

# The Periodization and Analytical Framework of Economic Long Waves: A New Study from the Perspective of Historical Materialism

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**Abstract:** Proceeding from the perspective of historical materialism, this article examines technological revolution and industrial revolution as intermediate-level concepts for analyzing economic long waves, and reconstructs the political economy analysis framework of long-wave theory. Based on this framework, and in order to avoid a “mismatch” between economic long waves and the cycle of technological revolution, this article modifies the traditional method of periodizing economic long waves from trough to trough, instead employing the method of periodizing them from peak to peak as proposed by Perez. In this way, this article alters the periodization of economic long waves from the traditional five “inverted V-shaped” long waves to six “V-shaped” long waves. Within each industrial revolution, the technological revolution and institutional change that occur correspond to two “W-shaped” long-wave trends. Economic long waves are thus shown to be in essence external manifestations of the trend of evolution of the mode of production. In the final analysis, long-wave theory should not only reveal the decisive role of productivity and the mechanism of interaction between technology and the economy, but should also reveal the long-term changes undergone by politics and culture, and the laws that apply to them.

**Key words:** Kondratieff cycle; industrial revolution; materialist conception of history

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Since the 2008 financial crisis, economic circles both in China and abroad have focused on the stages and trends of economic development in advanced Western countries. In a speech at the Central Economic Work Conference on December 14, 2016, President Xi Jinping pointed out that

People who study economic trends should look both ahead into the future and back into the past. They should “predict the future based on the past and infer the implicit from the explicit,” and to achieve an understanding, should base themselves on the long period of economic development and the general background of global politics and the economy. (Party Literature Research Centre 2017, 111)

In the field of economics, the theory of economic long waves is an analytical tool that is relatively effective for “predicting the future based on the past and inferring the implicit from the explicit.” This article will discuss various viewpoints on the research methods and periodization of economic long waves as well as explanations of the theory, while putting forward a new analysis and suggesting how it will evolve in the future.

The term “economic long wave” refers to an economic cycle that lasts around 50 years and includes the two wave phases of upswing and downswing. Interestingly, academic research on these waves is itself experiencing exactly similar cycles. As the famous scholar in the field of long-wave theory J. J. van Duijn stated, “long wave depressions coincide with peaks in long wave research” (van Duijn 1983, ix). Rises and falls in the interest shown in research on economic long waves represent a cyclical feature that runs counter to the rises and falls of economic activity. When theoretical circles focus on economic long waves, their concern is not a case of “being alert to dangers even in times of calm” during economic prosperity and the rising stage, but of “thinking about changes when in extreme poverty.” The calculation made by the British scholar Hyde Clarke in 1847 that previous economic activities exhibited a 54-year long wave is generally held to be the earliest exposition on this topic, and the period concerned (from 1793 to 1847) is generally thought to have been a long-wave “trough.” However, it was not until the end of the 19th and the beginning of the 20th century that systematic research on the phenomenon of long waves began in economic circles. The contributions made by the Russian scholar Parvus in 1901, by the Dutch scholar van Gelderen in 1912, by De Wolff in 1924 and by others laid the foundations for research on long waves (quoted in Zhao 1988, 7).<sup>1</sup> During the 1920s the Soviet economist

Nikolai Kondratieff conducted relatively systematic and positive research on capitalist economic development (cited in Xu 2009), and the title of “father of the long wave” conferred on him demonstrates the contribution he made to long-wave theory. In 1939 Joseph Schumpeter’s *Business Cycles* (1939) made the “Kondratieff cycle” widely known. With the advent of the post-war “Golden Age,” research on long waves largely ceased. In the 1960s Ernest Mandel was the first to return to researching long waves, and predicted accurately that the long-term expansion would end (cited in Pei 2003). With the emergence of “stagflation” in the 1970s, more and more scholars including those of the Neo-Schumpeterian School, the Regulation School and the School of the Social Structure of Accumulation (SSA) participated in research on economic long waves. The outbreak of the financial crisis of 2008 also aroused increasing concern with structural crises and economic long waves.

