REVOLUTION 4.0 THROUGH THE PRISM OF THE WORK OF F. VALENTA

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Abstract

F. Valenta was a Czech economist and member of the Academic Council. He was famous for his research on innovation theory's micro and macro (and consequences). He was interested in the development of science and technology, efficiency, and innovation processes. He developed a comprehensive theory of innovation. This article recapitulates Valenta's pioneering contributions to innovative thinking, particularly in developing the long wave K theory associated with the radical innovation of the highest orders. He contributed to developing the innovation explanation of business cycles, thus directly following J. A. Schumpeter. His ideas are still inspiring in both theory and practice, especially in the context of the current discussions on the so-called Revolution 4.0, including its phases (green, covid, etc.) and the projects of the post-covid world. The issue of the "magicality" of the Vth long wave K is also hinted at, including discussions about its termination and K-cycles with numbers VI or VII.

Key words: F. Valenta, theory of innovations, innovation orders, long K-waves

JEL Code: D22, E32, O30,

Introduction

The year 2022 marks the 20th anniversary of the death of F. Valenta, whose work remains unappreciated to this day. František Valenta (1928 - 2002) was a Czech economist, academic, politician, and public figure at the forefront of elaborating on innovation's micro-, meso- and macroeconomic context. His scientific interest was in scientific and technological development, efficiency, and innovation processes. He developed a comprehensive theory of innovation by classifying innovation using innovation orders. In addition to the business-economic aspects, he contributed significantly to developing innovative explanations of business cycles, especially long K-waves, directly following J. A. Schumpeter.

Concerning Czech (or more broadly Czechoslovak) economic thought, it is often stated that due to many diverse factors, there has never been a coherent theoretical school,

trend, or current that would have fundamentally influenced world economic thought. The original indigenous sources of thought remain problematic. A significant role has always been played by adopting foreign concepts and inspirations, which were also found in solving economic and political problems. Specific features include the frequent linking of economic concepts with political and other views and activities, the former long-standing connection between economic science and law, and the significant discontinuity of development in the 20th century. Czech economic thought is traditionally characterized by a good knowledge of the current state and development of world economic science, including rich traditions in the history of economic thought and economic history. However, Czech economic thought also brings concepts that transcend national borders, which can inspire the exploration of 4.0 and 5.0 processes[1]. The legacy of F. Valenta should not be overlooked. The article is an original scholarly review. The authors used data from secondary literature sources and the available research results on the topic. The methods of description, comparison, qualitative analysis, induction, and deduction were applied to achieve the goal.

1 A pioneer of innovative thinking

F. Valenta is one of the pioneers of *"innovation thinking"* in Czechoslovakia, developing J. A. Schumpeter's thoughts on innovation dynamics and trying to apply them to the conditions of contemporary economic practice. His knowledge about the innovation process is called Valenta's theory of innovation. Valenta's contribution is often related to applying innovation theory to corporate practice and enterprise science. Valenta focused mainly on the practical aspects of the innovation process (Valenta, 2001, etc.). However, the *"enterprise"* or *"managerial"* view of innovation goes beyond this in several respects. It extends innovation theory to the mesosphere or the whole economy, with implications for the functioning of business cycles led by long K-waves. Valenta's inspiring contribution to the theory (and practice) of innovation and long wave theory in the *"Schumpeterian spirit"* rests on materialistic foundations. Therefore, Valenta's reflections tend to be classified as a Marxist *"working"* theory of innovation (Sirůček, 2017, etc.).

In his scientific research activities - theoretical deductions, analyses, and empirical investigations - F. Valenta focused on the complex issue of the innovation process and the efficiency of industrial production. He developed a comprehensive theory of innovation, in which, among other things, he classified innovation into several orders. The contemporary

[1] Exploring Processes 4.0 and 5.0 see more (Schwab, 2017; Sirůček & Džbánková, 2017).

logic of industrial organization (association of enterprises, enterprise, plant, operation, workshop) gradually gave rise to Valenta's levels of innovation from the lowest to the highest order. Valenta also thoroughly elaborates on the category of efficiency, being one of the first to combine two aspects of efficiency - effectiveness, and efficacy. Valenta's original contribution is represented mainly by books from 1969 and 2001.

