Uncertainty, expectations and investment in technological change in Keynesian and neo-Schumpeterian approach: a theoretical model of analytical compatibility

Methodology and History of Economic Thought

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Resumo

Este artigo analisa como elementos da teoria keynesiana e evolucionária – incerteza, investimento e a formação de expectativas – demonstram-se relevantes no processo decisório orientado à mudança teológica das firmas. Emprega-se o método epistemiológico para articular a noção de temporalidade das expectativas e decisões de investimentos em mudança tecnológica presente nas duas abordagens teóricas. Dentre os resultados, destaca-se que a emergência de um novo paradigma tecnológico altera a eficiência marginal do capital previamente mobilizado, visto que as inovações radicais alteram às quase-renda vinculadas aos rendimentos prospectivos dos bens de capital. Logo, as decisões de investimentos relativas a inovações radicais (longo prazo) demonstram-se mais suscetíveis à incerteza do que as decisões de investimentos em inovações incrementais (curto prazo), dado o processo de aprendizado.

Palavras-chave: Teoria keynesiana. Teoria evolucionária. Expectativas. Incerteza. Inovação.
Código JEL: B2. B5. B22. B52. E12.

Abstract

This article analyzes how elements of Keynesian and evolutionary theory - uncertainty, investment and the formation of expectations - are articulated in the decision-making process oriented to the theological change of firms. Used was the epistemological method for to examin of temporality of expectations and investment decisions in technological change present at these theoretical approaches. Among the results, it stands out that the emergence if a of new technological paradigm changes marginal efficiency of capital that was initially invested. This because, radical innovations alter the "quasi-rent" of monetary gains derived from the use of capital goods. Therefore, investment decisions in radical innovations (long term) show more susceptibility to uncertainty than investment decisions in incremental innovations (short term).

Keywords: Keynesian theory. Evolutionary theory. Expectations. Uncertainty. Innovation.
JEL Code: B2. B5. B22. B52. E12.

1 Introduction

Markets are at the heart of economic activity and many of the central issues of the economy are associated with their modus operandi. Its configuration establishes some of the most important variables for directing the decisions made by agents in the economic system. There is, however, a set of decisions that are based on future expectations. This is because the trade offs faced by individuals require a comparison of the "cost-benefit" of different decision-making courses, which are not always immediately explained by the information and variables produced in the markets.

The uncertainty about the implications for the decisions of individual agents in the economic system is intertemporal - not only because the production process requires time, but, above all, because investment in capital goods reflects future consumption needs. In this perspective, Keynesian theory emphasizes the role of uncertainty in determining the level of investment, which in turn determines the levels of employment, production and income in the economy. In contrast, the evolutionary approach of the Schumpeterian and neo-Schumpeterian tradition emphasizes innovation as an inexorable aspect to the expansion of the productive system and, therefore, of the level of employment and income.

In the General Theory of Employment, Interest and Currency (hereinafter TG), Keynes (1996) is concerned with the functioning of a monetary economy and makes explicit the thesis that money does not consist of a neutral element and, consequently, the variation in their respective stocks affects the real behavior of the economic system. For this reason, it advocates that spending on technology, that is, on capital goods, is motivated by the expectation of obtaining income during the useful life of the asset, provided that the expectations of such income are higher (or equal) to the

expected return for monetary income provided by the financial system, according to the current interest rate. In short, TG allows us to consider that the technological change associated with the expansion of the income margin on the additional cost of producing a capital good determines, together with the interest rate, the level of investment and, therefore, the level of aggregate production.

In turn, Schumpeter's theory of economic development (1997) treats technological change as an endogenous factor to the economic system, autonomous and fundamental to capitalist dynamics. Based on this premise, neo-Schumpeterian economists of neo-Schumpeterian tradition, in rejection of the hypothesis of neoclassical maximization, argued that decisions on the level of investment are fostered by the innovative strategies that agents take on the market, given the imbalances present in the economy. . This conception supports the central argument of the evolutionary approach that "long-term and progressive change processes" are the determining elements of economic decisions, which, when known and articulated, generate the impulses responsible for the development of economic activity (NELSON; WINTER , 2005, p. 26). This approach is somewhat similar to the Keynesian premise of expectations, as it considers that uncertainty plays a fundamental role in driving technological change. According to Freeman and Soete (1997), there are three types of uncertainty that affect the innovative effort: business, technical and market. This set of uncertainties interferes in the decisions of the firms, as they restrict the confidence of the entrepreneurs about the expected return of the innovative process.

In this context, an articulation between the Keynesian and (neo) Schumpeterian approaches can be proposed, since the technological trajectory problematized by the (neo) Schumpeterian current can affect a vital element in the Keynesian theory - investment. In view of these aspects, the question arises: how does uncertainty and expectations affect firms' innovative efforts in Keynesian and neo-Schumpeterian thinking? To deal with this issue, this article aims to analyze the epistemological relationship between Keynesian and neo-Schumpeterian semantics of uncertainty, expectation and innovative effort. Specifically, we seek to compare the notion of innovative effort under conditions of uncertainty from the epistemology linked to the binomial probability-weight of the argument, expectation-state of trust and search-routine-selection. To achieve this objective, a philosophical-methodological analysis of the notion of knowledge linked to uncertainty and expectation is carried out, in order to establish a synchronic synthesis of the argument probability-weight binomials and expectations-state of trust present in the work of Keynes (1921 and 1996).

In the sequence, a similar analysis is elaborated for the notion of uncertainty and expectation of the innovative effort dealt with by neo-Schumpeterian authors of neo-Schumpeterian tradition, to finally demarcate the anthological aspects converging between these two aspects of economic thought, to show how uncertainty and expectations are related to the technological direction of the innovative effort in the short and long term. The epistemological approach has been used in several studies that seek to link economic theory to structures and conceptual paradigms from different theoretical perspectives (Dow, 1995; Dunn, 2018; Heesen and van der Kolk, 2016; Helzner, 2013; Jones, 2011; Kelly , 2003). Epistemology combines the common core of theories (Colin-Jaeger and Delcey, 2020), that is, the semantic and ontological object theorized in the different theoretical fields investigated, which implies the synchronous understanding of the meaning advocated by the author (s) previously selected. Thus, the use of the epistemological method allows to interpret the meaning of a meaning contained in a theoretical-conceptual model from the general principles and laws of another scientific structure or current. In this sense, the proposed analysis will take place on two levels: a) semantic, which deals with the meaning of uncertainty in Keynes (1921 and 1996) and in neo-Schumpeterian authors; and, b) ontological, alluding to the relationship of these meanings with the propensity and direction of the innovative effort.

Although innovation is rarely addressed in works of Keynesian inspiration (Romero, 2014), it is possible to identify in the economic literature some articulations between Keynesian theory and the neo-Schumpeterian evolutionary approach, under different approaches. Dosi and Orsenigo (1988) investigated the innovative process of productive-based monetary economies based on the conjunction between these two theoretical strands. In this perspective, Vercelli (1991) sought to present the complementarity between the concept of Keynes given to the monetary economy of production and the concept of economic system formulated by Schumpeter, treating money as an active element in the innovation process experienced by market economies. Feijó (1993) sought to analyze business decisions based on expectations about prospective earnings and the level of internal savings and the conditions for financing investment

by debt.

Crocco (1999) analyzed the process of forming expectations for investments in innovation from the Keynesian approach. Romero (2014) addressed the determinants of innovation and technological change in the light of the optimism of the representative entrepreneur. Aidar and Terra (2017) analyzed the post-keynesied firm, highlighting that the firms' innovative effort is inexorably a process delineated by fundamental uncertainty. This article collaborates with the reported academic debate and its main contribution lies in the association between Keynesian and neo-Schumpeterian theories to explain how the semantic perspective of the notion of knowledge present in these currents is linked to the process of forming the expectations of the innovative effort entrepreneurs and the direction of technological change, under conditions of uncertainty.

To this end, the work is structured in five sections, including this introduction. In the second section, uncertainty, investment and the formation of expectations from the Keynesian perspective are discussed. Sequentially, the third section exposes the neo-Schumpeterian approach, with the aim of developing the role of technological change in the economic system. In turn, the fourth section discusses the articulation between the Keynesian and neo-Schumpeterian perspectives, with the scope of discussing the relationship between innovation and uncertainty, investments and short-term and long-term expectations. Finally, the fifth section summarizes the arguments outlined and outlines the final considerations.