## **Methods of Research on Economic Long Waves**

Despite the new progress continuously achieved in research on long waves since the beginning of the 20th century, this field is still full of disagreement and confusion. The reason may lie primarily in

the pervasiveness of inadequate methods, and the dependence on mainstream epistemological requirements for the construction of theories and the definition of models. Neoclassical doctrines were frequently rejected, but the general recourse to linear econometric methods reintroduced the equilibrium concept and imposed drastic restrictions on the historical nature of the series. Positivist standards were often rejected, but many authors accepted the atomistic and deterministic implication of the decomposition of time processes. (Freeman and Louçã 2001, 119)

In the past half a century, some scholars in evolutionary economics and Marxism devoted themselves to getting rid of mainstream epistemology and neoclassical doctrines, and renovating the methods used for researching economic long waves.

### **The Neo-Schumpeterian School: Reviving the Historical Approach Abandoned by Neoclassical Doctrine**

In the view of Freeman and Louçã, there are three types of methods for researching long-term waves: historical analysis, statistical and econometric analysis, and simulation modeling analysis. Kondratieff’s research on long waves simultaneously employed the historical description method and the econometric method. Once econometric techniques established their dominant position, however,

standard statistical and econometric methods came to be widely employed while historical analysis was gradually forgotten. After the 1970s, the efforts of some Marxist and Neo-Schumpeterian scholars allowed the historical method to be revitalized. Research on long waves conducted by Mandel, Gordon, Shaikh and Boyer and other scholars simultaneously applied the methods of statistical and econometric analysis as well as analysis of concrete history (quoted in Meng 2011). Unfortunately, the above-mentioned methods failed to achieve mainstream status in long-wave research in Western countries. The widespread popularity of the standard econometric analysis advocated by Kuznets (2009) and of the simulation model advocated by J. W. Forrester (1971) resulted in time and history being placed in a subordinate position and in research focusing on “statistical existence,” which was deprived of any historical tendency and endowed with the nature of equilibrium. The result was “a perfectly all-comprehensive endogenous model capable of generating the cycles, or a Laplacean demon knowing everything” (Freeman and Louçã 2001, 111). Carlota Perez also holds that the prevalent long-term aggregate series analysis insists on finding regular rises and falls in gross national product and other aggregate variables, and attempts to span two or three paradigms while taking money as the unit. This makes no sense, and necessarily leads research on long waves into a “trap” (Perez 2002, 60–62).

Freeman and Louçã therefore call for initiating a new research agenda of “reasoned history.” They maintain that people must reject the practice of simply applying the mainstream statistical and econometric method to comprehensive analysis of the process of long-term growth and change, and should give priority to the “reverse problem” in quantitative analysis, i.e., should prioritize identifying the features of the real-time series instead of the establishment and simulation of abstract models, and should accept the existence of complex causal relations between social, institutional and political factors. In other words, the reasoned history approach is “developed in the intersection between the historical, analytical, and descriptive statistical methods for hypothesizing causal relations and the modern and infant methods of nonlinear quantitative and qualitative research” (Freeman and Louçã 2001, 117). This approach “denies the extreme assumption about self-contained models and methods, and looks for integrated theories that will be incomplete and not definitive, explanatory and not predictive, historical rather than simply economicist, and evolutionary rather than mechanistic” (117). In the view of these scholars, “given that each subsystem [science, technology, economy, politics, culture] is defined as the heuristics for some social relation, their interrelations cannot be deterministically discriminated by an exhaustive account of a simple model or by endogeneity or exogeneity of variables” (121). Technological change, structural change and socio-economic movement “can be explained only as historical developments, as co-evolutionary processes” (122),

and the most important variable in understanding historical dynamics is the coordination process itself. Similarly, Perez also believes that the focus of research on long waves should be transferred from econometrics to seeking a qualitative understanding of the complex tensions and forces in the process of economic change, and for this purpose she even proposes to replace the term “long waves,” which contains a mechanical metaphor, with “great surge of development.” Obviously different from the mainstream methods advocated by Kuznets, Forrester and others, the arguments of Freeman and Louçã are closer to the method of analyzing the contradictions between productive forces and relations of production as well as between economic base and superstructure that are stressed by Marxist historical materialism, and that can provide more valuable explanations for the long-term changes in the capitalist mode of production. Perhaps wishing to avoid the criticism of “technological determinism” or “economic determinism,” however, Freeman and others highlight the independence of each social subsystem, and do not assign any single subsystem the dominant position in causal relations. As a result, they fall inevitably into a relativist mire of overdetermination, and describe capitalism as a system marked by continuous development and evolution, instead of one that changes continuously while being destined to collapse.