The book *Creative Activity - Innovation - Effects* (Valenta, 1969) is a breakthrough. It recapitulates the results of the analytical phase of Valenta's research, which he has been doing since 1964. The book explains the development of the internal structure of production organisms, its changes (i.e. innovations), and the dependence of effects on these changes. It is based on experience gained during extensive empirical research in Czechoslovak industrial enterprises. It closes by outlining the interrelationship between the innovation process and the national economic management system, including the use of cyber tools. Valenta is also critical of the central directive management system and suggests- to properly absorb scientific and technological progress through innovation - the temporary introduction of an entrepreneurial environment.

The book's central theme is innovation, where Valenta, among other things, operates with orders of magnitude - from the simplest innovations, maintaining the corporate or other system in its current state, to the most complex, abandoning the existing basic principles of the system. Other stimulating topics include the dispersion of innovation effects, the primary elements of production organisms and their relationships, and the issue of innovation chaining. The issue of intensive development, including changes in the *"real content of the innovation process"* associated with the acceleration and new quality of scientific and technological development, is subsequently addressed in the text (Valenta, 1983).

Apart from the 1969 book, Valenta's contribution is most comprehensively characterized by the 2001 text Innovation in Management Practices. However, its content and processing are conceived primarily as a practical tool - a handbook for current and future managers at every management level. This is reflected in an oversimplification at times, with the aim of bringing complex topics closer to managers. The publication contains a selection of practical issues concerning the innovation process, including, for example, hints concerning the position of people in the innovation process. The text provides extensions of the original innovation orders and, for example, numerous inspirations for studying business cycles. Explicit references to J. A. Schumpeter's work and the systems approach and theory are present.

2 The concept of innovation and innovation orders

F. Valenta has been described as a *"classic"* author of the theory and methodology of innovation and is often ranked among the greats such as J. A. Schumpeter or P. F. Drucker. In Schumpeter's conception, *"new combinations of production factors"* are understood as absolute innovations (the world's absolute novelties) and are classified into five cases. These may take the form of: 1. the production of a new product; 2. the use of a new production technique (technology); 3. the acquisition of a new market; 4. the acquisition of new raw material resources; 5. the use of a new economic organization of production, and may occur together.

The correlation between successful innovations and extraordinary gains, which are only temporary, is also elaborated. It disappears when hitherto new commodities become widely produced and sold. Let us recall that J. A. Schumpeter saw the dynamic developmental element of the capitalist economic system in innovation, which he used to explain the key economic categories (capital, profit, interest, competition, inflation, etc.). On innovation rests his explanation of cycles and his vision of other perspectives of capitalism - the evolutionary concept of self-liquidation. Schumpeter distinguishes between invention (discoveries, inventions) and innovation (introduction into the system). A decisive part of the post-war conceptions of innovation is built on these foundations. Definitions of innovation are gradually being refined, but it is probably impossible to find an exhaustive and generally valid definition.

Valenta defines innovation more broadly, including innovations already introduced elsewhere but applied for the first time in a given system (relative innovation). *"Any change in the internal structure of a production organism is called innovation"* (Valenta, 1969, p. 42). *"Innovation is any change in social practice, in its real and ideal structures ... It encompasses every conceivable change in society, from the rearmament of the productive unit to the emergence of new religious rituals"* (Valenta, 2001, p. 12). *"Industrial"* innovations are born in the enterprise, and they enter the economy through it. Inventions are transformed into results in financial terms and enable the entity to compete. Innovation can be seen as an elementary part of the activities or direct manifestation of the existence of an enterprise. Moreover, according to Valenta, there can hardly be any dispute that innovation is an endogenous economic factor.

One of the essential aspects of innovation classification is represented by the aspect of groups and orders of innovation. According to the degree of complexity, contemporary

teaching or professional texts (e.g., Švejda et al., 2002) divide the ten positive innovation orders into three groups of innovations - rationalizing, incremental (incremental), and radical innovations.