2   Uncertainty, building expectations and investing in Keynes

This section performs an epistemological analysis of the concepts of uncertainty, expectation and investment present in Keynes's work (1921 and 1996), in order to establish a synchronic synthesis of the notion of knowledge intrinsic to the probability-weight binomial of the argument expressed in the Treaty on Probability (hereinafter TP) and expectation-state of confidence presented in TG. In this stage of the article, the discussion focuses only on the semantic aspect and, therefore, does not anticipate any inference regarding the relationship between uncertainty, expectation, investment and technological change, which will be dealt with more specifically in the fourth section, regarding the ontological approximation.

According to Ferrari Filho and Conceição (2001), uncertainty is the fundamental element of the Keynesian approach. Keynes's main contribution in this regard was developed in his Treatise on Probability (hereinafter referred to as TP), in which Keynes (1921) attributes the uncertainty to the fact of the occurrence of investment fluctuations and preference for liquidity. His argument postulates that, by nature, individuals have a degree of distrust in relation to the future, which is why they seek to preserve the stock of available currency, as a form of security in relation to the uncertainty that permeates their respective consumption and investment decisions.

In this sense, a coherent decision requires from individuals a reasoning based on previously known elements, capable of articulating their expectations with the probability of success of their choices, through logical comparisons. To this end, it rejected the classic assumption of uncertainty linked to risk, based on a well-defined probability distribution, in which economic agents would reach optimal decisions. Consequently, he developed a broader theory of probability and a less simplified analysis of the consequences of uncertainty on the economic system.

In the TP, Keynes (1921) treats probability as the degree of rational belief that individuals attribute to the different courses of decision. For a decision to be considered rational, it must be the "result of a reasoning process based on knowledge" (TERRA; GOUDARD, 2015, p. 4). This is because the probability represents the logical relationships established between a set of propositions (formulated hypotheses) and the conclusions drawn by the individuals. Thus, if the knowledge of a proposition justifies a degree of rational belief in a given conclusion, it is possible to state that there is a probability relationship between the proposition and the conclusion. Therefore, the probability is defined as a result of the evidence, that is, of the inductive knowledge. In general, human knowledge is often achieved inductively and, therefore, shares the characteristic uncertainty of any induction. Therefore, inductive reasoning uses evidence, that is, probable behaviors, capable of constant reproduction, capable of subsidizing the belief in systemic reproduction. In other words, any human decision is based on fundamental uncertainty and, therefore, it is based on some kind of exploratory knowledge. For Keynes (1921, p. 288) "pure induction can be usefully used to strengthen an

argument if, after a certain number of instances, the evidence is examined", determining a finite probability in favor of generalization, that is, rational belief.

For Keynes (1921), the impact of knowledge on rational belief will occur through the weight of the argument. Based on Vercelli (2010), it can be seen that the TP does not present a standardized concept about the term exposed in the work in three different definitions, but that, in general, aim to measure the degree of knowledge relevant to the probability. In the first definition, the weight of the argument is associated with the amount of relevant evidence to draw conclusions from the set of available propositions. In the second definition, the weight of the argument corresponds to a kind of balance between the absolute amounts of knowledge and ignorance relevant to the belief in the argument. Finally, the third definition refers to the degree of completeness of the evidence on which a given probability is based.

It can be said that the notion of weight of the argument places knowledge on the responsibility of establishing parameters for individual decisions. Therefore, the greater and better the knowledge about the evidence (weight of the argument), the less uncertain will be the conclusions that the agents will obtain from the preliminary propositions. In this case, as Keynes himself points out (1921), the probability can be reinforced and tends to increase towards certainty whenever the multiplication of the evidences verified in each instance enables inferences capable of strengthening the weight of the argument.

It is important to highlight, as pointed out by Vercelli (2010), Terra and Goudard (2015), that the notion of weight of the argument developed by Keynes is object of controversies in the economic literature. Even so, the notion raised in the TP is relevant to capture the role of knowledge in estimating the belief of the probabilities examined by individuals in the course of the decision-making process (Crocco, 2003). In this regard, knowledge can be classified into direct and indirect knowledge (KEYNES, 1921).

Direct knowledge is understood as the perception arising from the "experiences of individuals, which, in turn, involve (i) the use of the senses, (ii) the understanding of meanings and (iii) the perception of data derived from the facts" (FERRARI FILHO; TERRA, 2016, p. 79). It is the knowledge generated through mere observation, resulting in premises that are not always cohesive to reality. Because of this condition, according to Keynes (1921), even if direct knowledge results in true premises, it will always be limited, as it will rarely be able to present complete conjectures about the information captured in the observations made by individuals.

From direct knowledge, we move on to a kind of propositional knowledge. Thus, by means of "a mental process we are able to pass from the direct knowledge of things to a knowledge of propositions about the things about which we have feelings or understand the meaning (KEYNES, 1921, p. 25). In this regard, direct knowledge is linked to non-heuristic praxis in support of individual decisions.

Indirect knowledge, in turn, consists of the perception resulting from logical conditioning carried out by individuals from the premises intuitive by direct knowledge. Otherwise, it corresponds to logical conclusions, which have a high degree of belief and which are obtained by individuals through the experiences that form their direct knowledge. In this case, indirect knowledge develops from the arguments, that is, through the perception of the proposition's probability relation, which seeks to relate to the knowledge of other propositions (KEYNES, 1921). Semantic analysis makes it possible to differentiate between direct and indirect knowledge between rational belief based on learning and belief based on arguments, that is, heuristic praxis.

It is with this theoretical-conceptual background that Keynes (1921) elaborates the epistemological framework presented in the TP, in which he tried to present the process of apprehension of knowledge and conception of probability intrinsic to the decision-making process under conditions of uncertainty. Given the above, the argument of Dequech (1999a) is supported, that the uncertainty and the decision process correspond to fundamental elements in the theory of Keynes, being possible to observe a theoretical parallel in the use of the terms, both in TP, as in TG . In the first, uncertainty and the decision-making process are treated under the prism of the argument of probability-weight of the argument, whereas in TG the expectations-confidence state is emphasized. For Keynes (1996), in a productive-based monetary economy, expectations and decisions regarding the level of production and investment assume an essential role in determining employment and real income.

In a productive-based monetary economy, the demand for labor is sensitive to the pace of business production,

which, in turn, occurs based on the expectation that the monetary demand will be sufficient to absorb the volume produced. That said, it is defined that the level of balance of aggregate demand depends, ultimately, on the components of demand that are determined autonomously. Therefore, if the propensity to household consumption and investments by firms result in insufficient money demand to absorb aggregate production, the real level of employment will decrease until it is below the supply of labor potentially available at the real wage in force, so that the equilibrium real wage will be higher than the marginal disutility of the equilibrium employment level. Therefore, in an environment of fundamental uncertainties, the future profit of entrepreneurs and, therefore, the basis for current investments, cannot be reliably predicted from the existing market information, nor can they be endogenously determined according to the planned savings. On the contrary, investment expectations depended on exogenous expectations, which Keynes attributed to animal spirits, which makes D2 f f(N), either in the short term or in the long term, when the expectations of the entrepreneurs are adjusted.

This argument recognizes uncertainty as a prominent element for aggregate demand and the level of employment and, therefore, for economic growth:

In growth, with optimistic expectations of future profit, investments generate more jobs, a higher level of product and income and, therefore, a higher level of consumption and savings. In depression, pessimistic profit prospects generate profit frustration in the capital goods industry, fall in employment and income and, therefore, fall in consumption and savings levels (SILVA, 1996, p. 11, own translation).

In the fluctuations in the level of investment, driven by the expectations of entrepreneurs, the key lies in understanding the cyclical movements of capitalism. According to Keynes (1996, p. 71), "a simple change of expectation is capable, during the period in which it occurs, to cause an oscillation comparable to that of a cyclical movement". In this sense, in terms of economic policy, the postulates of Keynes (1996) suggest the creation of margins for price flexibility, through deregulation, dissemination of market information and removal of failures in business coordination, in addition to the promotion of global competition. with perfectly flexible spot exchange rates, so that it is possible to make business adjustments, almost simultaneously.

With this, Keynes (1996) places business investment as an essential element for capitalist dynamics, notably materialized in the form of a firm - the operational core of this investment, as highlighted by Aidar and Terra (2019). In TG, the definition of investment encompasses the "increase in capital equipment, whether it consists of fixed capital, working capital or net capital" (KEYNES, 1996, p. 93). In semantic terms, the Keynesian definition of investment is seen as the innovative effort operated by entrepreneurs, within the firm, expressed by the acquisition of capital goods with a view to expanding productive capacity and, therefore, profit. In this regard, the entrepreneur estimates the rate of return on his investment based on the projected level of expected profit, measured by direct knowledge of the behavior of market variables and the cost of expanding production capacity, given by the technological change made possible by the acquisition of new equipment. Thus, investment decisions are defined by the Marginal Efficiency of Capital, which allows the entrepreneur to intuit the "state of confidence" compatible with the expected returns.

