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Editorial
Uncertainty: political economy and its encounters with quantum mechanics in the interwar period

Incerteza: economia política e seus encontros com a mecânica quântica no período entreguerras

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In memory of Mauro Boianovsky

Werner Heisenberg's famous 1927 article, *Über den anschaulichen Inhalt der quantentheoretischen Kinematik und Mechanik*, in which he offers the original formulation of what would become known as the uncertainty or indeterminacy principle, is not, as one might expect, a text for non-specialists. The argument is concatenated in a continuous flow, and there is little room in the text for more general speculation with philosophical implications. Although philosophy was part of the young Heisenberg's education, at the time of this article the then 25-year-old Heisenberg was not interested in the development of this line of thought, which he would explore later.[1] In this 1927 article he explicitly states that these broader speculations are "unfruitful and useless" ("*unfruchtbar und sinnlos*"), since the only task of physics should be to describe the "relation between observations" ("*Zusammenhang der Wahrnehmungen*"). Nevertheless, he leaves us with an emblematic reflection that serves as a starting point for our reflection on uncertainty here. At the end of his article, he tells us that, with regard to the well-known formulation of the law of causality: "'if we know exactly the present, we can calculate the future', it is not the conclusion that is wrong, but the premise" (Heisenberg, 1927, p. 197).

At that moment, modern physics was abandoning the fundamental ambition of classical physics, that of a precise explanation of the phenomena of the natural world, which, since the scientific revolution of the seventeenth century, had offered a target for the aspirations of reflection on human and social phenomena, as, for

1 See in particular his *Physics and Philosophy: The Revolution in Modern Science*, which contains the "Gifford Lectures" he gave at St Andrews University between 1955 and 1956 on the intellectual history of physics.

example, political economy in its formation as an autonomous field of knowledge. Heisenberg, by making progress in the construction of quantum mechanics in those uncertain times between the wars, qualifies for historical reflection something that at first glance might sound trivial, always aware that the understanding of reality is always partial and limited, but by stating that "all perception is a selection from a great variety of possibilities and a limitation of what is possible in the future" (Heisenberg, 1927, p. 197), made it clear that the statistical nature of quantum theory limits the possibilities of understanding a given level of reality to a field of statistical probabilities, not deterministic certainties.

The extent to which this discussion (and the advances in quantum mechanics throughout the period) specifically influenced thinking about uncertainty in philosophy, history, the social sciences, and especially economics during the interwar period (and beyond) is another question, and one that is certainly too broad to pursue here. Nevertheless, it seems undeniable that modern physics, by questioning the certainties of classical physics, began to offer a wealth of metaphors and fundamental inspirations for thinking about uncertainty thenceforth. Pointing at some of these questions and some of these connections is a stimulating starting point for opening this volume on the political economy of uncertainty.

The discussion is broad and complex. Our objective is to capture some of these metaphors and inspirations in principle, with a view to introducing the discussion that will follow in the set of articles gathered here. The subject of the political economy of uncertainty is so vast that by deffinition it cannot be fully addressed in a few articles. Therefore, from the beginning, we have chosen to emphasize the idea of highlighting "certain perspectives" on the subject. The papers are associated with two research projects on complementary topics and were presented and discussed at a joint workshop at the end of March of this year.[2]

One of the core themes of the discussions in these research projects, which is evident in several of the articles collected in this volume, is the manner in which the discourses on uncertainty in economics that emerged during the interwar period

2 The projects in question are The Jean Monnet Chair – "European Cooperation in a Post-Pandemic World: History and Current Challenges in a Global Perspective" - PostPan (project number 101048203), co-funded by the Erasmus+ program of the European Union. And the research project "The Political Economy of Uncertainty: Reflections on Crisis, Planning, Risk, and Cycles from the Interwar Period to Contemporary Challenges" (project number 406296/2023-5), funded by the Brazilian National Council for Scientific and Technological Development (CNPq). The research workshop entitled "The Political Economy of Uncertainty" was held at the Centro de Desenvolvimento e Planejamento Regional (Cedeplar) of the Universidade Federal de Minas Gerais (UFMG) in Belo Horizonte, Minas Gerais, Brazil, on March 26 and 27, 2024.