In the original conception, Valenta usually distinguishes 0-7 orders of innovation (1969). Zero order means maintaining production at a constant quantitative and qualitative level, where there are no conscious interventions apart from repairs and maintenance. The scope of second-order innovations is simple organizational changes leading to an increase in production, but neither the product nor the technological process is changed. In the 3rd order, there is already a qualitative improvement in the process. The product does not change, nor does the principle of the process, but the production equipment is better adapted to the production requirements (so-called adaptive qualitative change). In the 4th order, some of the elements of production or some of the functions of the product are already changed, this is a qualitative change called the creation of a new variant. A 5th order innovation represents a change in all production elements or several product functions - the creation of a new generation. The 6th order is characterized by a change in product or production concept, i.e. the emergence of a new species. It culminates in the highest, 7th order of innovation (the creation of a new genus), characterized by a change in the very principle of technological process (it is a fundamental change - a technical revolution). The division can be refined; Valenta himself extended the seven-line division to fifteen other stages. He also elaborated a scheme of complex innovations of the production organism, etc. Later he modified the classification and adjusted it, considering new facts and empirical investigations of the original concepts of orders. The classification of innovation orders appears most recently in the form of: order minus n (*"degeneration"*), order 0 (*"regeneration"*), rationalization innovation - *"rationalization"* (order 1-4), *"qualitative innovation"* (order 5-8) and "technological *disruption - microtechnology"* (order 9).

Order 1 represents *"change in quantity" - "simple quantitative change"* (change in the number of machines and workers). All properties are preserved, and the frequency of factors changes. Order 2 is referred to as *"intensity" - "intensity in the execution of individual operations",* e.g., during a run-in, but production organization remains unchanged. Quality and connectivity are maintained, and the speed of operations is changed (such as increased belt shift). Order 3 refers to *"reorganization"* - adjustments to the *"organization of production"* (e.g. moving operations between sites). There is no change in the design, materials, or fixtures used. Quality characteristics are maintained. Order 4 is referred to as *"qualitative adaptation" - "a changed mutual adaptation of the production factors involved in*

the production of an unchanging variant" (Valenta, 2001, p. 41). The quality for the user is kept, the link to other factors is changed, and technological constructions are used as an example. Qualitative innovations are most recently represented by innovation order 5 *"variant"*, 6 *"generation"*, 7 *"kind"* and 8 *"genus"*. The *"variant"* order maintains the design solution but changes the partial quality (e.g. a faster machine). The *"generation"* series retains the design concept, but the design solution changes (machine with electronics, etc.). The order *"kind"* preserves the principle of the technology and changes the design concept (e.g. jet loom). The order *"genus"* retains membership of the tribe and changes the principle of the technology (non-woven fabric, hovercraft, etc.). The highest order is *"technological revolution - microtechnology"*, and order 9 - *is "tribe"*. Nothing is preserved, the approach to nature is changed, and gene manipulation serves as an example (Sirůček, 2017).

3 Innovation and the business cycle

Valenta's theoretical considerations are based on the assumption of a natural *"cyclical"* order of the enterprise or economy. This is in the spirit of Schumpeter's *"innovation"* approach, for whom innovation became the starting point for the study of economic dynamics in periodically repeating cycles. He links cyclical fluctuations to the irregular distribution of innovations over time, which occur cumulatively. They occur in *"waves"* - clusters, where a cluster leads to a boom, and a recession is associated with the exhaustion of the potential of a *"wave"* of innovation of a certain order. Valenta (2001) operates with the concept of multi-cycle development, including the interconnectedness of cycles, and directly refers to the work of Schumpeter, which he develops. Valenta works with Kitchin, Juglar (J-waves), Wardwell (W-waves), and Kondratieff (K-waves) cycles. He tries to document that one K-wave (about 50 years) contains two W-waves, one W-wave (22-25 years) contains three J-waves (about 9-11 years), and one J-wave contains three Kitchin cycles (about three years in length).