For Keynes (1996), in any investment decision, the entrepreneur is compelled to consider three fundamental uncertainties - technical, managerial and market. This is because any investment in technological change comes up against production discontinuities caused by the cost of using the equipment purchased (technical uncertainty). In the same way, the direction of technological change should exert an influence on the wage rate at which it is expected to remunerate the worker involved with the new technology, which generates managerial uncertainties. In addition, the future value of the expected series of yields for the new production technology will depend on market demand, subject to the current income of consumers and the interest rate. Secondarily, the technological change undertaken will be influenced by the price and availability of inputs, aspects that, associated, characterize market uncertainties. Together, these uncertainties gravitate towards the entrepreneur's expectations in what can be called the firm's uncertainty zone, resulting in technological uncertainties.

According to the semantics envisioned in TG, entrepreneurs' expectations can be synthesized as the hope of income based on rational conclusions obtained by entrepreneurs, when they trigger their own direct knowledge (business perception, management practice, demand and competition, for example) for develop arguments (indirect knowledge) that support a state of trust.

In this regard, the confidence attributed to the projected investment should include variables that allow estimating the income from the acquired capital asset, such as: expected revenues, production costs, and, finally, the interest rate of the economy. These variables, according to Terra (2015), will guide the expectations of entrepreneurs, making investment unfavorable whenever revenue expectations are low and production costs are high and / or increasing, which can occur concurrently. In the case of high interest rates, productive investment will prove to be unfavorable in relation to financial investment, thus representing a disincentive to innovative business efforts. From the semantics of trust, it is possible to intuit two types of knowledge in the TG: managerial knowledge and market knowledge. By individual knowledge, managerial knowledge is understood as the accumulation of tacit learning, which can be improved by management techniques, but which comes, above all, from the entrepreneurial experience itself.

Market knowledge corresponds to awareness and understanding of information produced outside the firm's boundary, related to the capture of variables that reproduce the circular flow of income in the economy, from that produced by consumer units, as well as by production and government units. It is worth noting, however, that market knowledge is distinguished from the mere science of economic variables, as these only constitute knowledge when articulated, with logical implications.

Given the inability to process all market variables instantly, it is reasonable to assume that, therefore, businessmen's expectations will not always be fully met. Still, he, knowing the limitation of his predictions, hopes to be surprised in a favorable way (DILLARD, 1976), since in his animal spirit, the entrepreneur "seeks to convince himself that the main driving force of his activity lies in statements of its purpose "(KEYNES, 1936, p. 156). In this regard, Keynes defines two types of expectations, considering the temporal nature of the expected returns, which are: short-term (STE) and long-term (LTE) expectations. In STE, the entrepreneur turns to sales of production from existing capital goods. These expectations are considered based on the cost of production and revenue. Its main characteristic is the fact that the capital stock is considered constant, which is why the recent trajectory of earned results supports the entrepreneur's decisions.

In contrast, LTE are based on expected sales revenue when there is a variation in the structure of capital goods responsible for production, which is characterized as an investment expectation. According to Keynes (1996, p. 156), investment decisions from LTE are based, in part, on the current amount of capital goods, above all, on the degree of confidence "with which we make this prognosis - insofar as we ponder the likelihood that our best prognosis will turn out to be entirely false. If we expect big changes, but we are not sure (...), the degree of confidence will be weak ". For Carvalho (2015, p. 49) "LTE should be theoretically treated as exogenous because they can and certainly are, influenced by current conditions, but not determined by them".

Dequech (1999), Dequech (1999b), Romerlo (2014) and Crocco (2003) argue that the state of Keynesian LTE is determined by three essential factors, which are: (i) indirect knowledge; (ii) optimistic disposition; and, (iii) creativity. Because the Keynesian innovative effort is notably a long-term investment, driven by "fixed capital assets, that is, the industrial plant and equipment" (FEIJÓ, 1993), so that it is not possible to determine ex-ante their respective prospective yields. This causes the argument weight to be structured in a logical manner, in association with the expected behavior of each relevant variable to guide the decision. In this case, it is necessary to establish a longitudinal forecast for market prices (inputs and substitute products), technological depreciation (cost of use), current wages and interest rates. Given this prognosis, the entrepreneur will arbitrate his degree of confidence based on his level of optimism (animal spirit), that is, he will fix his LTE based on the balance between indirect knowledge (rational hypotheses) and ignorance (technological awareness). Thus, it is reasonable to admit that even with an unfavorable perspective, LTE can be positive, due to aversion to technological uncertainties (technical, managerial and market).

According to Dequech (1999b), creativity, in turn, corresponds to the rational and cognitive capacity that entrepreneurs use to conjecture aspects of the future that are radically different from the present, proving to be relevant in the formation of the degree of confidence attributed by entrepreneurs to future conditions of production provided technological change undertaken. Thus, it is understood that creativity plays a fundamental role in the entrepreneur's optimistic disposition. In this case, individual and market knowledge becomes vital, as the creative process of entrepreneurs allows to mobilize skills acquired throughout business activity, so that tacit and / or technical learning will also be used to lead their aversion to technological uncertainties. Ultimately, creativity is about the entrepreneurial
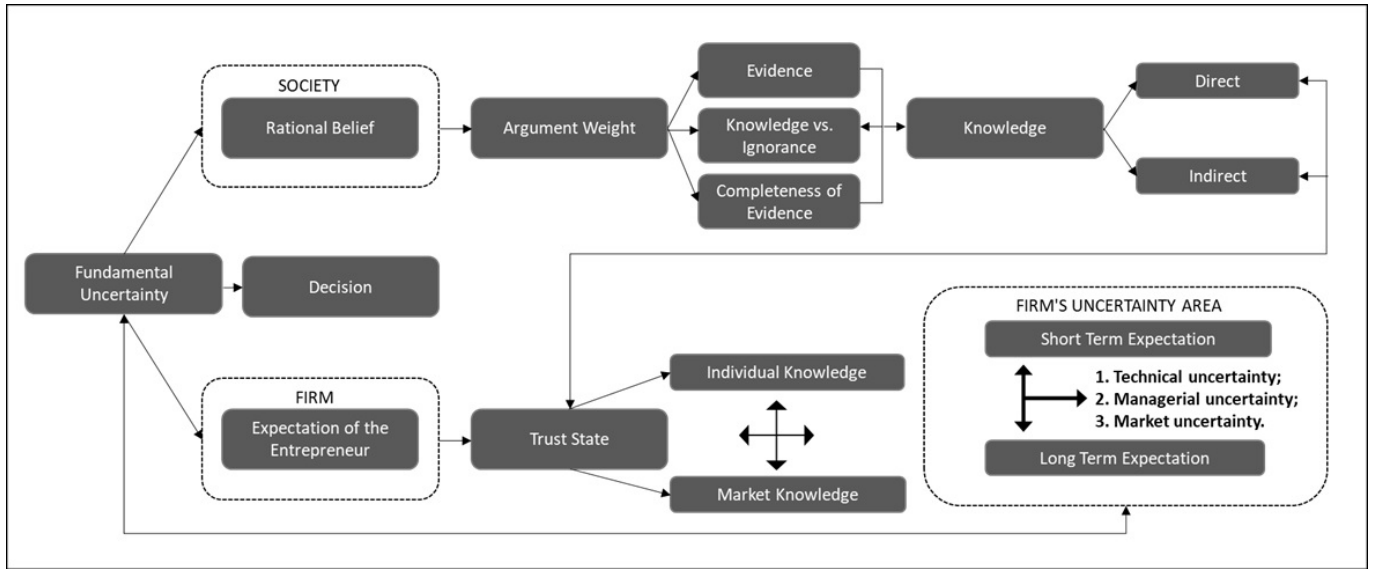
Figure 1: Synthesis and systemic representation of the Keynesian binomials of uncertainty

ability to invest and "interpret" the market.