have exerted a profound influence on the evolution of the discipline (see Cunha and Suprinyak, 2021). Moreover, they continue to offer invaluable insights for reflecting on the current challenges, particularly because the interwar period itself can be seen as a concentration of impasses and challenges, some of which are reappearing in recent years.

Not just in relation to the interwar period, but quite broadly, it is not difficult to argue that uncertainty is one of the most important sources of economic reflections. Will human population outgrow food supplies? Will profit rates decrease to the point of the extinction of industrial capitalism? Will social inequality increase to the point of civil insurrection? Will a planned economy be able to eliminate evils such as unemployment and inequality? Will consumers be able to purchase all that is produced in capitalist economy? Will peripheral countries one day reach the development standards of the capitalist center? Will capitalism be able to adapt to new environmental conditions? All these are questions that motivated economists over the history of economic thought to produce and refine theoretical elaborations which have shaped economics as we know it today. This history, however, is not linear: there are times in which uncertainties are comparatively more urgent, which makes the demand for solutions even more compelling.

At this point, we can draw this parallel between our current historical juncture and that of about one hundred years ago. The interwar period was marked by significant disruptions to the certainties that had existed in many parts of the world in the preceding decades. The *Pax Britannica* was irreparably broken, leading to the collapse of the 19th-century world order founded on liberal ideology and the gold standard as the basis for economic policy. The emergence of modern warfare transformed the frugal governments of the 19th century into the large-scale spenders of the 20th century. Furthermore, the great economic crisis of the 1930s dealt a serious blow to the confidence in free-market capitalism, which meant an increase in uncertainties not only related to exchange rates, prices and employment, but also the aggravation of social anxiety and political instability. All this paved the way for war and destruction, but also to transformations in the relationship between state and economy that would determine economic theory and policy for the decades to come. In Europe, this entailed the opportunity for reconstruction and the relaunch of international cooperation on a new basis.

In studying history, it is inevitable that we look at the past with eyes that are necessarily forged in our present days. At the same time, to make sense of the present, we inevitably mobilize characters, concepts, words and ideas originating in the past – sometimes in a relatively distant one. This crossing of temporalities

can be fascinating and productive, if attention is paid to specificities and singularities – this, in fact, distinguishes sound historical research from anachronistic elaborations. To understand, for example, the recent rise of right-wing extremism in world politics, it might be helpful to compare the connections between social behavior and economic crises in both contexts. A similar argument can be made for the interaction between state and economy, which is explored in this issue in several ways. About a hundred years ago, the state developed instruments to tackle the challenges posed by political conflicts and economic crises: in most cases, it involved some form of economic planning. Planning the economy, however, is a very plastic strategy, in that it might serve to secure the prosperity of a democracy or to channel resources to war and genocide. This dilemma was experienced in the early 20th century and, albeit reconfigured in an important number of ways, poses itself again. The enduring fragility of national economies since at least 2008-09, with the ensuing political reactions, are demanding policy strategies that might lead to very different outcomes, ranging from prosperity to misery, from international cooperation to war. In a word, the current juncture and the interwar period are characterized by a common denominator that allows for interesting comparisons: a particular concentration of uncertainty.