### **Marxist Theory: Intermediate-Level Analysis Taking Its Departure from the Contradictory Movement of Productive Forces and Relations of Production**

Just like scholars of the Neo-Schumpeterian School represented by Freeman and Perez, Marxist scholars including Mandel also object to the practice of mainstream

Table 1. Methodological Differences of the Three Basic Schools in Economic Long-Wave Theory

<i>School</i>	<i>System theory</i>	<i>Tool and method</i>	<i>Key indicator</i>	<i>Basic concept</i>
<b>Neoclassical</b>	Single system	Simulation model of linear econometrics	Reflected as the regular rise and fall of the macro-variables of currency and price	Simple and repeated movement
<b>Evolutionary economics</b>	Multi-system (overdetermination)	Non-linear, irreversible reasoned history	Coordination process of development and co-evolution	Irregular relativism
<b>Marxism</b>	Multi-system (with the economic system predominant)	Contradiction analysis of productive forces and relations of production	Capital accumulation process	Objective historical law

long-wave researchers who replace an in-depth analysis based on the process of qualitative economic change with econometric analysis and model simulation analysis. Mandel points out that

From the point of view of method, the choice of the key indicators is the first distinctive feature of the Marxist theory of long waves in economic development, as distinguished from the current academic theory. Marxists would refuse to follow those economic historians who center their analysis of the long waves on price and money movements. They would not deny that these movements are relevant to the diagnosis of the long waves, and they would even admit a relative autonomy of monetary phenomena. But they would start from the assumption, essential to Marxist economic analysis, that the basic laws of motion of the capitalist system are those of capital accumulation and that capital accumulation originates in the production of commodities, of value and surplus value, and their subsequent realization. (Mandel 1980, 8)

He therefore holds that the key indicators for research on long waves are those related to the movement trend of commodity production and commodity sales, i.e., the movement trend of social reproduction.

Although Marxist economists share the approach of taking capital accumulation and social reproduction as the key indicators, there are differences within the school where economic long-wave theory is concerned. For example, David M. Gordon, the famous researcher on economic long waves and founder of the SSA School, criticized Mandel for failing to “articulate a full methodological foundation for his interesting analysis of successive stages in the world capitalist economy” (Gordon 1998, 123). This shortcoming led Gordon to correlate directly the general law of capital accumulation with the concrete history of capitalist economic movement, and to formulate his explanation of the asymmetry of the upper and lower turning points of long waves. Although Gordon’s views seem to maintain a “consistency” between the tendency of the general rate of profit to fall and long-wave theory, they simultaneously separate the logical consistency of the long-term development of the capitalist economy and Marxist explanations. Both the SSA and Regulation schools believe that the capitalist economy is not only inclined to long-term fluctuations in the speed of capital accumulation, but also that these fluctuations are intermediated by the established institutional structure, i.e., the “Social Structure of Accumulation.” Members of these schools have made great efforts to establish a type of “intermediate-level analysis” between the general principle of capitalist development and concrete history, in order to explain the long-term fluctuations of the capitalist economy through analyzing the relationship between the capital accumulation process and the full set of the social institutions that affect it. Intentionally

or unintentionally, however, they neglect the important role played by technological revolution, and fail to advance “a comprehensive methodological foundation” for research on long waves (Meng 2011, 103).

