated directly influence the system’s ability to foster investment.

To sum up, this brief discussion emphasizes the dual importance of financial systems for economic growth, given the crucial role they play in determining both finance and funding.

2.5. Uncertainty, expectations, conventions and confidence

As argued in the previous sections, in the post-Keynesian tradition, decisions regarding the allocation of resources in a monetary production economy depend directly on *expectations* about the future returns of different assets. This observation stresses the importance of understanding how these expectations are formed.

Keynes (1970: 46–47, 145–146) defined two types of expectations: (i) short-term expectations (STE), and (ii) long-term expectations (LTE).¹⁹ Short-term expectations are related to decisions regarding how much to be produced under present conditions (existing stock of capital, demand, etc.). In this case, therefore, the capital stock is considered fixed.

¹⁶ It is important to stress that Keynes (1937b) does not mean that investment is *not* financed by savings. Instead, he argues that finance through credit and through the allocation of existing savings happen simultaneously. However, Keynes (1937b) seeks to emphasize that: (i) investment finance can occur independently of savings and (ii) that in monetary production economies bank finance (credit) predominates. “In the main the flow of new finance required by current *ex-ante* investment is provided by the finance released by current *ex-post* investment” (Keynes, 1937b: 666).

¹⁷ The Minskyana approach to financial crises will not be discussed in this paper, despite its importance in the post-Keynesian tradition, since it is beyond the direct purpose of this paper’s scope. For an analysis that incorporates Minsky’s approach, see Raposo and Resende (2008).

¹⁸ As Keynes (1970: 160) argued, “This is the dilemma. So long as it is open to the individual to employ his wealth in hoarding or lending *money*, the alternative of purchasing actual capital assets cannot be rendered sufficiently attractive (. . .), except by organizing markets wherein these assets can be easily realized for money”.

¹⁹ Discussing the concept of expectations (short-term, in particular) in Keynes, Dequech (1999a) argues that the post-Keynesian view is not compatible neither with rational expectations, since it is pervaded by uncertainty, nor with adaptive expectations, due to the fact that Keynes (1970: 50) stresses that “it is sensible for producers to base their expectations on the assumption that the most recently realized results will continue, *except in so far as there are definite reasons for expecting a change*” (emphasis added).

Long-term expectations, in turn, relate to decisions regarding the allocation of resources with long-term maturity, as investments, taking into account future conditions (changes in the stock of capital, preferences, wages, etc.). In this case, therefore, the capital stock is variable. These two expectations differ mainly regarding: (i) the period of time involved in the process; (ii) the magnitude of resources expended in each decision; and (iii) the amount of uncertainty about future outcomes involved in each decision (Crocco, 2008: 278). According to Crocco (2008), the period of time necessary to make a decision and adjust for errors (and the associated costs) is significantly smaller in the formation of STE in relation to LTE.²⁰ Thus, LTE are associated with degrees of uncertainty considerably higher than the ones associated with STE.

The relationship between STE and LTE is a matter of debate in the post-Keynesian tradition. Kregel (1976) highlights three different models used by Keynes. The first model, called the “static model”, assumes that LTE are constant and that STE are always satisfied.²¹ The second model, called the “stationary equilibrium model”, assumes that STE can be unfulfilled without affecting LTE.²² And the third model, called “alternate equilibrium model”, assumes that STE disappointments affect LTE. However, since the second model is the model that seems to predominate in the first 18 chapters of *The General Theory*, the discussion presented in this paper follows this model.²³

Keynes (1970) pointed out, however, that credit and investment depend not only on LTE, but also on the confidence agents have in these expectations or predictions. According to Dequech (1999a: 417), therefore, for Keynes, the state of LTE depends: (i) on LTE themselves (prognostics) and (ii) on the confidence in the LTE. In the words of Keynes,

“The facts of the existing situation enter, in a sense disproportionately, into the formation of our long-term expectations; our usual practice [(or convention) to form expectations] being to take the existing situation and to project it into the future, modified only to the extent that we have more or less definite reasons for expecting a change. The state of long-term expectations, upon which our decisions are based, does not solely depend, therefore, on the *most probable forecast* we can make. It also depends on the *confidence* with which we make this forecast” (Keynes, 1970: 148 – first emphasis added).²⁴

Given the importance of the state of LTE in determining credit and investment, therefore, this section discusses the determinants of this state.

According to Dequech (1999a,b: 421), confidence depends on: (i) uncertainty perception, which depends on agents’ optimistic disposition and knowledge and (ii) uncertainty aversion, which depend solely on agents’ optimistic disposition.²⁵ According to Crocco (2003: 183–184) and Dequech (1999b: 422, 424), the impact of knowledge on confidence works through the so-called “social weight of argument”, which justifies a particular course of action (decision).²⁶ This weight, in turn, influences agents’ uncertainty perception. Consequently, in this approach, knowledge influences confidence through uncertainty perception.