This marked the anxieties, expectations and frustrations of an entire generation between the intensity of the Roaring Twenties and the pessimism of the Thirties, and it also left very deep marks on the intellectual and artistic worlds, which enables us to navigate an endless number of perceptions of this fragmented time, so rich in metaphors related to uncertainty. The widespread ambition to offer answers to the many fractures of that time ends up offering cultural landscapes, in a broad sense, that were collectively shared and allow us to carry out various investigations into the intellectual history of a theme such as uncertainty. In terms of *Zeitgeist* perception and the metaphors associated, quantum mechanics is only one of several possible topics. In this sense, a study of "uncertainty and surrealism" in the interwar period would be equally fascinating or metaphorically productive. Yet in this period there are, particularly through mathematics and statistics, several suggestive approximations between physics and economics that we can explore here, in order to draw a more suggestive starting point for our discussions in this special issue.

Back to Heisenberg's celebrated uncertainty principle. This is essentially a formulation and discussion about the impossibility of simultaneously measuring the location and momentum (velocity) of subatomic particles. The fundamental aspect that places this relationship at the level of a principle, despite the fact that this

terminology is not employed by Heisenberg in his 1927 article,[3] and which must be highlighted from the outset, is precisely that it is not a question of (technological) limitations in the capacity to measure. This phenomenon can be understood as an approach to the question of the randomness inherent in the functioning of subatomic phenomena. Consequently, the very use of terms such as position, velocity, and energy is not analogous in quantum mechanics and classical physics, despite the fact that we use the same terms to describe them.

In Heisenberg's terms, uncertainty refers to a fundamental relation of indeterminacy. This is presented in the formulation that the variations in position (Δx) and momentum (Δp) in a quantum system cannot be less than the Planck constant (h) divided by 4π, i.e.: $\Delta p \Delta x \geq h/4\pi$. From the perspective of classical physics, the assumption that both position and momentum can be determined with certainty would necessitate a null variation in each of these variables, i.e., $\Delta p = 0$ and $\Delta x = 0$. This would render the relationship invalid, given that $h/4\pi$ is an extremely small number, but naturally not zero. In other words, Heisenberg posits that at the level of physical systems with dimensions approaching or below the atomic scale (Planck's constant, h, is approximately 6.63×10^{-34} Js), as we reduce the indeterminacy of one of these variables, we inevitably increase that of the other.

A substantial number of intricate issues and concepts, which significantly influence the development of quantum mechanics, are involved here. This encompasses, for instance, at least two issues directly associated with Heisenberg (and the University of Göttingen). Firstly, the formulation of matrix mechanics as an explanation of quantum mechanics by Max Born and Heisenberg in 1925 represents a significant development in the field. It builds upon Born's studies of wave functions as probabilities, incorporates Niels Bohr's discussion of discrete energy states and

3 As David C. Cassidy (1998, p. 278-9) notes, Heisenberg does not use the German word for "indeterminacy" (*Unbestimmtheit*) in the 1927 article, preferring the term *Ungenauigkeit*, i.e. inaccuracy. But in the addendum added to the proof page of the article, in which he refers to discussions he had with Niels Bohr after submitting the article, Heisenberg uses the word *Unsicherheit*, or "uncertainty", but does not use the term repeatedly at that time. What Cassidy suggests is that Bohr (with whom Heisenberg spoke mainly in Danish) must have been the source of the choice of the term "uncertainty", which was used by Heisenberg at the time in the German equivalent and has since been adopted in the English-language literature, starting in particular with the article in English that Bohr presented on the question a few months later and subsequently published in *Nature*. In Heisenberg's comments on Bohr's article, however, the choice of words would point to the term "inexactness" without referring to the idea as a "principle" (*Ungenauigkeitsrelation* or "inexactness relation" is the term used). Heisenberg would use the term "principle" for the first time in the English translation of lectures he gave at the University of Chicago in 1929, but the choice of words in the German originals do not gave preference to this idea, usually emphasizing the term "relation", passing through *Ungenauigkeitsrelation*, or "inexactness relation", to finally give special preference to *Unbestimmtheitsrelationen*, or "relations of indeterminacy".

quantum jumps, and offers a new interpretation of the physical properties of particles as matrices that evolve over time. Secondly, the principle of complementarity, as presented by Niels Bohr in 1927, articulates the wave-particle duality with the relation of indeterminacy that Heisenberg had communicated to him just before the publication of his famous article. This led Heisenberg himself to add an observation to his original argument in an addendum[4], which was developed with a focus on discontinuities, about this articulation between particle theory and wave theory.