The long K-waves are triggered by *"radical"* innovations, *"whereby new industries and branches of production are introduced. Schumpeter refers to them as "carriers" ... In the middle of the K-wave, several other related new industries start on the basis of the previously established new industries of the Wardwell wave"* (Valenta, 2001, p. 31). In the developed countries since the first industrial revolution, he identified: I. K-wave (from the end of the 18th century-1842, provoked by the steam engine and steam-powered machines, in the middle comes the application of the stationary steam engine as a means of propulsion of vehicles and locomotives in intra-company transport); II. The K-wave (1842-98, *"carrier"* is the expansion

of investment in public railways and the boom of steelmaking, in the middle begins the spread of industrial inorganic chemistry); III. K-wave (1898-ca. 1950, starting with the expansion of electricity, electrical engineering, automobiles, and aircraft, with new fields using electricity in the middle - vacuum electronics, radio, and later television) and IV. K-wave. This is supposed to last from 1947 to about the 1990s. He started with the semiconductor transistor's invention and soon began the expansion of transistorized mainframe computers, second-program television, and the penetration of electronic control into manufacturing facilities. On this basis, investment renewal of machinery and the production of electronically regulated household machines take off. The W-wave started around 1975 with the expansion of microelectronic chip applications (in computing and control technology, manufacturing, transport, medicine, communications, entertainment, households, etc.).

Valenta is considering the end of IV. K-wave and the onset of the V. long K-wave, e.g. in the USA in the 1990s. The economic downturn affecting Europe in the 1990s was already behind the US economy during the 1980s. The signs of the beginning of the V. K-wave are e.g. GDP growth, falling unemployment, low inflation, or an increase in material reserves. The most severe changes were to be triggered by the advent of a set of other micro technologies during the 1990s. At the beginning of V. K wave, the role of *"driving force"* was to cater to the increasingly widespread practical use of the Internet. All the new sectors of micro- and nanotechnology and their new types of products and services have common background characteristics. This distinguishes them from the new industries of the first three K-waves and the craft industries of the earlier ones. The emergence and spread of microtechnologies and the expansion of a fan of new industries and fields on this basis *"is an innovation of a higher order than, for example, the introduction of the steam engine and mechanical machinery in the Industrial Revolution. It is comparable to the advent of macro-technologies 12,000 years ago"* (Valenta, 2001, p. 40). The industries created in IV. K-wave, based on semiconductor electronics and microelectronics, were to inaugurate a new strain of microtechnologies.

However, the end of the IV. long K-wave, respectively the (non) onset of the V. K-wave remains a subject of debate (Dobrylovský, 2019; Sirůček, 2005, 2007). Some are inclined to the view that the V. long K-wave is still out of the question on a global scale, but others even operate with the onset of the VI. long wave (L. A. Nefiodow and others) (Sirůček, 2017; Džbánková et al., 2021).

Conclusion

F. Valenta directly followed J. A. Schumpeter, creating a comprehensive theory of innovation, which he classified into ten stages (orders). He explained the functioning of long-term economic cycles, where long K-waves are triggered by *"radical"* innovations of the highest orders, associated with *"the emergence and spread of completely new industries"*. He has undoubtedly contributed to creating the theoretical tools necessary to understand the current processes we call R4.0 or R5.0 and indirectly to the current debates about which phase and long K-wave we are currently in.

Contemporary global society is marked by the accumulation of long-standing unresolved problems that have escalated (migration crisis, warming of the planet, wars, etc.). Moreover, their successful resolution (or possible non-resolution) will undoubtedly significantly impact future developments and changes in local and global character (Jurásek, M. & al., 2016). The human community asks itself a series of questions, "What are our prospects in the first quarter of the new century? What should an adequate thought model for the 21st century look like?" The traditional capitalist economic system is associated with the imperative of economic growth and modern technology. Hence the West's *"obsession"* with innovation. The cult of constant change (as a supposedly automatic desirable good) versus the balance between change and stability. F. Valenta reminds us, however, that not every change is a change for the better; not every innovation necessarily has positive effects. In addition to positive innovations, harmful innovations are consequences of negative human activity. Growth and progress can, on the one hand, solve social problems (inequality, poverty, etc.) and, on the other hand, exacerbate environmental problems (pollution, loss of biodiversity). In this context, existing economic paradigms are often attacked. There is a critique of standard economics and the homo oeconomicus model. At the same time, there is an emphasis on environmental and social sustainability as an alternative to the ideology of growth at all costs. But what should an economy that provides a decent life for all people while respecting the planet's limits look like? What should be the practical pathways to no-growth (in local communities, at the national and global levels)?"(Raworth, K., 2020). Addressing these issues remains a challenge for the time being. New technologies may bring fundamental changes that the current global system becomes unsustainable. The development of V. and other K-wave technologies may need different conditions and *"rules of the game"*.

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