Dequech (1999a: 73, 1999b: 420) associated *optimistic disposition* with *animal spirits*. For Dequech (2000: 162), however, “situations of fundamental uncertainty are not reduced to a simple dichotomy between action and inaction [as done by Keynes]; rather, there can be *different types of action*, depending on the quality and the intensity of the optimistic disposition to face uncertainty. The idea to be conveyed is that of a disposition that comes in (ordinal) degrees and is combined with optimism or pessimism”.²⁷ It is crucial to note, however, that Dequech (1999a,b) distinguishes between optimistic disposition and spontaneous optimism. Nonetheless, he does not make clear enough how these two concepts

²⁰ This paper does not seek to develop a deeper analysis of the relationship between STE and LTE in the post-Keynesian theory. See Kregel (1976) and Crocco (2008) for discussions on this topic.

²¹ According to Kregel (1976: 214), this model was used by Keynes for exposition purposes, aiming to highlight the possibility of equilibrium with unemployment even without disappointment of expectations.

²² For Kregel (1976: 215), Keynes used this model to highlight the role of effective demand in determining employment.

²³ Carvalho (1989: 189) seems to adopt the same position.

²⁴ According to Dequech (1999a) and Crocco (2003) (amongst others), the convention of projecting the present into the future is a way to deal with the uncertainty that pervades decision processes.

²⁵ Keynes does not explicitly distinguish the influence of *animal spirits* on LTE from its influence on confidence.

²⁶ Dequech (1999b: 424) does not use the term “social” in his analysis. He argues that “weight and confidence must be distinguished. Weight is linked to perceived uncertainty, while confidence depends also on uncertainty aversion”.

²⁷ “Most probably, of our decisions to do something positive, the full consequences of which will be drawn out over many days to come, can only be taken as a result of our *animal spirits* – of a spontaneous urge to action rather than inaction, and not as a outcome of a weighted average of quantitative benefits multiplied by quantitative probabilities” (Keynes, 1970: 161 – emphasis added).

differ. Dequech (1999b: 420) seems to associate spontaneous optimism with Keynes' concept of animal spirits, while he associates optimistic disposition (animal spirits redefined by him) with "confident optimism" (Dequech, 1999a: 73).²⁸ However, since optimistic disposition cannot be at the same time a determinant of confidence and confidence itself, this paper avoids to separate spontaneous optimism from optimistic disposition and does not interpret optimistic disposition as "confident optimism". Instead, in this paper the term animal spirits is associated with optimistic disposition only to stress that agents can have different *degrees* of optimism (or disposition to act).

Knowledge, in turn, can be divided into: (i) codified knowledge and (ii) tacit knowledge.²⁹ The post-Keynesian approach, in turn, places greater emphasis on the importance of tacit knowledge (e.g. learning-by-doing) in building confidence and the state of LTE.

Knowledge not only influences uncertainty perception, but it also affects LTE through *conventions*, which are informal (tacit) institutions. Hodgson (2006: 2) defines institutions as "the system of established and prevalent social rules that structure social interactions". Two aspects of this definition must be stressed: (i) that institutions are *enduring*³⁰ and (ii) that institutions are *social* rules. Regarding the durability of conventions, it is interesting to note that although they provide some stability to the system (Keynes, 1970: 152), they also hinder transformations.³¹ In relation to the social aspect of the conventions, Crocco (2003: 180) emphasizes that the existence of conventions presupposes a "social knowledge" about the conventions.³² According to Crocco (2003: 181), however, in a situation of collective uncertainty, social knowledge is poor, so that it is only possible to know the *likely* course of action of agents. Social knowledge, therefore, becomes uncertain (probable).³³ Two important implications follow from this analysis. First, although conventional behaviour helps guiding decisions, it does not eliminate the uncertainty inherent to forward-looking decisions. Second, conventions are directly related to the level of social knowledge.³⁴

According to Dequech (1999a, 2000), in addition to knowledge and optimistic disposition, creativity influences the formation of LTE as well. He defines creativity as "the mental creation of aspects of the future that are radically different from the present" (Dequech, 1999a: 73).

For Dequech (1999a: 73, 1999b: 418, 2000: 160), therefore, the state of LTE is ultimately determined by three factors: (i) knowledge; (ii) optimistic disposition; and (iii) creativity.