There is no way to go into this set of questions in depth here, either because of the limitations of the authors' knowledge in the field of theoretical physics, or because of the limits and scope of this text, but some aspects can be highlighted just to reach a certain set of metaphors that would emerge and that we are interested in capturing here.

First of all, as regards matrix mechanics, we can observe an interesting aproximation with processes underway in the field of economics. The studies by Wassily Leontief, bringing matrix algebra to the study of inter-industrial structure based on an input-output analysis, are an excelente example (Shackle, 1967: 7-8 / see also Wheatcroft & Davies, 1985: xix). Even more interestingly, there is a connection with John von Neumann, a central name in the later development of game theory and mathematical economics, but who arrived at the University of Göttingen in 1926 to work as an assistant to the famous mathematician David Hilbert. Neumann would soon (in a series of articles published in 1927) make a central contribution to establishing the mathematical equivalence between Heisenberg's matrix mechanics and Erwin Schrödinger's wave equation. Based in Zurich, the latter had developed, at the same time, a wave mechanics that, although based on different grounds, pointed to the same results as Heisenberg's. The reference to Neumann is particularly relevant, not only because of its connection to studies in the field of matrix algebra, but also to probability, since one of his central contributions to quantum physics was precisely to advance the probabilistic interpretation in physics, related to the use of statistical matrices to describe a set of systems of different quantum states (Leonard, 2010, p. 42-55).

In regard to the principle of complementarity, it is crucial to recognize that the inability to observe phenomena simultaneously does not hinder an understanding of the totality. In fact, this comprehensive perspective is a fundamental aspect of reflection, as it is essential to consider the functioning of a system in its entirety

4 "Addendum to the correction. After the present work was completed, more recent studies by Bohr led to points of view that allow a significant deepening and refinement of the analysis of the quantum-mechanical relationships attempted in this work. (…)" (Heisenberg, 1927, p. 197)

rather than discussing its constituent elements separately. It is not surprising that this posed a significant challenge for physics.

We can insist on the contrast. On the one hand, the traditional Cartesian approach to physics assumes that there is a reality in space-time and that this reality is a determinate thing whose aspects can be seen or articulated at any moment. On the other hand, in quantum mechanics Bohr insists on the "indivisibility of the quantum of action", which is to a large extent how he describes the uncertainty principle, This implies that not all aspects of a system can be observed simultaneously (Frescura & Hiley, 1984). As noted above, this does not prevent or compromise an understanding of the system as a whole. In examining the connections with other fields, Makoto Katsumori (2011, p. 157) notes that, for Bohr, whose philosophical elaboration was a result of his early reflections in theoretical physics, the two fields were inextricably linked. In his work as a philosopher, Bohr elucidated the concept of complementarity in quantum theory (as well as in any other field of science). This concept is closely related to complementarity in epistemology, which Bohr understood to be a fundamental aspect of human understanding. Bohr's insight was that "since quantum theory is one of the fields in which we use and define concepts and words while at the same time materially engaging with nature".

Various reflections in the field of statistics and probability made progress in the interwar period, and in economic theory the publication in 1921 of *Risk, Uncertainty, and Profit* by Frank H. Knight and *A Treatise on Probability* by John Maynard Keynes are important milestones for the discipline and for the reflections we are introducing here. In this case, these are not developments coincidental with physics, since both perspectives (Knight's and Keynes's) had already taken shape before the advances in the formalization of quantum mechanics in Göttingen and Copenhagen, which began to take shape in the mid-1920s, as we have discussed above. Furthermore, it is worth adding that both Knight and Keynes, in the moments when they came to make comparative considerations between the fields of physics and economics, made it clear that their view of physics was essentially that of classical physics. The indeterminacy of the subatomic world had not yet shaken the perception of the certainties of classical physics. Knight, for whom physics was "the model and archetype of an exact science of nature," described in his 1921 work exactly this precision of relations in the field of physics, at a level at which economics simply could not operate (in part because it could not control the conditions and premises in the same way): "In a similar way, but for various reasons not so completely and satisfactorily, we have developed a historic body of theoretical economics which