Based on this discussion, it is possible to establish a synchronic synthesis and a systemic representation of the notion of knowledge linked to the Keynesian binomials "probability-weight of the argument" and "expectation-state of confidence". In general, it is possible to affirm that the individual, inevitably, will face an uncertainty of fundamental character in whatever the course of decision he may establish. Usually, individuals respond to this type of uncertainty in society through epistemological probability, which is based, essentially, on the rational belief of the weight of the argument based on empirical and subjective evidence. This evidence forms the epistemological basis of the decision-making process, that is, the set of knowledge that individuals use to guide the most varied types of decision. However, within the firm, the individual's main decision is denoted by the innovative effort required to expand the level of corporate profitability. For this reason, the individual, in the figure of the entrepreneur, will respond to uncertainty through expectations, given the state of confidence linked to the return that is expected to be obtained by the innovative effort undertaken.

In complete aversion to uncertainty, the entrepreneur may decide to keep the stock of technology constant, with financial investment as preferable, whenever the interest rate is more attractive. In a condition of optimism, the entrepreneur's response will be guided by individual and market knowledge, which will provide him with a temporal prognosis. Thus, the degree of the entrepreneurial innovative effort will be determined by the short and long term expectations linked to the Marginal Efficiency of Capital, in the face of what is called technological uncertainty, the result of expectations about the technique, the business and the market.

However, the view of the firm apprehended in this representation is strictly simplified, given that in real conditions the firm does not hold profit as a restricted objective (NELSON, 2006). In this way, the innovative effort goes beyond the investment in capital goods (AIDAR; TERRA, 2017, 2019; FEIJÓ, 2004; POSSAS, 2008), so that the set of uncertainties faced by the entrepreneur increases substantially. In a neo-Schumpeterian perspective, for example, the notion of technological uncertainty expands, altering the way in which the expectation formation process of entrepreneurs occurs. For this, it is necessary to understand the epistemology intrinsic to the semantics of uncertainty, expectation and innovative effort in a context where the decisions of firms are dynamic.

3 Technological change under the (neo) Schumpeterian approach

In this section, an analysis similar to the one carried out in the previous section is elaborated, with the purpose of capturing the epistemological perspective intrinsic to the trinomial routine-search-selection present in the neo-

Schumpeterian semantics of uncertainty, expectation and innovative effort. Therefore, the treatment given to the firm will receive an evolutionary dimension, based on the thesis that firms seek to achieve positive profits, but not necessarily maximum profits. This argument remotes the hypothesis of natural selection from evolutionary biology, initially approached to Economic Science by Alchian (1950) and Enke (1951) to explain the mechanisms of business competition, having replaced the neoclassical principle of optimization of the production and cost function by the evolutionary argument of prevalence, which they define as being the competitive strategies by which firms seek to remain in the market. Later, Friedman (1953) and Becker (1962) used the concept of natural selection to outline a critique of the firm's supposed profit-maximizing behavior, so that they moved the discussion of competitive behavior to a non-atomic context.

Despite this, the effective theoretical development of the evolutionary approach only occurs in the second half of the twentieth century, under two specific contributions. On the one hand, there is the work The Economics of Industrial Innovation, in which Freeman (1974) rescues the study of economic cycles developed by Schumpeter, using it to support his demonstration that technological change is at the heart of the movements cycles of the capitalist economy. On the other hand, drawing inspiration from the Darwinian theory of evolution, Nelson and Winter (2005), in 1982, proposed the incorporation of technological change into the analytical framework of the theory of the firm through the book An Evolutionary Theory of Economic Change, in which the authors they deal with the dynamics of business behavior under the Darwinian concepts of selection, adaptation and inheritance.

For Nelson and Winter (1977, p. 36), an innovation theory must explicitly incorporate the stochastic nature of innovation, in order to consider diversity and organizational complexity as preponderant elements for the innovative process. This is because "innovation involves uncertainty in a fundamental way". In the semantics of these authors, innovation consists of a social phenomenon and, therefore, not strictly economic. These are non-trivial changes in the product or production process without any precedence, involved in a continuous process of imbalance. Therefore, the innovative effort towards a substantial change in product or process involves a considerable degree of uncertainty, which subsides from the elaboration process that precedes the launch on the market, such as the period that follows. This is because the innovative development process allows unknown or even reactionary technological efforts to coexist with the change introduced in the market, a fact that sustains the persistence of imbalances in the productive and competitive process.

According to Possas (1988), the innovative effort of firms generates a direct impact on the way the market develops over time, due to the eminently dynamic character of innovation, which places uncertainty as a central aspect of the theory of neo-Schumpeterian innovation. The notion of uncertainty contained in Nelson and Winter (1977) is abstracted on two levels: individual, specific to the entrepreneur; and exploratory, at the firm level, related to the heuristic search for market solutions. This is because the innovative effort is not restricted to the expansion of productive capacity or the acquisition of capital goods that alter a production function that can be optimized, but encompasses a large set of projects capable of generating knowledge and learning.

Thus, as Simon (1987, p. 14) points out, "explaining [entrepreneur's] decision-making behavior in dynamic and complex circumstances that involve a great deal of uncertainty" requires more than optimization assumptions. Therefore, the effectiveness of the result of the entrepreneur's innovative effort will be determined by his ability to collect, systematize and understand useful information for the formulation of decision-making courses. However, in view of the limited rationality of the agents, it is impossible to predict, without restriction, the result of their innovative effort.

With regard to this aspect, the uncertainty of innovation can be defined as the indeterminacy of the result of the search for new technological trajectories, among the countless possible alternatives, where rationalization is used as a weighting criterion, responsible for: i) listing the possible decisions ; ii) estimate the consequences of each alternative investment in innovation, in the form of probability distribution; and, iii) the comparison of these alternatives through the sets of consequences that were attributed to them, based on pre-defined pay-offs (SIMON, 1978).

In this perspective, knowledge is an essential element for achieving the innovative effort. In semantic terms, knowledge refers to the systematic understanding of information, but it is shown to be incomplete and inaccurate, when it comes to distributions of future probabilities, given the individuals' cognitive limits. In view of this epistemological premise, inherent to Simon's model of rationality (1987), Nelson and Winter (1977) stated that a coherent decision

linked to the innovative effort requires businessmen based on an exploratory search process, given that the flow of innovations constantly changes the set of information in which entrepreneurs guide their decisions, which reinforces the complexity of their choices. This search process is expressed by a set of procedures to identify, track and locate promising ways of sustaining the innovative effort, which provides a certain distribution of conditional probability of innovations (or characteristics of innovation), given the conditions of appropriability of knowledge faced inside the firm.

In this approach, Research Development (R&D) projects are relevant. Because they are a mechanism for systematizing information and expanding the stock of knowledge mobilized by the firm, both to subsidize the process of generating or modernizing the product and process, and to allow the management of business risks, in terms of cost, demand and competition. From R&D, firms develop a sequence of short and / or long-term routines for their different decisions, which can be dynamic or static, that is, resulting from new learning or invariant and associated with the capital stock.

According to Dosi (1988), the routines linked to R&D allow the apprehension of knowledge, which, in turn, contributes to the formation of positive expectations regarding the decision-making process of firms regarding the innovative effort, since they strengthen confidence in change technological innovation intended by the entrepreneur. From the semantics of routine, one can infer the existence of two particular types of knowledge: tacit and codified. In general, tacit knowledge refers to experience-based learning, generally associated with the firm's technological trajectory. It is knowledge based on short-term routines, with regard to productive activity. On the other hand, codified knowledge mobilizes a complex set of information, whether from an internal or external source, which is generally sophisticated and disruptive.

Neo-Schumpeterian economists point to the construction of this type of knowledge as essential for the development of technological paradigms, which defend to be made possible, to a large extent, by investments in R&D responsible for codifying knowledge, allowing it to be transmitted, manipulated, stored and reproduced. It is, therefore, the innovative effort, according to the neo-Schumpeterians, a set of competitive strategies in which the firm aims to achieve positive profits, such as: internal and external R&D, development engineering (DE), acquisition of external knowledge (technical consultancies) , for example), marketing, staff training and the usual effort to acquire machinery and equipment.

This process of knowledge apprehension in the form of an innovative effort converges to the notion of adaptation and genetic inheritance transposed to economic analysis, as it will determine the path necessary for the survival of firms. In this regard, it is understood that the search process and the systematization of routines contribute to mitigate the uncertainties of the innovative process, but do not completely eliminate them. This is because the results of R&D efforts depend on a later stage, which selects the innovations that will be disseminated, in line with the last phase of the psychic and economic creative process. According to Nelson and Winter (2005), the preferential locus of selection of innovations resulting from the firms' innovative effort occurs in the market, but it is also exercised by regulatory agencies and institutional standards, which condition the trajectory of the innovations disseminated by the firms. This includes consumer preferences, differentiation strategies from competitors and sectoral legislation.