The relationships described in the paragraphs above are represented in Fig. 1. This figure shows that both optimistic disposition and knowledge exert a double impact on the *state* of LTE, since both influence the formation of LTE and the confidence in these expectations.

Thus, assuming the existence of different degrees of uncertainty, optimism (or optimistic disposition) and confidence, the *state* of LTE will vary with the degrees of optimism and confidence prevalent in the economy.³⁵ Consequently, the state of LTE can be either *strongly positive* (very confident positive LTE), *weakly positive* (not very confident positive LTE), *strongly negative* (very confident negative LTE), or *weakly negative* (not very confident negative LTE). Hence, strengthening this *state* of expectations is crucial to expand credit (by banks) and investments (by firms).

It is also important to note that from the society's perspective, the strength of this state is related to the degree of its generalization. In other words, the strength of this state is related to the *social* weight of argument (which derives from social knowledge) in favour of investments. Thus, strongly positive state of LTE is observed when, in the face of positive expectations, a large number of agents chooses to invest, indicating high confidence and optimism. A weakly positive state of LTE, in contrast, is observed when even in face of positive expectations little investment is made, indicating weak confidence and optimism.

²⁸ Dequech (1999b: 420) states also that "spontaneous optimism means optimism not based on any knowledge".

²⁹ Tacit knowledge is the knowledge that can only be obtained by practical experience and is hard to codify. See also Crocco (2003).

³⁰ See Crocco (2003) for a discussion of conventions in the post-Keynesian theory.

³¹ It is not the purpose of this paper to discuss the process of institutional change or the process of formation of conventions. In this regard, see Hodgson (1988, 2006) and North (1990). Although the understanding of the formation and change of institutions is of great importance to understand more clearly the process of decision-making, for the analysis presented in this paper it is enough to recognize the importance of knowledge in the conformation of conventions.

³² Crocco (2003) emphasizes the importance of social knowledge related to the rights and obligations related to each "position" in society (e.g. the position of the parent, of the postman, of the investor, etc.). Thus, "for a routine to be established, all actors affected by this routine must have a common understanding about the situation in which that specific routine applies" (Crocco, 2003: 181).

³³ It is important to recall that *probably* does not mean that all possible future states are known.

³⁴ Dequech (1999: 74) seems to share this view.

³⁵ Recall that although optimistic disposition influences confidence, the two are not the same.

The analysis of investment developed by Hirschman (1958) can contribute to better clarify the idea presented here. Hirschman (1958) distinguishes between two types of investments: (i) induced investment – driven by increases in demand or external economies caused by the implementation of previous investments and (ii) autonomous investment – investment decisions independent of demand pressures and external economies. According to the author, induced investment decisions are easier, given the reduced uncertainty that pervades them. Autonomous investment decisions, in turn, require greater *ability to invest*, which is used to assess the economic conditions and possibilities of investment success. The *ability to invest* corresponds to the tacit knowledge previously mentioned, being acquired through the practice of investment, i.e. through continued growth – *learn-by-doing* (Kaldor, 1966). Hence, this analysis emphasizes the importance of tacit knowledge in the post-Keynesian approach.

A strongly positive state of LTE can be identified when the response of induced investment to demand pressures is high, i.e. when a large number of agents are willing to invest under favourable circumstances (or lower uncertainty). The acquisition of greater ability to invest (tacit knowledge), in turn, contributes to raise the level of investment (both induced and autonomous), since it strengthens the state of LTE.

The analysis presented here, therefore, forms a circuit of cumulative causation (Myrdal, 1957) in which growth increases the ability to invest, which strengthens the *state* of LTE, which motivates further investment and growth.

Finally, it is important to connect the arguments outlined throughout this section with the arguments presented in the previous sections. Due to uncertainty, knowledge and optimism play central roles in investment decisions. Through their impacts on the state of LTE, these variables influence both the demand for investments by firms and the disposition of banks to provide the resources (finance) that make these investments possible. Therefore, in periods of greater uncertainty, as in the downward phase of the business cycle, both firms and banks have higher liquidity preference, which means less demand for illiquid assets – investment and credit, respectively. The opposite is observed in the upward phase, when positive expectations generate a prospect of continued growth and rising asset prices. In this scenario, greater optimism and confidence reduce the liquidity preference of firms and banks, motivating continuous increases in investment and credit, respectively.³⁶

3. The neo-Schumpeterian approach

Unlike the post-Keynesian theory, in which innovation is rarely addressed, in the neo-Schumpeterian tradition, innovation occupies a central place. In this approach, innovations are crucial to sustain economic growth, since they raise productivity, profitability and income.