deals with 'tendencies'; i.e., with what 'would' happen under simplified conditions never realized, but always more or less closely approached in practice. But theoretical economics has been much less successful than theoretical physics in making the procedure useful, largely because it has failed to make its nature and limitations explicit and clear" (Knight, 1921, p. 4-5).

Keynes, on the other hand, years later, when contrasting economics (and defending it as a moral science) with (classical) physics, would point at a kind of formulation which, instead, might well refer to a certain degree of complementarity with quantum physics. In a letter to Roy F. Harrod dated July 16, 1938, referring to the apple tree that is said to have inspired Isaac Newton's reflections on the theory of gravity, he says that: "I also want to emphasise strongly the point about economics being a moral science. I mentioned before that it deals with introspection and with values. I might have added that it deals with motives, expectations, psychological uncertainties. One has to be constantly on guard against treating the material as constant and homogeneous. It is as though the fall of the apple to the ground depended on the apple's motives, on whether it is worth while falling to the ground, and whether the ground wanted the apple to fall, and on mistaken calculations on the part of the apple as to how far it was from the centre of the earth" (Keynes, 2013[1938b], p. 300).

The path traced by Keynes, which emerges in his work in the field of logical probability and subsequently manifests itself in the various implications of his argument on uncertainty, points to a type of reflection on indeterminacy that allows us to consider these overlaps and complementarities. In this regard, it is worthwhile to consider the contrast between Knight's and Keynes' arguments in the field of probability. Even though interpreters such as Garner (1982, p. 414) and Runde Runde (2001, p. 138) observe similarities between Knight's and Keynes' views on the relationship between probability, risk, and uncertainty, the types of probability theory advanced by each of them are typically classified as opposites. Knightian statistical probability deals with a type of random probability, in the sense of capturing a (measurable) property of the outside world. In contrast, the approach that would later be classified as Keynes' "logical probability" refers to a type of epistemic probability, related to the way we think about the outside world. Keynes was, thus, more directly interested in questions such as the probability of propositions (about results or events) than in the results or events themselves. Alternatively, with regard to the concept of indifference, we observe that Knight concentrates on the gaps in the causal determination of reality, whereas Keynes is concerned with the gaps in our knowledge of the causal determination of reality.

In his 1921 work, *Risk, Uncertainty and Profit*, Knight establishes a distinction between risk and uncertainty that can be clearly operationalized. He contrasts risk, which is characterized by a known chance, and true uncertainty. Additionally, he advances into more nuanced qualifications of probability situations. These include *a priori* probability, statistical probability, and estimates (Knight, 1921: 224-5). Nevertheless, in the aftermath of his contributions to *A Treatise on Probability* (1921), Keynes develops an ontology of the logical relations of probability. Despite the inclusion of more contentious elements, this ontology enables a more comprehensive approach to the phenomenon of uncertainty, understanding for example that numerically defined probabilities can be derived from qualitative comparisons of probability relations. The special circumstances are that the relevant situation must be such as to allow the legitimate application of the principle of indifference (Runde, 2001, p. 134-6).

For Keynes, then, probabilities would be evidential relations between a hypothesis and some evidence, just like the relations of deductive logic. His 1921 work was a seminal contribution to this type of perception in a systematic and rigorous way, with a substantial impact on the field of philosophy of probability influencing the work of numerous subsequent authors (Peden, 2021, p. 933). Reflection in the field of probability philosophy is undoubtedly a central element in Keynes's thinking about uncertainty (Lawson, 1985), and this epistemologically sophisticated approach to probability would continue to be an important tool for understanding uncertainty in the field of post-Keynesian economics (Peden, 2021, p. 948).