The selection phase determines the pace of diffusion of innovation, which may follow the same technological regime (FREEMAN; SOETE, 1997), based on technical changes residing in a technological trajectory already selected and disseminated in the market (NELSON; Winter, 2005); or to promote radical changes, which result in ruptures and discontinuities in the technological paradigm in force in the selection environment (GIOVANNI; DOSI, 1988). Freeman and Soete (1997) fragment the concept of innovation, differentiating it into incremental and radical innovation. From this perspective, Dosi (1988) uses the definitions of technological paradigm and technological trajectory to demarcate these definitions. A technological paradigm consists of technological opportunities for the development of innovations and their forms of exploitation, while the technological trajectory represents the direction of innovation, in terms of similarities and regularities, determining the technological regime followed by technology in a technological paradigm.

In this regard, incremental innovations are defined as technological changes that follow a certain technological trajectory, that is, that maintains a model or the same pattern of solutions to technological problems applicable to the productive segment or economic activity in general. In turn, radical innovations correspond to the type of technological

change that breaks with the existing technological trajectories, inaugurating a new technological route and, therefore, a new paradigm (Giovanni Dosi, 1988; Freeman Soete, 1997; Nelson Winter, 2005). For Tigre (2014), an incremental innovation represents improvements or modifications in the technological framework, production techniques or usable capital goods. On the other hand, radical innovations correspond to discontinuous leaps in technology within a regime.

Dosi, Tyson and Zysman (1989) explain that the uncertainty that permeates investments in innovation occurs not only because of the selective nature of the markets, but mainly because the new technological trajectories do not have their consequences and adaptations determined in an anticipated context. In the competitive context, a new technological trajectory inserted in the market by a competitor can neutralize the firm's adaptive strategy, while its innovation can quickly become obsolete. According to Dosi (1988, p. 1227) "the success of future innovations depends, fundamentally, on the investment decisions taken (in the present) by all firms in the market, since they tend not to cooperate technologically". In this way, the uncertainty associated with technological change increases as the natural selection of markets leads rival firms to autonomous and distinct investment decisions. As a result of this process, there are consistent technical-economic asymmetries between firms, sectors, countries and even over time.Segundo Dosi (1988) essas diferenças setoriais em nível da firma explicitam-se em virtude do tipo de inovação – produto, processo, marketing ou organizacional.

Nelson (2006) adds that the main source of this difference is related to the degree of appropriability of knowledge, which results in the development of dynamic and organizational skills that make it possible to integrate the innovative effort into the different internal divisions of the firm. In this perspective, Malerba (1992) elaborates three fundamental propositions: a) learning is an expensive and endogenous process to the different internal divisions of the firm (production, engineering, R&D, finance and marketing); b) learning is linked to different sources of knowledge, internal or external; and, finally, c) learning is a cumulative process, which tends to increase the stock of dynamic capacities.

In this regard, Dosi, Fagiolo and Roventini (2010) emphasize that the technological framework of the firms is heterogeneous, which leads to different investment decisions. This is because the level of investment directed at the capital stock and technological change correspond to an adaptive strategy, through which firms seek to preserve themselves in the market. Consequently, the technological change resulting from adaptive strategies focused on investments in capital stock has discontinuities over time, reflecting instability in the economic system, alternating periods of crisis and growth. According to Baptista (1997), the neo-Schumpeterian-inspired evolutionary approach postulates that adaptive strategies impose on firms a set of complex decisions whenever they trigger investments oriented to their installed capacity or to a new technological trajectory.

In addition, firms are immersed in specific sectoral contexts, which operate as strong constraints on innovative activity. Therefore, it is reasonable for a firm not to promote innovation in all possible specific directions. This is because the different branches of industry have their own technological dynamics, determined by different competition patterns and heterogeneous conditions of technical resources and specialized knowledge, in addition to different R&D and DE structures. The authors Winter (1984), Cohen and Levinthal (1989) and Malerba and Orsenigo (1997) sought, in some way, to address the importance of specificities in the knowledge base of firms for the emergence of these technological regimes and industry standards. Initially, Winter (1984) states that the two Schumpeterian views of innovation - creative destruction (SCHUMPETER, 1997) and creative accumulation (SCHUMPETER, 2016) - can be associated with different technological regimes. Under the perspective of rupture and discontinuity, the industry tends to harbor a range of radical innovations, largely promoted by incoming firms, given the absence of significant barriers to the entry of new firms imposed by the technological regime in force. However, from the perspective of continuity of cumulativeness, the industry tends to configure itself based on innumerable intrasectoral technological standards, since the process of differentiating products and processes inherent to the generation of incremental innovations has intensified the competitive behavior of firms.

In neo-Schumpeterian literature, the development of sectoral taxonomies is employed in order to capture regularities and specificities of innovation in economic sectors. A pioneering taxonomy to aggregate sectors according to their innovative characteristics was developed by Pavitt (1984), in which he classifies firms into four groups: a) sectors dominated by suppliers, whose innovation comes from suppliers of capital goods and have technological trajectories defined by reduction of costs; b) sectors dominated by the scale, which internalize most of the technologies used in
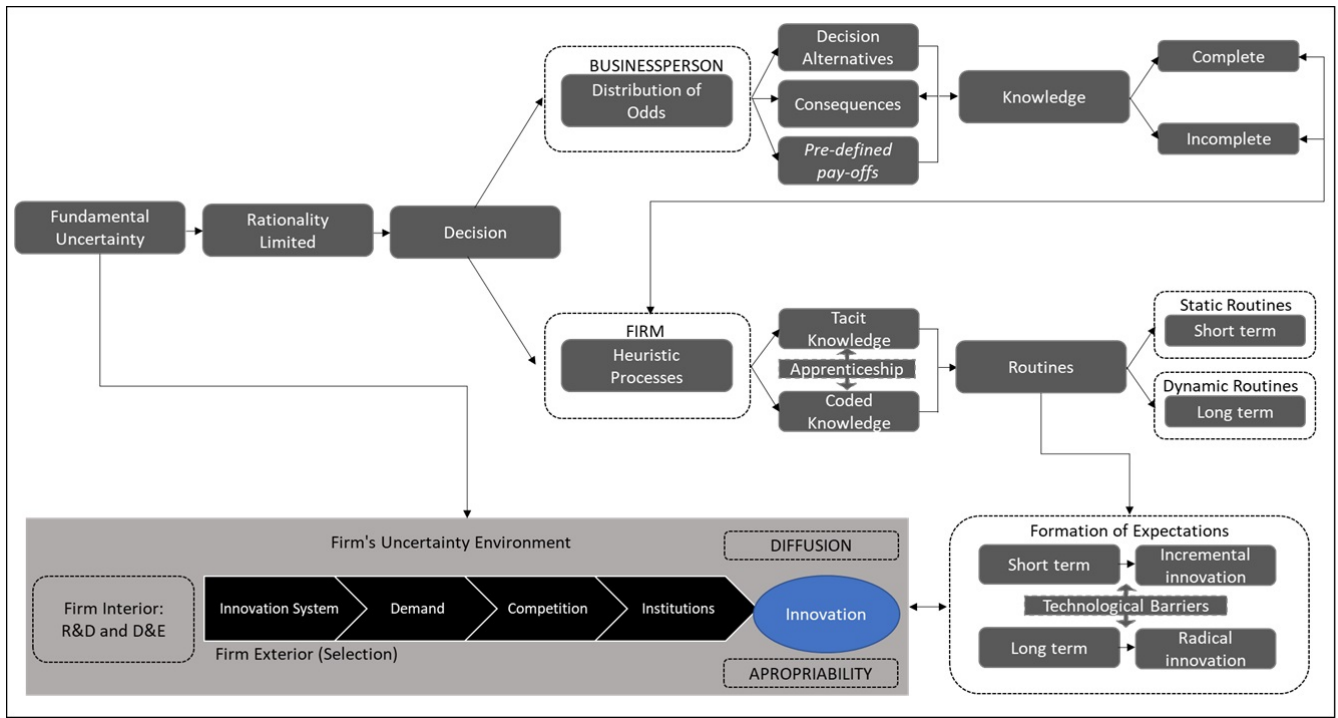
Figure 2: Synthesis and systemic representation of Neoschumpeterian uncertainty

the production process; c) science-based sectors, whose innovation is essentially due to R&D, with a high degree of appropriateness; and, d) specialized supplier sectors, responsible for transmitting technology to other industrial activities, in the form of technological design. Inherent in this context, Kupfer (1992) asserts that the decision-making process related to adaptive strategies focused on technological investments depends, primarily, on the expectations of entrepreneurs regarding the sectoral trajectory of innovation.