In the neo-Schumpeterian theory, the creation and incorporation of technology depend on the economy's existing institutional arrangements.³⁷ This apparatus, called National Innovation System (NIS – Nelson, 1993; Lundvall, 1992), determines the incentives for innovation in each country.³⁸ The formation of this institutional setting, however, involves considerable efforts and costs (Gerschenkron, 1962; Lall, 1992; Jacobsson, 1993).³⁹

The neo-Schumpeterian approach stresses the different characteristics of NISs in developed and underdeveloped countries, arguing that the NISs in developed countries put greater emphasis on the *creation* of innovations, while in developing countries NISs are more focused on the *absorption* of innovations created in developed countries. This difference is explained by the fact that the costs of incorporating technology developed abroad are considerably lower than the costs of creating new technologies. Thus, developing countries can benefit from their technological backwardness by absorbing foreign technology (Posner, 1961). This process of technological diffusion from developed to underdeveloped countries is called technological *catch-up*.

³⁶ The existence of financial systems ends up magnifying cyclical fluctuations (Dow, 1986: 247). That is, the behaviour of banks, due to their optimistic or pessimistic expectations, makes financial cycles inevitable (Keynes, 1970, Chapter 12).

³⁷ The microeconomic analysis of innovation in the neo-Schumpeterian approach is not addressed in this paper. See Cimoli and Dosi (1995) for a discussion about this approach and its connection with the macroeconomic analysis presented here.

³⁸ This institutional setting is interpreted as encompassing both formal and informal institutions, as well as organizations. As Nelson (2008) argues, the traditional neo-Schumpeterian approach places more emphasis on the organizations that integrate the NIS – such as research institutes, universities, technology parks, amongst others.

³⁹ The decisions regarding the absorption or creation of innovations are also influenced by these costs. Analysing the case of South Korea, Jacobsson (1993) finds evidence that the effort (in terms of costs) required for the production of high-tech goods has grown considerably over the past decades.

Determinants of the state of long-term expectations

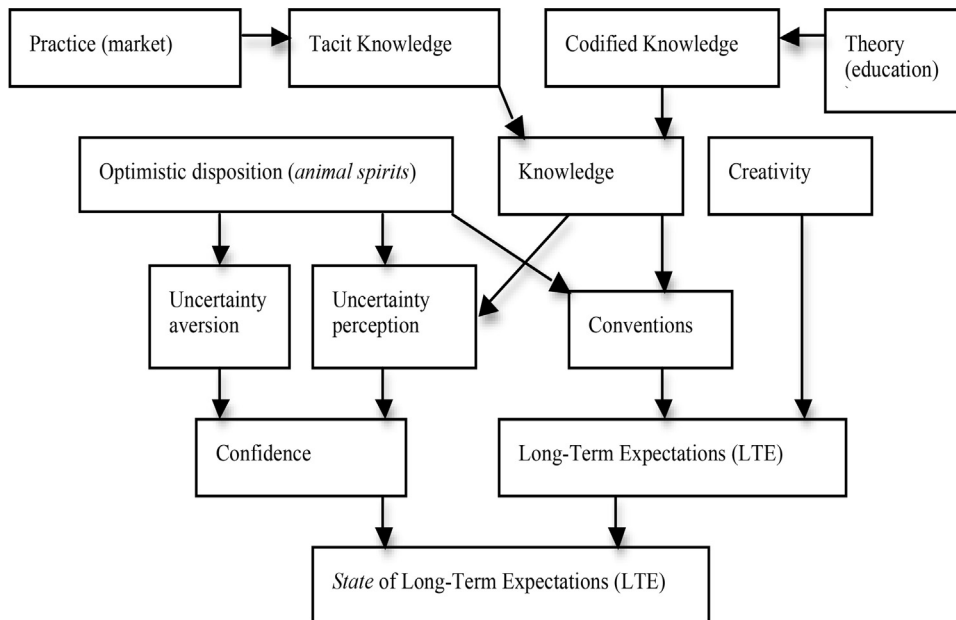


Fig. 1. Determinants of the state of long-term expectations.

Source: Author’s elaboration based on Dequech (1999b: 418).