As previously stated, Keynes addressed the relationship between economics and physics on different occasions. Without specifying the exact moment when this occurred, Keynes recalled a meeting with Max Planck, the discoverer of energy quanta.[5] During this meeting, the renowned physicist commented, certainly with a hint of irony, that at the outset of his career, he had considered pursuing a degree in economics, "but had found it too difficult!". Keynes comment on this episode is particularlly interesting: "Professor Planck could easily master the whole corpus of mathematical economics in a few days. He did not mean that! But the amalgam of logic and intuition and the wide knowledge of facts, most of which are not precise, which is required for economic interpretation in its highest form is, quite

5 There is no reference to the date of the meeting, but it certainly took place before 1924, the date of the first publication of the text in memory of Alfred Marshall, in which the reference originally appeared (*The Economic Journal*, Vol. 34, No. 135 (Sep., 1924): 311-372). The text was republished with some modifications two other times, including the one in *Essays in Biography* (1933), but the reference to the meeting with Plack was already in that 1924 version.

truly, overwhelmingly difficult for those whose gift mainly consists in the power to imagine and pursue to their furthest points the implications and prior conditions of comparatively simple facts which are known with a high degree of precision" (Keynes, 2013 [1933], p. 186).[6]

In drawing attention to the problem of precision, however, Keynes shows once again in these remarks that his conception of physics, even in this reference to Planck, was based on the classical conception. Nevertheless, in an attempt to mark the distances between physics and economics, Keynes draws attention to important aspects of economic theory, the parts of which that can be expressed mathematically end up being a simplified and incomplete sample of what can be known by experience of the myriad interrelationships that actually compose reality. After all, for Keynes, "economics is a science of thinking in terms of models joined to the art of choosing models which are relevant to the contemporary world. It is compelled to be this, because, unlike the typical natural science, the material to which it is applied is, in too many respects, not homogeneous through time" (Keynes, 2013[1938a], p. 296 / see also: Perelman, 2007, p. 169).

It is this possibility of only partial knowledge of reality and the imperative selection of aspects on a plane of uncertainty to guide the need for action on the plane of economic governance that marks a passage of particular interest here, linking probability and uncertainty. As Keynes writes in his well-known article published in the *Quarterly Journal of Economics* in 1937:

> *"By 'uncertain' knowledge, let me explain, I do not mean merely to distinguish what is known for certain from what is only probable. The game of roulette is not subject, in this sense, to uncertainty; nor is the prospect of a Victory bond being drawn. Or, again, the expectation of life is only slightly uncertain. Even the weather is only moderately uncertain. The sense in which I am using the term is that in which the prospect of a European war is uncertain, or the price of copper and the rate of interest twenty years hence, or the obsolescence of a new invention, or the position of private wealth-owners in the social system in 1970. About these matters there is no scientific basis on which to form any calculable probability whatever. We simply do not know. Nevertheless, the necessity for action and for decision compels us as practical men to do our best to overlook this awkward fact and to behave exactly as we should if we had behind us a good Benthamite cal-*

6 It is worth noting that Max Planck relocated to Göttingen shortly after the Second World War, where he passed away in 1947. Additionally, following the conclusion of hostilities, the *Kaiser-Wilhelm-Institut für Physik* (KWIP, Kaiser Wilhelm Institute for Physics), subsequently renamed the Max Planck Institute for Physics, relocated from Berlin to Göttingen with the approval of the British occupation authorities. Its director since 1942, Heisenberg, would also return to the city in connection with some of his most significant scientific achievements. In the year of Planck's death, he and Heisenberg were in fact neighbors and resided just a few meters apart on *Merkelstraße* in Göttingen, adjacent to the verdant *Schillerwiese*. Planck, however, was never close to Heisenberg academically, preferring Schrödinger's model of wave mechanics to Heisenberg's matrix mechanics, for which he did not spare criticism.