Therefore, the greater and more drastic the innovation, the greater the entrepreneur's uncertainty regarding the investment returns employed. In an environment of expressive technological change, "the amount of investments to be made and the returns provided becomes virtually unpredictable, regardless of the state of confidence" of the entrepreneurs (KUPFER, 1992, p. 11). According to Romero (2014), the high uncertainty related to investments in technological change has two distinct, but complementary sources. Firstly, it is emphasized that investment in technological change does not guarantee that the innovations necessary to increase competitive advantages in the face of natural market selection are effectively achieved. Furthermore, the creation of an innovation derived from the innovative effort does not guarantee the realization of extraordinary profits, since they depend on the performance of the product in the market, in terms of demand. Thus, the absence of a pre-existing market that is capable of guiding the technological investment decision makes it difficult to predict the acceptance of the product by consumers. At the same time, expectations of the emergence of competing innovations increase uncertainty, both in terms of monetary gains, as well as competitive and technological ones.

Given these theoretical elements, a synchronic synthesis and a systemic representation of the notion of knowledge linked to the search-routine-selection trinomial becomes feasible, portrayed from the innovative effort, under conditions of uncertainty (Figure 2). In a dynamic economy, in which the process of creative destruction (SCHUMPETER, 1997) promotes permanent flows of imbalance in the markets (NELSON; WINTER, 2005), the prevalence of firms (FRIEDMAN, 1953 and 1974) will be determined by their ability to bypass uncertainties associated with innovative efforts and technological competition. Given that the imbalances caused by the creative destruction process are cumulative and constant, the entrepreneur faces a fundamental uncertainty, so that the return on investment in innovation can never be guaranteed anticipated.

Under the neo-Schumpeterian perspective, fundamental uncertainty is associated with limited rationality, which imputes to individuals the inability to maximize their decisions based on the stock of available knowledge, so that

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they cannot infer an optimal decision-making course from the known parameters. Within the scope of the innovative process, individuals respond to this type of uncertainty through two decision-making nuclei - probabilistic and heuristic. In the probabilistic nucleus, the individual, in the figure of the entrepreneur, fixes his decisions based on a probability distribution, conditioned to a series of decision alternatives, which bind to him a series of consequences (expected return and positive implications and / or negative). The more complete the information on these consequences, the better the condition for rationalizing individual decisions, that is, the greater the likelihood of satisfaction. That is, the entrepreneur will take a decision, the reward of which will be closer to what was expected.

Therefore, it is information that forms the epistemological basis of the neo-Schumpeterian entrepreneur's decision-making process, that is, the set of knowledge that individuals use to rank their decision alternatives. In a perspective endogenous to the entrepreneur, the knowledge may be complete, so that it is possible to absorb the totality of information necessary to establish the level of the innovative effort. Thus, it is reasonable to assume that all information concerning your own investment capacity will be known. However, the inability of the entrepreneur to map and explore the full range of available alternatives, as well as their respective consequences, exposes him to procedural uncertainty, which results in an incomplete stock of knowledge. In this sense, the decision process moves to the heuristic nucleus, inside the firm, by which entrepreneurs seek to mitigate procedural uncertainty, bypassing the risks inherent in the innovative process, both in terms of cost, as well as scientific development, adequacy technical and production mechanisms.

The search process is based on an epistemological basis consisting of internal and external learning processes, arising from the productive process (learning by doing), the use of capital goods (learning by using), the absorption of developments generated by the (inter) national science and technology system, imitation or incorporation of technologies and intersectoral processes, internal R&D or cooperation with other actors in the innovation system, such as suppliers and customers. Based on these learning processes, entrepreneurs use the tacit and coded knowledge generated within the firm to establish routines compatible with the rewards defined through the distribution of conditional probabilities. Thus, short- and long-term expectations are established, associated, respectively, with the type of innovation - incremental or radical. Expectations will be positive, as far as the knowledge base and the learned processes allow to overcome technological barriers.

The expectations formation process of the firm takes place within an environment of fundamental uncertainty, composed of the R&D and D&E departments - within the firm - and the selection environment, outside the firm. In this case, the expectations of the innovative effort are formed on the probability that the research activities will provide technical and economic elements for the implementation of innovations. However, the effectiveness of these innovations depends on several selection mechanisms. This is because during the research process internal to the firm, it is possible for new technologies to coexist or changes in the technological trajectory in which the firm operates. Allied to this, sectorial constraints can substantially alter the specificities of the technological regime of the sector in which the firm is inserted, and, in an extreme condition, may render the results of the internal innovative effort obsolete. Therefore, the more the firm's knowledge and learning base is aligned with the (inter) national innovation system, the greater the security of entrepreneurs to make investments in the innovative effort.

It is also important to highlight that firms 'expectations should be based on market heuristics, so that it is possible to match the innovative results of the innovative effort to the consumers' desires, since without adherence to demand, innovation is not effective in the market.

Furthermore, the technological dispute between the firms requires that expectations take into account the ability of rival firms to anticipate substitute technological solutions to the market. Finally, it is important to highlight the role that institutional rules and regulations play in the innovative efforts of firms, since, in certain sectors, authorization is required for certain innovations to be introduced in the market. In addition, the expectations of firms regarding the innovative effort must, ultimately, be based on the speed of diffusion of the proposed technology. This is because the occurrence of innovations only reverberates in an increase in the profit margin when there is no widespread diffusion of technological change or of the process of differentiation of goods. Because, when innovations spread rapidly, their impact on the market structure will only focus on reducing the firm's limit price margin. For this reason, firms that deal with uncertainty from a more complex epistemology, will promote greater appropriability of knowledge

through instruments of intellectual property, which allow the creation of sectorial technological barriers and, therefore, competitive advantages.

The epistemological representation of the relationship between uncertainty, expectation and innovative effort extracted from the neo-Schumpeterian approach is shown to be broader, when compared with the representation apprehended in Keynesian semantics. Nevertheless, it is based on a microevolutionary view of the decision-making process, so that it neglects the financial sector as an outlining element of the innovative effort (DABIC; CVIJANOVIC; LOUREIRO-GONZÁLES, 2011). According to Hodgson (1998), in a dynamic economy, uncertainty is not restricted to future events per se, but also about the opportunities available to entrepreneurs' goals. In this regard, as pointed out by Possas (2008, p. 68), it is relevant to incorporate "a more complex set of financial elements, including short-term investments and the respective rates of return, desired liquidity, retained earnings, interest rates on debts [. ..] "to outline how uncertainty and expectations affect firms' innovative efforts in the short and long term. Therefore, an ontological approach between these two approaches is necessary.

3.1   Theoretical proximity between Keynesian and evolutionary theory

This section seeks to highlight the anthological aspects about the semantics of uncertainty, expectation and innovative Keynesian and neo-Schumpeterian effort, so that it is possible to capture the similarities and dissimilarities between these approaches. From this demarcation, inferences are drawn about the role of the macro spectrum in the conditions of the entrepreneurial innovative effort, under conditions of uncertainty and asymmetry.

In Keynesian theory, technological change is treated as an exogenous factor to the economic system, unlike the emphasis given by the neo-Schumpeterian approach, in which technological change corresponds to an inexorable and endogenous element to the capitalist system itself. For this reason, neo-Schumpeterian economists consider technological change as a business opportunity, operationalized by firms as a way to increase revenues and, simultaneously, as a competitive strategy for adaptation and survival in the market. This understanding highlights the main distinction between the two theories regarding innovative effort, since neo-Schumpeterians consider that technological knowledge is asymmetrical, not being available to firms in the same proportion, an aspect not considered by Keynes, even when addressed the topic indirectly in Chapter 11 of the TG.

From this distinction, however, it is possible to observe similarities between the two approaches. This is because both Keynes (1936) and the neo-Schumpeterians interpret technological change as an investment opportunity, materialized in the form of an innovative effort. At TG, investments in capital goods - considered by the neo-Schumpeterians as the main technological framework of firms - may increase revenues, while contributing to the reduction of production costs, thus enhancing the marginal efficiency of capital. employed in the activity. It is inferred, therefore, that the Keynesian innovative effort is stimulated by effective gains in production yields. In turn, the neo-Schumpeterian approach treats technological change as a reflection of the adaptive strategies of firms, which are based on investments aimed at the development of new products, production or marketing methods, which are derived from the absorption of technological opportunities. inherent to the technological development trajectory in force in the market.