However, the existence of costs related to technology absorption (albeit lower than the costs of creating new technology) can slow or even block the technological catch-up of developing countries. Abramovitz (1986: 388) was amongst the first authors to emphasize the importance of creating the right set of *capabilities* to carry out technological catch-up. He associates *capabilities* with factors related to human capital and institutions (market structures, governance, financial systems, linkages, etc.).⁴⁰ After him, however, many authors have emphasized the importance of building capabilities to speed up technological catch-up.⁴¹ Thus, since capabilities/skills are acquired through learning processes, it is possible to define *capacity* as the knowledge (practical and/or theoretical) required to perform a given task. Consequently, this approach stresses once again the importance of *knowledge* for growth. Thus, to stress the importance of acquiring capabilities to carry out technological catch-up is similar to say that to acquire advanced technical knowledge one must first acquire a certain level of basic knowledge. The acquisition of basic knowledge, therefore, characterizes a pre-catch-up phase (see Verspagen, 1991).⁴²

Albuquerque (1999) proposed a method to classify the level of development of each country’s NISs. He built an Opportunity Taking Indicator (OTI), calculated dividing the country’s share in world’s patents (granted by the USPTO), by the country’s share in world’s scientific articles (indexed by the ISI). The numerator is a *proxy* for technology production, and the denominator is a *proxy* for scientific production. Thus, indicators close to (or above) one indicate high capacity to transform scientific knowledge into technology/innovation, suggesting that the country possesses a mature NIS. By contrast, indicators below one indicate low capacity to transform scientific knowledge into technology/innovation, suggesting that the country possesses an immature NIS. Thus, it is argued that developing

⁴⁰ Since both the neo-Schumpeterian and the post-Keynesian theories consider that banks decisions of resource allocation are crucial for innovation, different arrangements of the financial system have distinct influences on the generation of innovations and on income growth (see Gerschenkron, 1962; Zysman, 1982; Christensen, 1992). Such arrangements, however, are considered part of each country’s NIS.

⁴¹ In the neo-Schumpeterian literature there are references to “technological capabilities” (Lall, 1992), “absorptive capacity” (Cohen and Levinthal, 1990), “learning capacity” (Verspagen, 1991) and to “social capacities” (Abramovitz, 1986). This paper, however, does not seek to develop a more thorough discussion of the differences between these terms, and adopts a general approach that stresses the importance of capabilities.

⁴² This paper does not seek to discuss what specific capabilities are necessary for catch-up. See Lall (1992).

countries with indicators associated with a mature NIS would be absorbing technology created abroad, i.e. performing technological catch-up.

Following the historical analysis of development processes proposed by Gerschenkron (1962), several studies linked to neo-Schumpeterian approach emphasize that a mature NIS can be composed of different institutional arrangements.⁴³ Freeman (1995) used the examples of Japan and USSR to highlight the impact of specific historical and institutional backgrounds on the configuration of each country's NIS. The author pointed out that although extremely high spending on R&D is observed in both countries, the former managed to develop a mature NIS, while the latter did not. According to Freeman (1995: 11–12), this shows that “simply to commit greater resources to R&D did not in itself guarantee successful innovation, diffusion and productivity gains”. For him, the fundamental difference between the two systems was the strong presence of internal R&D in Japan, as opposed to R&D developed in universities and research institutes in the USSR. Furthermore, it is noteworthy that in the USSR the incentive for innovation at the firm level was extremely low, making the productive incorporation of innovations generated in the institutes considerably difficult. Hence, despite the high spending on R&D, the USSR was unable to generate an institutional arrangement that enabled an efficient relationship between production units and research institutes.⁴⁴

Although the neo-Schumpeterian literature avoids proposing a general configuration for mature NISs, it is possible to identify in the neo-Schumpeterian literature some policies usually associated with the acquisition of the capabilities necessary for technological development. Abramovitz (1986), Lall (1992) and others, emphasize the importance of education and infrastructure, as well as broader macroeconomic and industrial policies. Lall (1992) and Nelson and Pack (1999) emphasize the importance of specific policies that aim to encourage exports. Moreover, these authors stress also the relevance of welfare policies that seek to reduce the conflicts that emerge due to the technological and productive transformations associated with the catch-up processes. Cohen and Levinthal (1990: 138), in turn, emphasize the importance of R&D expenditure, arguing that such expenses are fundamental not only to create innovations, but also to enable the absorption of foreign technology. Finally, reviewing the empirical studies related to the neo-Schumpeterian approach, Fagerberg (1994) indicates the importance of the effort (measured by investment, infrastructure, etc.) to acquire knowledge (measured by education, R&D, patents, etc.) in determining productivity growth.⁴⁵

Thus, it is noteworthy that although the neo-Schumpeterian approach emphasizes the importance of tacit knowledge (especially related to linkages and networks in the productive and innovative structures) for technological progress and income growth, considerable emphasis is placed on the importance of acquiring codified knowledge (e.g. education, science, and research) to enable technological progress.