> *culation of a series of prospective advantages and disadvantages, each multiplied by its appropriate probability, waiting to be summed.*
>
> *How do we manage in such circumstances to behave in a manner which saves our faces as rational, economic men? We have devised for the purpose a variety of techniques (…)"* (Keynes, 1938, p. 213-4).

There are undoubtedly many similarities/approximations that could be considered here, suggesting not only contrasts but also bridges between economics as Keynes thought of it, not with the precision of classical physics, but with the indeterminacy of quantum mechanics. At the end of this introductory discussion, therefore, we could finally allow ourselves to (boldly) refute something in Heisenberg's argument in his seminal 1927 article, by insisting that the more philosophical speculations that he quickly advances at the end of the text to question the principle of causality, as we have alluded to above, pave the way to the establishment of various relationships that undoubtedly go beyond physics and are anything but "unfruitful and useless".

Once again evoking this inspiration from quantum mechanics to reflect on the political economy of uncertainty, in our reflection we are endeavoring to deal with totality, but from a deliberately fragmented perspective. At any given moment, a certain viewpoint may render another impossible, and more than that, may condition the other. However, while it is not feasible to grasp the entirety of the phenomenon under study in a unified manner, partial observations can still be incorporated into the analysis without compromising the pursuit of a comprehensive understanding. This necessitates the recognition of the inherent complementarity between the various levels of analysis, which can be applied to the examination of uncertain times, both past and present, as well as the visions of the future that are inscribed in them.

It is to explore this kind of debate that this special issue of *Nova Economia* was conceived, offering not a coherent narrative on the political economy of uncertainty, but a certain glance ("*un certain regard*", as in Cannes), indeed "*glances*", in the plural, looking at different directions and hopefully innovative in their style and perspectives. What the reader has here is a joint effort to examine the interplay between socio-economic uncertainty and political economy at critical junctures of the last hundred years, from quite different perspectives. The team of authors is diverse in many ways. While some lean towards a more historical approach, others have a more theoretical concern. While most deal with uncertainty in the early to mid-20th century, others focus directly on contemporary challenges. This diversity speaks to the experimentational nature of the topic of uncertainty: it entails, at the same time, anxiety and opportunity, danger and novelty. In a word, this issue is a

combination of research endeavors that concur to provide a kaleidoscopic regard on the political economy of uncertainty. As in a kaleidoscope, the reader might decide on the sequential order for reading the contributions, which are independent of each other. However, we organized them in the following way: the eight articles that this introductory essay follow a more or less chronological order, beginning with a reflection specifically on Knight and ending with a contemporary exploration of economic governance in the European Union.

By examining the works of Frank Knight, Michele Bee and Rafael Lazega explore the topic of uncertainty from an interesting point of view: its benefits, its positive side. Knight argues that uncertainty can inspire people to action, since life without uncertainty is "unlivable". The paper shows that for Knight the relevant question is how to find the "good measure" of uncertainty and how to make "the pleasure of playing the game" not just the privilege of a few rich people, but also something available to the working masses who otherwise lead monotonous lives, a game they participate in not for pleasure, but for sheer survival needs.

In a contribution on the economists representing the American Economic Association (AEA) in the Social Science Research Council (SSRC) in the 1920s, Victor Cruz-e-Silva sketches a profile of the American economics profession at this juncture. In addition to pluralism as a general feature, Cruz-e-Silva highlights one shared attribute of these economists that is particularly interesting: their embrace of statistics and, later, of probability theory. As part of a larger movement of estrangement with the deterministic perspective of 19th-century mechanical physics, among these economists prevailed the idea that the future cannot be known with precision, and that economic processes cannot have their results known beforehand.