Where the transformation of the production system caused by technological revolution is concerned, Mandel provided us with a useful reference. Centering the analysis in his book *Late Capitalism* on the trend of development of social reproduction, he selected six key indicators: organic composition of capital, distribution of constant capital between fixed capital and circulating capital, rate of surplus value, rate of accumulation, turnover-time of capital, and the relations of exchange between the two departments. In this way, he provided an important reference system for accurately understanding technological revolution and transformation within the production system (Mandel 1975). In his subsequent *Long Waves of Capitalist Development* he focused his research on the contradiction between the productive forces and the relations of production, under the title “Long Waves, Technological Revolutions, and Class-Struggle Cycles” (Mandel 1980). Douglass North, the well-known economist from the School of New Institutional Economics and keen scholar of the long-term trends of economic change, spoke highly of this analytical framework that connected technological revolution with class struggle:

The Marxian framework is the most powerful of the existing elements of secular change precisely because it includes all of the elements left out of the neoclassical framework: institutions, property rights, the states, and ideology. Marx’s emphasis on the crucial role of property rights in efficient economic organization and on the tension that develops between an existing body of property rights and the productive potential of a new technology is a fundamental contribution. It is technological change that produces the tension in the Marxian system; but it is through class conflict that change is realized. (North 1981, 61)

The Marxist theory of economic long waves thus needs to realize a synthesis. On the one hand, it must absorb the methods of the Regulation and SSA schools, employing “intermediate-level analysis” and connecting economic long waves with various stages of capitalist development. On the other hand, and while referring to Mandel’s framework, it needs to grasp the contradictory movement of the productive forces and the relations of production, at the same time as it comprehends the trends of movement of capitalist reproduction within a framework that attaches importance to the fundamental position of the productive forces and is compatible with technological revolution and institutional change.

In brief, although Marx himself did not explicitly refer to economic long waves within capitalism, his analysis of the contradiction between the productive forces

and the relations of production, together with his principle of historical materialism, can provide the methodological basis for long-wave research. First, economic long waves within capitalism represent the long-term tendency and external manifestation of the evolution process of the capitalist mode of production.<sup>2</sup> This tendency is the concentrated expression of the combined action of multiple factors and various forces at various stages in the development of the capitalist economy. That is to say, economic long waves in capitalism make up a “symphony” within which multiple factors interact with each other; they represent the “joint effect” of “innumerable conflicting forces, an infinite number of parallelograms of forces,” and not a “solo” of economic power.<sup>3</sup> Together with the social structure and regulation system of capital accumulation, each social subsystem of science, technology, the economy, politics and culture is an important element indispensable for understanding and explaining the economic long waves of capitalism. Second, the economic long waves of capitalism correspond to the long-term tendency of the contradictory movement of the productive forces and the relations of production, and are external manifestations of it; meanwhile, it is this tendency that determines the basic direction of development of the capitalist economy at various stages. In other words, factors such as wars, natural disasters, gold production and population shifts can disturb or impede, but cannot change, the basic tendency shaped by the above-mentioned leading forces. At the same time, the economic long waves of capitalism do not repeat themselves mechanically, operating in a cyclical manner, but constitute a dynamic process in which various contradictions of capitalism are continuously deepened and developed. Finally, these waves are ultimately the external manifestation and reflect the long-term tendency of the laws of development of the capitalist productive forces, and this tendency is the basic force that determines economic development at the various stages of capitalism. “All collisions in history have their origin . . . in the contradiction between the productive forces and the form of intercourse” (Marx and Engels 2010a, 74). Thus,

In acquiring new productive forces men change their mode of production; and in changing their mode of production, in changing the way of earning their living, they change all their social relations. The hand-mill gives you society with the feudal lord; the steam-mill, society with the industrial capitalist. (Marx and Engels 2010b, 166)

Grasping the inherent essence of the capitalist structural change implied by economic long waves, therefore, is only possible if our point of departure is the law of development of the productive forces and the law of movement of the contradictions between the productive forces and the relations of production, and if this is combined with concrete historical and intermediate-level analysis of capitalist development.



Where the direction of theoretical development is concerned, we accept the emphasis indicated by Gordon (1998, 123) when he criticized Mandel for providing “successive stages in the world capitalist economy”; that is, an intermediate-level summarization, in stages, of the overall feature of social reproduction. Placing too much emphasis on the factor of institutions, however, and making theoretical summarizations from the institutional level is not conducive to grasping this overall feature. We should instead seek to grasp the direction of the movement of social reproduction within a framework that is compatible with technological revolution and institutional change, and Mandel’s framework is a good reference in this respect. Therefore, “a comprehensive methodological basis” should effectively synthesize intermediate-level analysis with the importance of technological revolution, while summarizing the basic characteristics of different stages of economic and social development starting with the movement of the productive forces and the relations of production. In this way, an intermediate-level analysis that interprets economic long waves can be formulated. Technological conditions and stages of industrial development that directly manifest the level of the productive forces are the key elements that should be given priority. For this, the perspective of “productive forces in a broad sense,” employed by Marx in investigating various industrial stages, can provide helpful inspiration:

a certain mode of production, or industrial stage, is always combined with a certain mode of co-operation, or social stage, and this mode of co-operation is itself a “productive force.” Further, that the aggregate of productive forces accessible to men determines the condition of society, hence, the “history of humanity” must always be studied and treated in relation to the history of industry and exchange. (Marx and Engels 2010a, 43)

## **Periodization of Economic Long Waves**

The first question that research on economic long waves needs to answer is whether various concrete historical periods are located in the upswing or downswing phase of a long wave. In other words, when do the upswing and downswing of each long wave begin and end? This judgment is also known as the periodization of economic long waves. Divergences in research methods necessarily lead to differences in theoretical viewpoints, and these differences are reflected in differences in the periodization.

Table 2 shows that although researchers of long waves generally agree on the existence of four long waves, they disagree on the time when each long wave began and ended as well as on the periodization, which has caused many mainstream scholars to doubt the existence of economic long waves. For example,

Table 2. Different Scholars on the Periodization of Long Waves

	The first long wave		The second long wave		The third long wave		The fourth long wave	
	upswing	downswing	upswing	downswing	upswing	downswing	upswing	downswing
Kondratieff	1780 to 1810-1817	1810-1817 to 1844-1851	1844-1851 to 1870-1875	1870-1875 to 1890-1896	1890-1896 to 1914-1920			
Schumpeter	1787-1813	1813-1842	1842-1857	1869-1897	1897-1911	1911-1946	1946-	
Rostow	1790-1815	1815-1848	1848-1873	1873-1896	1896-1920	1920-1935	1935-1951	1951-1972
Mensch	1795-1825	1825-1845	1845-1885	1885-1905	1905 to 1930-1935	1930 to 1935-1945	1950-1970	1970-1990
van Duijn	1780-1825	1825-1845	1845-1872	1872-1892	1892-1929	1929-1948	1948-1973	1973-
Freeman	1780-1815	1815-1848	1848-1873	1873-1895	1895-1918	1918-1940	1941-1973	1973-
Mandel	1793-1825	1826-1848	1848-1873	1874-1893	1894-1913	1914-1939	1940-1945 to 1967	1968-
Tao Zhao	1760-1825	1825-1830	1830-1850	1850-1872 (1873-1880 Great Depression)	1880-1914	1915-1940 or 1950	1956 (1950)-1972	1973-
Feng Gao	1790-1815	1815-1848	1848-1873	1873-1896	1896-1929	1929-1948	1949-1973	1973-1982
Angelo Reati and Jan Toporowski	1780s-1815	1815-1848	1849-1873	1873-1895	1895-1918	1919-1940	1941-1973	1974-1992
Mario Coccia	1780-1811	1811-1838	1838-1867	1867-1892	1892-1919	1919-1945	1945-1974	1974-1992

Source: Zhao (1988, 9-10, 16, 23, 48-49, 243-246), Freeman and Louçã (2001, 141), Mandel (1980, 105), Gao (2018, 60-105), Reati and Toporowski (2009, 147-190), and Coccia (2010, 730-738).