For neo-Schumpeterian economists, the modernization of capital stocks not only expands the entrepreneur's prospective earnings, that is, "the series of quasi-annuity annuities that is expected to be obtained from the sale of production arising from the allocation of capital goods during its useful life ", as postulated by Keynes (1996, p. 120), but inaugurates other possibilities of income, due to the alteration of technological trajectories, or even the establishment of new consumption patterns, when innovations become so radical to the point of introducing new technological paradigms to the market (Crocco, 2003). However, it is important to highlight that in both theories, the incompleteness of the set of information available on the market, whether regarding the economic situation or the available technological knowledge, impose uncertainties on the result of his innovative effort, making it impossible to predict whether his expectations will be confirmed, however optimistic they may seem.

In this regard, there is a certain epistemological compatibility between the concepts of uncertainty, expectation and innovative Keynesian and neo-Schumpeterian effort. In terms of decisions related to technological change, the perennial uncertainty of both approaches assumes a fundamental character due to the limitation of knowledge, incomplete

Table 1: Trilateral comparison between tacit-coded, indirect-direct knowledge and technological change

INNOVATION		Knowledge		
	Incremental	Tacit	**Direct**	Latent
			It stems from (the entrepreneurs' experiences) Makes use of the senses (of the entrepreneurs) It is based on the perception (of the entrepreneurs) It develops in the short term	
	Radical	Encoded	**Indirect**	Logical
			Mobilizes complex information (market and firm) Logically structured Generates conclusions from the knowledge already acquired It develops in the long term	

according to Keynes (1926) and imprecise in the perspective of Nelson and Winter (1977 and 2005). In an ontological inference, it is understood that mitigating the uncertainty of the innovative process, whether from investment in capital goods or in R&D, requires a different understanding of the relevant logical relationships between the evidence surrounding the entrepreneur. In a similar ontological interpretation, the formation of expectations about the return on investment, that is, the innovative effort (acquisition of knowledge), will depend on the temporal reach of the information captured by the entrepreneurs. In this regard, the philosophical-methodological relationship between the degree of the result of the innovative effort - incremental or radical - will depend on the heuristic threshold and the weight of the argument (routines).

There are two essential elements that can be explored in the articulation between the concept of uncertainty inserted in the thought of Keynes and neo-Schumpeterian. As presented in the previous sections, the neo-Schumpeterian interpretation of the uncertainty regarding the confidence with which investments in technological change are made has two different sources. Firstly, it is highlighted that the entrepreneur is faced with a set of insufficient information to make predictions about the adequacy of the innovations intended to achieve competitive advantage in the competitive context, in addition to the fact of incompleteness and limited rationality. At the same time, the incompleteness of the information available to entrepreneurs makes it impossible to predict whether the additional production resulting from technological change will be accompanied by a demand that will make it possible to realize extraordinary profits. Comparing this source of uncertainty to Keynes's thought, there is a theoretical proximity to the concept of weight of the argument, proposed in the TP. As seen in section two, Keynes (1921) indicates that the weight of the argument is associated with the amount of relevant evidence to draw logical conclusions, or even consistent predictions. Therefore, the first source of uncertainty discussed by neo-Schumpeterians alludes to a problem of low weight of argument in the course of making investment decisions inherent to the innovative effort.

The second source of uncertainty related to the introduction of an innovation corresponds to the knowledge necessary to promote technological change. An incremental innovation and the emergence of new technological trajectories stems from pre-existing knowledge, while for the emergence of a new technological paradigm it comes from a completely new knowledge, originated by radical innovation. Thus, "the decision-making process related to the introduction of radical or incremental innovation will be different, depending on the role played by prior knowledge" mobilized by the entrepreneur (CROCCO, 2003, p. 511). Dosi, Fagiolo and Roventini (2010), for example, distinguish knowledge in tacit and codified. These terminologies fit the notion of direct and indirect knowledge by Keynes (1921), as shown in Chart 1. Source: Author.

In a simplified way, the comparison proposed in Chart 1 seeks to synthesize the similarities existing in the concepts of tacit and coded knowledge (of neo-Schumpeterian origin) and indirect and direct (derived from Keynes TP), relating them to technological change . The innovative effort undertaken by firms to promote less disruptive technological

changes, that is, product or process innovations based on technological improvement, requires a less complex heuristic, since the innovative process is based on knowledge already absorbed by the firm. An incremental innovation is based on a technological trajectory in which the firm already operates. Thus, the innovative effort depends on previous decisions or experiences made in the past (BURLAMAQUI; PROENÇA, 2009), so that uncertainty is aligned with path dependence.

In this regard, it is observed that incremental innovation is based on existing knowledge, which refers to the understanding of the firm as a locus of experimentation. Therefore, the mobilized knowledge derives, essentially, from the experiences of the entrepreneurs, who make use of the senses and the animal spirit to fix the weight of the argument of their decision alternatives. It is knowledge based on the skills and competences acquired by the firm through learning processes of less systematization (learning by doing and learning by using). Therefore, the decision heuristic uses evidence of low completeness to form the weight of the argument (Figure 1).

As these are innovations adhering to a technological trajectory already underway, the uncertainty of the innovative process tends to be reduced, with regard to the environment of uncertainty external to the firm (Figure 2), as it circumvents the mechanisms of selection attributed to the (inter)national innovation and/or institutional system, which reinforces the entrepreneur's confidence state. However, the uncertainties regarding the selection mechanisms attributed to the market are preserved, both in relation to consumers and in relation to competitors, since technological changes within the same trajectory are subject to simultaneous and continuous differentiation strategies by competitors. This aspect reinforces technological competition between firms, which seek to attract consumers through organizational and marketing innovations, in addition to the product.

Therefore, the innovative effort based on the continuous development of a technological trajectory provides the entrepreneur with information capable of subsidizing adaptations in the capital stock. This is because the accumulated experience will allow investment decisions to be based on a greater degree of confidence. Because in the short term, investment decisions in technological change are satisfied by the knowledge that the entrepreneur manages to mobilize about the technological trajectory, which, in general, imposes a short-term temporality for the expectations associated with incremental innovation.

On the other hand, radical innovations are characterized by a more disruptive innovative effort, responsible for breaking with the current technological trajectory in the sector, promoting a significant impact on the market structure, towards a change of technological paradigm. It is a technological change centered on the impact of innovations, as opposed to the perspective of "degree of incremental novelty". In this way, the learning heuristic of firms is based on complex knowledge, which surpasses "the cumulative discovery of pre-existing information" (Hodgson, 1998, p. 68). In this case, the decision-making process starts from a procedural uncertainty about the performance of the projected radical innovation and, therefore, is not based on mere estimates of subjective probability in the light of the known data.

Investment decisions of this nature depend on sophisticated cognitive structures, capable of articulating the entrepreneur's individual and market knowledge (Figure 1), through the conjunction of tacit and coded knowledge (Figure 2). Thus, entrepreneurs, through the firm, will structure investment alternatives based on routines, that is, logical decision structures. These logical decision structures helped to mitigate the technical, managerial and market uncertainties Keynes (1921 and 1996) related to the selection mechanisms external to the firm Nelson and Winter (1977 and 2005).

In summary, investments in radical innovations are shown to be more sensitive to entrepreneurs' LTE, since changes in the technological paradigm require more refined technological knowledge that, of course, will only be achieved through the continuous development of the technological trajectory, that is, constant innovation. incremental increase in the fixed capital stock and the increase in spillovers resulting from R&D. This is because incremental innovations are developed with the existing stock of fixed capital, while radical innovations can only be made possible with a new stock of capital, therefore, more investments in capital goods, training, marketing, engineering and knowledge acquisition. external coded. An alternative to LTE is the adoption of adaptive R&D strategies, with which entrepreneurs can expand the level of technological knowledge and, thus, minimize the risk of investing in radical innovations. The result of the R&D actions will provide evidence and parameters capable of increasing and / or improving the weight

of the argument on which the entrepreneur's LTE is based, when he seeks to migrate towards another technological paradigm.

In this regard, the neo-Schumpeterian authors emphasize the concept of technological entrepreneurship, which refers to the entrepreneur's willingness to direct investments towards the development of new technological paradigms, minimizing the uncertainties of radical innovations and subsidizing the creation of goods without close substitutes, but with a strong appeal to consumption (TIGRE, 2014). In comparison with Keynes' thinking, technological entrepreneurship can be associated with the animal spirit postulated in TG, in which the entrepreneur, even under strong uncertainty, directs investments in the introduction of a new technological paradigm in the market, hoping to increase his revenues, but, above all, to reduce the positioning of its competitors before its consumers. Finally, it is concluded that the uncertainties are insurmountable in the decision-making process, which may occur to a greater or lesser degree, due to the knowledge of the entrepreneurs. For this reason, investment decisions will always be guided by STE and LTE, in addition to the risk propensity that the "entrepreneurial spirit" is willing to take in the search for new technological trajectories or technological paradigms.