In an essay on the dissemination of the ideas of the German émigré Carl Landauer, Luiz Felipe Bruzzi Curi tells us a story deeply marked by the uncertainties of the interwar period. Landauer, a Jew and social democrat, emigrated to America because of the threats posed by the rise of fascism in Europe. His theoretical elaborations were in turn a response to the uncertainties following the Great Depression: economic planning should ensure that the economy does not deviate from its established purpose. Unexpectedly, Landauer's ideas were also used to legitimize economic planning as a strategy for promoting industrialization in the periphery.

Marcos Melo situates the work of the French Marxist philosopher Henri Lefebvre within the historical context of the interwar period's crisis of European civilization. To do so, Melo examines Lefebvre's writings on rationality and science. The article examines Lefebvre's initial critique of traditional philosophy as a response to modern

rationality issues, which later evolved into a Marxist perspective based on dialectical materialism. Particular attention is also given to how Lefebvre's methodology calls for a critique and renewal of modern rationality through his studies in logic and methodology.

In a contribution that explores the challenges and ambiguities of post-war French planning, Katia Caldari focuses on Pierre Massé's attempts to legitimize planning and adapt it to the changing circumstances of the 1960s. A metaphor used by Massé in this context illustrates the dilemmas faced by planners at the time: an economic plan is made up of "part ink" and "part pencil". As something that links the present with an uncertain future, the plan has a fixed part, representing the will to achieve specific goals, and a malleable part, ensuring its adaptability to new conditions.

Now turning to Latin America, Roberto Lampa and Florencia Sember deal with the political economy of capital flows. They offer an appealing perspective on the so-called "neo-dependentists" and suggest dealing with inconsistencies through the self-critical work of the late Raúl Prebisch. They argue that Prebisch's theory evolved to include a significant emphasis on political economy, with particular attention to the internal social structure of Latin America. Therefore, Prebisch serves as a reference for research in the field of financial subordination, as he indicates the need to reform the institutions of these countries, so as to reduce the uncertainties created by reliance on external capital flows.

Kai Lemann's contribution is an attempt to devise four simple rules that condense the reasons why Latin America (and Brazil in particular) remains in a state of permanent uncertainty and recurrent crises. The third rule proposed by the author ("Attend to what is happening now") has an interesting implication for the design of policies for the region that is often neglected by policymakers, especially outsiders: policies must be flexible in time and space, combining permanent elements with an adaptive character.

Finally, the special issue presents a contribution dealing with the contemporary challenges of the European Union. On the one hand, you advocate a more robust supranational coordination system; on the other hand, you undermine this system by removing any enforceable mechanisms that allow each individual country to pursue its own macroeconomic objectives. This is an example of what Fabio Masini calls in his paper "constitutional uncertainty". According to him, it is a factor contributing to Europe's recent economic underperformance, not only relative to developing countries such as China and India, but also relative to an advanced economy such as the United States.

And last, but not least, to mention once again one of the projects that supported the work presented in this special issue (the one funded by the CNPq, "The political economy of uncertainty: reflections on crisis, planning, risk and cycles from the inter-war period to contemporary challenges"), it is imperative to point out here that Mauro Boianovsky, who left us so suddenly and prematurely last February, was part of our original team. In addition to being a renowned expert on many of the issues and authors related to uncertainty in economics, Boianovsky was enthusiastic about the possibility of discussing these issues in the context of the project and, in particular, in the planned workshop that finally took place the month after his death. His absence from the workshop and the lack of a contribution from him in this special issue is deeply regretted. Boianovsky is and will be sorely missed by the history of economic thought community in Brazil and around the world. But the greatest loss is undoubtedly the one we feel personally, as his colleagues and friends. We dedicate this special issue to his memory, remembering his valuable scientific contribution, our friendly interaction over many years, and also how uncertain tomorrow always is.

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