Samuelson in his textbook made no remarks on whether economic long waves were a basic law or fortuitous historical phenomena, holding that it was currently hard to decide whether economic long waves were purely accidental caused by the discovery of gold mines, new inventions or wars (Samuelson 1982, 357). Majewski also notes that in Samuelson's view, "the so-called 'Kondratieff wave' is a hypothesis which has not been verified" (Majewski 1993, 16). However, the difficulties of identifying long waves cannot be used to deny their existence. van Duijn pointed out that it was impossible to establish the peaks and troughs of long waves precisely, and that a margin of error should be allowed where the dating of long-wave turning points was concerned (van Duijn 1983, 79). The Japanese scholar Miyoei Shinohara held that technological revolution determines the cycle of long-term fluctuations, and that the length of the long-term fluctuation is determined by the speed and scale of technological revolution. Due to the differences in the speed and scale of technological revolution in different historical periods, Kondratieff long waves should not be expected to display a strict regularity, but neither should the existence of long-term fluctuations be denied due to the large differences in their cycles. It is an undeniable fact that there are long-term fluctuations in capitalism, lasting longer than short and medium-term fluctuations (Shinohara 1983). Freeman and Louçã also believe that the term "long wave" can easily create a false impression that these waves are smooth and regular, though these are not true characteristics of the long-term fluctuations that researchers describe. Because every technological revolution is uneven in its effects, the periodization of long waves is inevitably irregular (Freeman and Louçã 2001, 150). In our opinion, economic long waves are complex phenomena with long time-spans, so making accurate periodizations of them is neither realistic nor necessary, and a certain range of tolerance should be allowed. Regardless of whether differences in the periodization of long waves are the result of differences in the statistical data and methods of analysis employed by researchers, or whether the differences occur due to changes in the historical conditions influencing the long waves themselves, the existence of economic long waves and the value of conducting research on them will not be affected. "The succession of different economic eras generates 'long waves'" (Nelson 2001, vii). The value of research on long waves does not lie in accurately identifying the specific time-frames involved, but in permitting a scientific grasp of the "period trend" of different economic eras, so as to explain the long-term changes in the capitalist mode of production in a more reasonable manner.

### **The Question of the Beginning of the First Long Wave**

Table 2 shows that although there are disagreements as to the specific periodization of each long wave, researchers generally hold that the first long wave began

between 1780 and 1790. An exception here is Tao Zhao. One of the first Chinese scholars to conduct systematic research on economic long waves, Zhao believes that “the capitalist economy experienced its first long wave between 1760 and 1830, with the period between 1760 and 1825 representing the upswing of this long wave and the period between May 1825 and 1830 the downswing” (Zhao 1988, 117). The reason why Zhao arrived at this position is her belief that the first economic long wave was the product of the Industrial Revolution. In fact, scholars have not reached a consensus on the starting point of the first long wave. Immanuel Wallerstein pointed out that the Kondratieff cycle is an indispensable component of the process of capitalist development, and that it can logically be inferred that the cycle began at the point when capitalism came into existence; that is, that the cycle has operated since “the long 16th century” (Wallerstein 2013, 6). Similarly, works by J. Goldstein and others have also argued that before the Industrial Revolution and in the late 18th century the Kondratieff cycle already existed, caused by historical developments resulting from various exogenous factors and reflected as an irregular economic phenomenon (Majewski 1993). Nevertheless, most scholars are still inclined to believe that before the First Industrial Revolution human society remained in a situation of natural economy with economic development slow and smooth, that an economic long wave could not possibly emerge, and that the first long wave began when Britain entered the Industrial Revolution (Zhao 1988, 107). Due to the lack of materials and data, we will provisionally accept the view that the first long wave began around 1760–1770.<sup>4</sup>

We contend, however, that the first long wave, which accompanied the development of the First Industrial Revolution, manifested itself first as a downswing. The Russian economist Majewski argued that economies in the late 18th century fell into depression as a result of the last exogenous long wave in Europe and North America, and that this was followed by the first long wave in the industrialization period. That is to say, the First Industrial Revolution began at a time of rupture between the old and new structures of the European economy, as a result of which the economy was positioned in the downswing of the long wave. In fact, analyses by many researchers of long waves support the above view. Kondratieff’s research demonstrates that price levels and physical output showed a synchronous fluctuation, and judged by the fluctuation of the price index, the British economy before 1789 was undoubtedly in the downswing of a long wave (van Duijn 1993, 78–83, 121). Walt Rostow, a modern theorist of long waves who also explained them as price cycles, not only confirmed that 1789–1790 was a downswing year for prices, but also pointed out that although the incessant warfare before the 1780s did not lead to an absolute decline of production, it slowed the growth of the British economy, causing the growth rate of the international trade of Britain and the world to decline sharply from 62% and 59% during 1720–1750 to 10% and