4. Contributions to understanding the dynamics of innovation from a post-Keynesian perspective

As noted in Section 2, post-Keynesian theory emphasizes the importance of investment for economic growth. Technological progress, in turn, is rarely addressed in the works of Keynes, and its importance is considered only in terms of its influence on the profitability of investment (Crocco, 2008: 281). Hence, much of the post-Keynesian literature considers innovation a factor associated with capital accumulation due to its impact on expected returns. However, according to Crocco (2008: 282), post-Keynesian models generally “do not explain *how* technological opportunities are generated (...) and completely neglect the role of technical knowledge in the investment decision”. Although the Kaldorian tradition within post-Keynesian economics is an exception to this rule, the neo-Schumpeterian analysis on innovation discussed in the previous section can be combined with the post-Keynesian approach to help

⁴³ See Sharif (2006) for a discussion of the reasons for the flexibility of the concept of NIS within the neo-Schumpeterian tradition.

⁴⁴ Regarding Latin America (LA) and Asia, Freeman (1995: 13) argues that the fall in per capita GDP growth in LA in view of the continued growth of Asia is largely explained by the introduction of more radical social reforms in the Asian countries, such as land reform and universal (and improving) education. This argument indicates the importance of factors related to increased *capacity* for the formation of a mature NIS. According to Freeman (1995: 18), therefore, the intensification of globalization has not reduced the role of the state on promoting growth, but has instead increased the importance of states' actions related to design, implementation and support of NISs. Thus, while some authors argue that economic globalization (especially through multinational companies) has promoted technological diffusion and greater homogenization of technology across countries, Porter (1990) and Patel and Pavit (1991) emphasize that: (i) large firms develop most of their technological activity in their countries of origin and (ii) that technological activities are significantly influenced by the characteristics of the country of origin.

⁴⁵ The high correlation between variables, however, complicates the determination of the relevance of each one of them in the explanation of technological catch-up.

solving this important limitation. This section discusses the role of knowledge (tacit and codified) in investment decisions and innovation.

4.1. Determinants of private spending on R&D

This section introduces firms' decision to invest in R&D into Keynes' asset choice model discussed in Section 2.2. In the present analysis, innovations are considered a particular type of asset, which has in investment in R&D its primary cost. Following Freeman (1995) and Cohen and Levinthal (1990), however, it is crucial to note that although private spending on R&D is considered critical both to create and to absorb technology, such spending might not be sufficient to fulfil these goals.

In order to introduce innovations (or private spending on R&D) into the asset choice model, it is first necessary to analyse the general characteristics of this asset, given the attributes considered in the model. Note, however, that inventions only become innovations when they are introduced into production and/or commercialization. Furthermore, note also that the discussion presented in this paper places more attention on innovations related to product differentiation than on innovations related to improvements in production techniques and equipment.

Within the asset choice model, the main attribute of innovations is their high expected return ($q + a - c$) (Perez and Soete, 1988).⁴⁶ However, another important feature of innovations is the high uncertainty surrounding their performance in the market, which implies a very low liquidity premium, i.e. high (non-probabilistic) risk ($r = -l$). The high risk related to the introduction of innovations has two distinct sources. First, investment in R&D does not guarantee that innovations will be obtained. Second, the creation of an innovation does not guarantee that extraordinary profits will be obtained, since such profits still depend on the performance (demand) of the new product in the market. Thus, the absence of a pre-existing market to guide the decision to introduce an innovation makes it difficult to predict demand and product acceptance, while the possibility of emergence of competing innovations increases even more the uncertainty about the returns of each innovation (Dosi, 1982; Cimoli and Dosi, 1995).

4.2. Knowledge, confidence, conventions and innovations

As noted in the previous section, innovations are pervaded by high uncertainty, presenting small liquidity premium and large expected returns. Thus, it is crucial to analyse how expectations are formed to guide the decision to search for innovations (via absorption or creation of technology).⁴⁷ In other words, this section analyses the extent to which the post-Keynesian analysis of uncertainty and formation of expectations can contribute to better understand the decision to invest in R&D.

To analyse the process of formation of expectations related to the decision to pursue innovation, Crocco (2008) differentiates incremental and radical innovations. Following Dosi (1982), Crocco (2008) uses the definitions of technological trajectory (TT) and technological paradigm (TP) to define incremental and radical innovations. *Incremental innovations* are defined as innovations that follow a certain TT, while *radical innovations* are defined as innovations that change the TP, thus initiating a new TT. Seeking to transpose the analysis of innovation to the post-Keynesian approach to the formation of expectations, however, Crocco (2008) adds that incremental innovations are developed with the existing (fixed) capital stock, while radical innovations are developed with new capital stock.⁴⁸

According to Crocco (2008: 286), the process of formation of expectations related to the introduction of incremental innovations does not fit easily into the state of LTE or into STE. With respect to STE, while incremental innovations supposedly occur with a given stock of capital, the decision to introduce these innovations is associated with considerably higher degrees of uncertainty than the simple daily decision of how much to produce, since the impact of

⁴⁶ Intellectual property rights and patents seek to guarantee that inventors will extract the profits from their inventions, aiming to encourage the pursuit of innovations – although the absence of such mechanism does not necessarily mean that innovations are not economically attractive.