In summary, it is observed that the weight of the argument linked to incremental innovations and, consequently, to the adjustments in prices and production during the useful life of the investment materialized in an innovative effort, as well as the state of confidence linked to radical innovations, are demonstrated. sensitive to the marginal efficiency of capital. This is because investment will fluctuate to the point of the investment demand curve where the marginal efficiency of the innovative effort is equivalent to the market interest rate (KEYNES, 1996). In this sense, Aidar and Terra (2017, p. 33) emphasize that the volume of investment is given "by confronting the marginal efficiency of capital with the interest rate, [...] by which the entrepreneur will seek to measure opportunity costs between more liquid assets, remunerated by interest rates and the less liquid - of capital - expected [...] ".

Notwithstanding, even though the marginal efficiency of capital is higher than the return on assets remunerated at the current interest rate, another element is capable of affecting the investment decision linked to the entrepreneur's innovative effort - inflation. According to Feijó (1993a, p. 1278) a "permanent inflation with high rates, [...] has a deleterious effect on the functioning of the economy, as it increases the social conflict, causing a chain of reactions between the agents who wish to protect their incomes ", which includes the entrepreneur. In an inflationary scenario, expectations regarding the future value of the expected yield range for the new technology will not depend exclusively on market demand, but also on the relative costs of the technology absorbed by the firm in the form of innovative efforts. In this sense, the eventual gains resulting from technological change can be neutralized by inflationary shocks, incurring a reduction in the mark-up of firms (Eichner, 1985).

There are several relevant post-Keynesian contributions to explain the role of monetary dynamics and the financial system on innovation and, therefore, there is no intention to resume this debate (Christensen, 1992; Crocco, 1999; Crocco, 2008; Minscky, 1986; O 'Sullivan, 2005; Perez, 2020). The emphasis here is on the assertion that the financial system corresponds to a fifth selection mechanism, in addition to the innovation system, consumers and competitors (market) and institutions (rules and regulations). In view of the approach raised by Keynes (1996) about the capital formation process, as well as in the perspective of financing the innovative activity proposed by Schumpeter (1997), the monetary provision is a preponderant element for the achievement of investments in innovative efforts. According to (Carvalho, 1997, p. 471), the investment process begins with the supply of money to entrepreneurs. For this reason, the fate of firms depends on the monetary dynamics of the economy, as it is monetary policy that indicates the probable course of future interest rate dynamics.

Given that the effectiveness of an innovation, especially in radical terms, depends on the speed of technological diffusion, it is possible that the uncertainty regarding the future behavior of interest rates and inflation may interfere in the entrepreneur's confidence state. This is because the attractiveness of the innovative effort itself can prove to be harmless in the long run, after fluctuations in interest rates, which modify the marginal efficiency of capital. In addition, the behavior of the prices of the economy may affect the income of consumers, so that the aggregate demand does not adjust to the expected level, frustrating the expectation of additional gains with the adoption of a new technology. In this sense, when observing the flow of the uncertainty environment of the firm in figure in Figure 2, it is noted that the monetary dynamics will also influence the technological trajectory. This is because the financial

system itself "is an integral part of the national innovation system, since the financing arrangements are fundamental for the development of R&D activities" (PAULA, 2011, p. 11). Therefore, the prevalence of a business innovation will depend on the firm's ability to adapt to the technological conditions of the innovation and monetary system of the financial system, in constant "survival" to the internal innovative effort, so that this investment is selected.

4   Final considerations

This article aimed to analyze the epistemological relationship between Keynesian and neo-Schumpeterian semantics of uncertainty, expectation and innovative effort. Specifically, it sought to compare the notion of innovative effort under conditions of uncertainty from the epistemology linked to the binomial probability-weight of the argument, expectation-confidence state and the search-routine-selection trinomial. The article presents an exploratory contribution to the theory of innovative effort, by integrating two approaches that treat knowledge as a guiding element of this type of effort.

The articulation between Keynesian and evolutionary approaches, taking technological change as a reference, proves to be feasible. Elements inserted in both approaches - uncertainty, investment and the formation of expectations - are relevant to discuss the determinants of technological change. In Keynes, uncertainty is linked to the process of forming expectations, being a crucial element in defining business decision making regarding investment. Investment, in turn, depends on the degree of confidence that entrepreneurs mobilize from the knowledge derived from the logical probabilistic decision process. In a monetary economy of production, the decision-making process will be guided by knowledge of market information and by the forecasts that entrepreneurs have rationally established about the future, considering, for this purpose, the marginal efficiency of the capital applied to production.

Neo-Schumpeterians, however, link the level of investment to expectations of profit realization, which given the evolutionary and selective character of the market, will only be possible through the modernization of fixed capital stocks, through incremental and radical innovation. In this regard, expectations regarding the returns on investments in technological change will be given according to the knowledge that entrepreneurs will be able to mobilize to make adaptations in technological trajectories or develop new technological paradigms, in order to minimize costs, expand demand and position themselves strategically vis-à-vis competitors. In this sense, for both Keynes and neo-Schumpeterian economists, decision-making regarding investments permeates the formation of expectations and the uncertainties that determine them, considering the impact that the change in the capital stock will bring to production income, although with different approaches.

There is a complementarity in the notion of Keynesian expectations on investment decisions in innovation postulated by the neo-Schumpeterians, since the radicalization of technological paradigms will require a range of complex knowledge, which will only become viable in the long run, after the continuous experimentation of technological trajectories. In this way, the important STE and LTE concepts are demonstrated to explain the way in which technological change is linked to the entrepreneur's intertemporal investments. Therefore, it is concluded that the emergence of a new technological paradigm alters the marginal efficiency of previously mobilized capital, since radical innovations alter the prospective returns of the innovative effort.

In general, it is pointed out that technical, managerial and technological knowledge, when combined, form the epistemological basis used by the entrepreneur to circumvent uncertainty and, thus, form his short and long term expectations to undertake the innovative effort. It is noted by the semantic comparison and ontological inference used in the article, the greater the systematization of knowledge, the greater the degree of confidence of entrepreneurs to undertake innovation, which reverberates in the disposition to operate more disruptive technological changes. Therefore, it is understood that the acquisition of knowledge, revealed by monetary investments in learning processes linked to internal and external bases of the firm are modalities of innovative effort. The synchronous representation of these aspects alludes to an analytical convergence, between the notion of probability-weight of the argument and expectation-state of trust in the face of the search-routine-selection trinomial, so that it underlines a philosophical complementarity.

In this framework, attention should be drawn to the coexistence of latent and logical knowledge for the formation of expectations of entrepreneurs, but whose degree of importance varies depending on the disruptive scope of the innovative effort, whether incremental or radical. From the trilateral comparison between tacit-coded, indirect-direct knowledge and technological change, it is concluded that the theoretical approach between Keynesian and neo-Schumpeterian epistemology allows to indicate the financial system as one of the selection mechanisms present in the monetary economy dynamics. Differing from other approaches, it is proposed that monetary dynamics not only interfere with investment decisions in innovative efforts, but determines the speed and prevalence of innovations produced in the market. Thus, the "financial routines" are inexorably linked to the heuristic of the dynamic innovative process.

In this regard, the innovative effort is not understood as a spontaneous result of the entrepreneurs' decisions, as it is conditioned, to a large extent, by the degree of maturity of the innovation system and the national financial system. Therefore, the formation of expectations regarding the innovative process is based on a heuristic that seeks to mitigate the uncertainties arising from technological and sectorial barriers in the market, as well as uncertainties about the marginal efficiency of capital (innovative effort), given the monetary dynamics of the economy. In practical terms, the currency is relevant to explain the way in which the selection of market innovations occurs. For this reason, in view of the uncertainty that permeates the innovative effort, especially in developing countries, the State shows itself to be preponderant to mitigate the fundamental uncertainties of the firm's heuristic process. Innovation policies, for example, may be triggered to correct technological distortions and asymmetries caused by monetary dynamics, particularly in countries where the low development of the financial system is associated with a path dependence.

Nevertheless, it is recognized that the research carried out in this article represents a preliminary inference on the role of knowledge in shaping the innovative business effort, as well as the selective characteristics of the financial system. An additional effort must be made to advance understanding, based on the resource-based view, the role of knowledge and monetary dynamics as a macroevolutionary element in the process of forming expectations in an innovative effort.

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