33% during 1750–1780, respectively (Rostow 2014, 42, 116–117). Other scholars employing long-term aggregate series analysis also mostly acknowledge that 1789–1790 marked the lower turning point, that is, they hold that the British economy in the preceding years was in a long-wave downswing. Analyses by the Neo-Schumpeterian School, which employs a method different from that of the mainstream, also support this view. Gerhard Mensch in his 1975 work *Stalemate in Technology* explicitly pointed out that “only in the trough of the cycle, when the profits of used-up technologies are unbearably low, will capital overcome its aversion to risk-taking and throw itself upon the possibilities of available basic innovations” (cited in van Duijn 1983, 108). In other words, it is only during the depression stage of the long wave that basic innovations can occur in groups. Similarly, Perez holds that technological revolutions characteristically begin “amidst a world threatened with stagnation” (Perez 2002, 49). Britain after the 1760s was clearly in such a period. From the 1760s onward, the number of patents approved in Britain showed a tendency to rise sharply. It was not until the late 1780s, however, that these inventions were applied widely in industrial production. Both in terms of empirical data and of theoretical logic, we have cause to believe that the period from 1760–1770 to 1790 represented the downswing of the first long wave.

### **Economic Long Wave Trends since 1973**

Unlike the consensus reached by scholars on the beginning of the first long wave, interpretations of the present period are mixed. Most researchers believe that 1973 initiated the downswing of a long wave, but there are diverse views on whether this downswing has ended, and in general on how to characterize the stage that the contemporary world economy has reached. Scholars including Freeman and Louçã (2001), Reati and Toporowski (2009), Mario Coccia (2010), and others hold that the years from the 1970s to the 1990s, marked by structural adjustment policies, were a period of long-wave downswing. According to these researchers, 1992 marked another lower turning point, after which a new expansionary long wave began. The Chinese scholars Zeyuan Liu (1995), Ke Wang (1997), and Ligao Chen and Junyan Qi (2004, 2007, 2009) also believe that the long-wave downswing that began in the 1970s ended around 1992, and that a new expansionary long wave then followed. Other scholars have expressed different opinions. For example, Professor Feng Gao has revised the view proposed in 2002 that the most recent upswing began in the 1990s (Gao 2002), contending that this expansionary long wave should be dated to the years between 1982 and 2008 (Gao 2018). Gao also considers that the “Golden Age” between the 1950s and 1970s should not be denied, and holds that the long-wave downswing beginning in the 1970s lasted only ten years.

Disputes on when the long-wave downswing that began in the 1970s ended are linked to similar disagreements on when the following upswing began, that is, on the question of whether an expansionary long wave occurred after 1980. Broadly speaking, scholars who have focused on the rate of profit as an indicator hold that if the United States is taken as representative of the capitalist world, an expansionary long wave emerged after 1980. Anwar Shaikh is among those who take this view; he has proposed that after 1980 a “great boom” occurred, marked by an increase in the rate of profit in the United States (Shaikh 2011). Data provided by Duménil and Lévy (2016) also show an obvious picking-up of the US profit rate from the 1980s. Gao (2018) provides a detailed analysis pointing to an expansionary long wave after 1980. Gao concentrates on three aspects: technological revolution, a pick-up in the profit rate and enlargement of the world market. Many Marxist economists, however, do not accept the existence of this round of long-wave upswing. One is the American scholar Robert Brenner, who holds that neoliberalism triggered a round of long-term recession from the 1970s to the 1990s (Brenner 2006). Others with similar views include the American scholar James Crotty (2000).<sup>5</sup> Representative empirical data are provided by the research of Phillip O’Hara (2003), which covers the whole period from 1973 to 1995 as an integral field of investigation. O’Hara attaches importance to trends in other countries apart from the United States, and considers that from the perspective of the whole globe, the upswing after 1980 is not so conspicuous.<sup>6</sup>