⁴⁷ Note that foreign technology can represent an innovation in the home market.

⁴⁸ Another possible scenario is the production of an existing good with the introduction of more advanced production technique. In this case, the firm is not creating an innovation, but incorporating an innovation (new capital good) developed in another country or in the capital goods sector. However, if some learning effort is required to operate the new capital good, then the costs associated with this effort can be included in the R&D expenditure and keep the same analysis applied to the *creation* of an innovation for the analysis of the *absorption* of innovations (despite the fact that the levels of expenses are different). This is the approach adopted throughout this paper.

these innovations extends by more than just one period of time. With respect to the state of LTE, the introduction of an incremental innovation is not associated with the same degree of uncertainty associated with the purchase of new capital goods neither, again due to the period of time involved in these decisions.

For Crocco (2008), the characteristics of incremental innovation require the introduction of medium-term expectations (MTE) in the original post-Keynesian analysis. “Medium-term expectations are concerned with a new product that is at the same time a development of the previous one. Holding everything else constant, this means that a firm can affect its own demand by launching a new product in the market” (Crocco, 2008: 287).⁴⁹ This stresses the existence of an element of continuity associated with the inherent change related to incremental innovations. This continuity, in turn, is derived from the fact that each incremental innovation is linked to a particular TT, which makes it slightly easier to form expectations about the market performance of the innovation (unless a change in the TP occurs – Crocco, 2008: 290). Tacit (practical) knowledge related to a particular technology and to market behaviour increases along the TT, increasing firms’ confidence due to the impact of tacit knowledge on uncertainty perception.⁵⁰ According to Crocco (2008: 292), in the case of continuous introduction of incremental innovations, the state of LTE becomes *partially* endogenous, depending to a large extent on firms’ past performance in the introduction of innovations related to a particular TT.⁵¹ However, the author points out that the introduction of innovations in Keynes’ analysis of the formation of expectations does not change the core of the post-Keynesian theory.

Regarding the formation of expectations about the introduction of radical innovations, Crocco (2008: 297) argues that this process is similar to the formation of expectations about investments in capital goods, which follow the state of LTE. Radical innovations, however, are associated with changes in the TP and with high degrees of uncertainty, so that projecting the current situation into the future does not seem to be a satisfactory form of dealing with the uncertainty involved in the process. Hence, the decision to introduce radical innovations seems to be more dependent on codified knowledge. The effect of codified knowledge into the formation of a strongly positive state of LTE works mainly through *confidence*. Due to the high degree of uncertainty about future returns, confidence in the firm’s prognostic becomes particularly relevant. Codified knowledge, in this case, is crucial to assess the viability of the innovation in solving the practical problem it is addressing. Furthermore, codified knowledge helps also with risk analysis by exploring the experiences of radical innovations observed in other firms/industries throughout history. The greater importance of codified knowledge for radical innovation does not mean tacit knowledge is not relevant. The accumulation of tacit knowledge is crucial for innovation, given the importance of this type of knowledge for any type of investment due to its relevance for understanding market movements (e.g. Hirschman, 1958; see also Raposo and Resende, 2012). Nonetheless, although tacit knowledge is always important (in view of past experiences of introducing radical innovations), it loses some space to codified knowledge in radical innovation due to its greater disassociation in relation to the existing market conditions and TT.

Finally, it is important to note that establishing a situation of constant introduction of innovations leads to the creation of a *convention to innovate*. With constant increases in the number of innovations, the expectation that other firms will innovate encourages firms to invest in the search for innovations (R&D), raising technological development and income growth. After some time, if innovations continue to be introduced, investment in R&D and the search for innovations become conventions.

⁴⁹ Although a fuller discussion of the relationship between supply and demand is not the purpose of this paper, it is crucial to note that a possible point of conflict between the post-Keynesian and the neo-Schumpeterian approaches is the importance that each of these theories attributes to demand and supply factors in determining growth. This is an issue that seems to still require further discussion. In this paper, as in others (e.g. Dosi, 1982; Cimoli and Dosi, 1995; Crocco et al., 2008), supply and demand interact with each other, and both influence decisions.

⁵⁰ According to Crocco (2008: 288), knowledge created through internal R&D can counteract the negative effect of disappointments.

⁵¹ Innovation dynamics in sectors producing capital goods follows the same logic, except for the fact that STE in this sector must follow the state of LTE of firms producing final goods using these goods capital (Crocco, 2008: 298). It should also be emphasized that although Keynes (1970, Chapter 11) call attention to the fact that the expected introduction of new and more productive capital goods (innovation) reduces the expected return of existing capital goods (marginal efficiency capital), the fact that knowledge accumulation influences the future performance of firms acts to offset this reduction in the expected return of the existing capital. In other words, the expectation that knowledge accumulation might influence future earnings, also the expectation that if this accumulation does not occur a competitor can obtain an advantage in the future (as a result of having accumulated such knowledge) counteracts the expectation that capital goods will be more efficient in the future than in the present. This effect, however, depends also on the current TT, since at the end of the each TT the benefits of knowledge accumulation are lower than at its beginning – see Crocco (2008: 298–299) for similar arguments.

As noted in Section 2.5, *conventions* influence the state of LTE through their impact on the formation of LTE, since they provide information about the likely actions of agents.⁵² Thus, when the introduction of innovations becomes widespread in the economy and a convention to innovate is established, it becomes common (tacit) knowledge that the market dynamic (competition) in this economy involves, to a large extent, the introduction of innovations. Consequently, while firms continue to take into account the risks and uncertainty involved in the search for innovations, the recognition (tacit knowledge) that innovations will arise and determine market performance results in the establishment of a general understanding that the search for innovations is a *conventional* activity. Thus, the existence of this convention to innovate influences firms' LTE. This brief explorative analysis emphasizes the importance of carrying out more careful and thorough studies on how institutions (among them conventions) are created, sustained and changed.

In the neo-Schumpeterian tradition, as discussed in Section 3, the conformation of this convention to innovate is associated with the maturity of the NIS. According to Dosi (1982) and Crocco (2003), the direction of innovations, especially in the case of radical innovations, is influenced by social knowledge, i.e. the social and institutional structures of each society.

In short, although both incremental and radical innovations depend on codified and tacit knowledge, it is argued here that the absorption/creation of incremental innovations depends to a greater extent on *tacit knowledge* (practical – related to the current TT) while the absorption/creation of radical innovations depends to a greater extent on *codified knowledge* (theoretical – related to the possibilities of the new TP). It is crucial to note, however, that investment and innovation feed back into the state of LTE through increases in tacit knowledge, which stresses the relevance of this type of knowledge for technological progress and income growth.

5. Concluding remarks

This paper stressed how the post-Keynesian theory, associated with the neo-Schumpeterian analysis of innovation, can contribute to improve the understanding of the factors that influence innovation. More specifically, the paper aimed to highlight the importance of knowledge, both tacit and codified, for the formation of a strongly positive *state* of LTE. This state, in turn, guides the decision to search for innovations and to invest in R&D. This impact takes place through two channels: (i) strengthening *confidence* in LTE and (ii) establishing a *convention to innovate*.

Firstly, although post-Keynesian theory puts more emphasis on the importance of tacit knowledge and neo-Schumpeterian theory puts more emphasis on the relevance of codified knowledge, it was argued that both types of knowledge are important in strengthening the *state* of LTE. In particular, given the higher degree of uncertainty associated with radical innovations, it was argued that such innovations are more dependent on the accumulation of codified knowledge, while incremental innovations (inserted into an existing TT) are more dependent on tacit knowledge about the current market conditions and TT.

Secondly, it was also argued that the accumulation of knowledge collaborates to establish a situation of constant introduction of innovations, which contributes to create a *convention to innovate*. The (tacit) knowledge that other firms are constantly seeking innovations and that innovations determine market performance leads to the establishment of this convention in economies where innovations are constantly introduced, in spite of the high degree of uncertainty inherently associated with innovation. In both post-Keynesian and neo-Schumpeterian theories, following conventional behaviour is a form of dealing with uncertainty. The convention to innovate, which can also be understood as the formation of an innovative culture, motivates private spending in R&D by increasing agents' expectations about what determines market performance.

The paper stressed, therefore, that the conformation of a mature NIS impacts the state of LTE through its impact on knowledge accumulation, which provides an important incentive for investment and innovation.

The investigation carried out in this paper, however, provides only an initial analysis of some determinants of the decision to innovate that have not yet been adequately explored. Considerable work is still necessary to identify all the factors involved in this decision, to determine the channels through which these factors operate, and to clearly understand the relative importance of each factor.

⁵² Transposing this logic to the analysis of innovation, Crocco (2003) stressed that social probable knowledge rises along the TT, increasing the social weight of argument, which then increases agents' confidence. Gradually, therefore, the use of a particular technology becomes a convention (Crocco, 2003: 188).

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