We contend that no matter whether the mainstream method of aggregate series analysis or Freeman’s “reasoned history analysis method” is employed, the view that the downswing of the last long wave ended in the 1990s can always be well supported. According to calculations by the British economic historian Angus Maddison, the average annual GDP growth rate of the United States, France, Germany, the Netherlands, the United Kingdom and Japan declined from 5.31% in 1950–1973 to 2.41% in 1973–1992. The average annual growth of labor productivity declined from 4.91% to 2.34%, and of total factor productivity, from 3.04% to 0.83%. Data for the G7 countries provided by Brenner also indicate that average annual growth in the output of private enterprises in the G7 declined from 4.5% in 1950–1973 to 2.2% in 1973–1993, while the average annual growth of labor productivity declined from 3.6% to 1.3% (Gao 2010). The years from 1973 to 1992 were obviously a very different period from the “Golden Age,” with significantly lower rates of growth in GDP and productivity. From 1992 accompanying the relative prosperity of the “new economy” brought about by the spread of the new technological revolution, the acceleration of globalization caused by the extension of neoliberalism and the collapse of the Soviet Union and Eastern European countries, and the generalization of new business forms such as the world-wide division of value chains (Liu 2016), the global economy entered into

a new wave of expansion. This new upswing was to last until the outbreak of the 2008 financial crisis. According to statistics from the International Monetary Fund, the average annual growth rate of the global economy between 1996 and 2007 reached 3.9%.<sup>7</sup> The outbreak of the 2008 financial crisis, marking the upper turning point of the long wave, initiated a huge change in the mode of production and a global depression that saw extensive adjustments to the “technological structure” and “institutional structure” of capitalist accumulation.

### **Six “V-Shaped” Long Waves**

On the basis of previous studies and the above analysis, we provide a timeline of long waves as shown in Table 3. It needs to be illustrated that: (1) since the First Industrial Revolution, capitalist economic development has experienced six Kondratieff long waves, and is currently situated in the downswing of the sixth wave, the upswing of which will begin in the 2030s; (2) the transition from one long wave to another is a process involving continuous evolution, and the selection of a certain year as the beginning or end of a long wave is only of symbolic significance, indicating that the year concerned is approximately when the turn occurs. Meanwhile, the duration of long waves varies, though on the whole there is a tendency for them to become shorter; (3) the decision to demarcate long waves on a trough-to-trough or peak-to-peak basis is not a simple question of random selection, but on the contrary, requires an accurate understanding of what constitutes an independent long wave. Perez points out that Kondratieff, Schumpeter and most of their followers measured each long wave from trough to trough, effectively including the second half of one technological revolution with the first half of the next. To avoid a mechanical understanding of all previous Kondratieff long wave time series, Perez takes as the starting point the important technological breakthrough that on each occasion triggered the rise of technological revolution, and defines each economic long wave as lasting from peak to peak. Each long wave thus covers the whole lifecycle of a technological revolution. This allows a better understanding of the essence of the structural changes implied by all previous long waves (Perez 2002, 23, footnote 30). The American member of the SSA School David Kotz adopts a similar approach. In order to avoid the practice of including different “economic periods” in one long-wave cycle, Kotz revises the practice of the SSA School of including the “Golden Age” after the Second World War and the “stagflation period” after the 1970s (i.e., the period of Keynesianism and that of neoliberalism) in one long wave, and places them in two separate long-wave cycles with different institutional arrangements (Kotz 2009). In order to accurately grasp the essence of economic long waves, we refer to the above viewpoints and periodize each long wave by beginning with the downswing, thus obtaining six “V-shaped” long waves.

Table 3. Timeline of Long Waves

	<i>downswing</i>	<i>upswing</i>
The first long wave	1760s–1790	1790–1825
The second long wave	1825–1848	1848–1873
The third long wave	1873–1893	1893–1913
The fourth long wave	1913–1945	1945–1973
The fifth long wave	1973–1992	1992–2008
The sixth long wave	2008–2030(?)	

### Theoretical Explanation of Economic Long Waves

Seeking a theoretical explanation of the formation mechanism of economic long waves, the mainstream aggregate analysis treats them as undulatory movements formed by changes in the speed of economic growth, and thus focuses on explaining aggregate indicators such as GDP growth rates. More valuable insights are to be had from the Neo-Schumpeterian School and from Marxist doctrines. Freeman and Louçã point out that the rise and fall in each long wave are not only reflected in changes in the growth rate of gross output, but more importantly lie in the structural adjustment brought about by the new technology clusters. The combined aggregate of all industries, they note, can “hardly reflect the structural adjustment of the long wave” (Freeman and Louçã 2001, 257). Perez as well believes that an explanation of economic long waves should not rely primarily on economic factors, and that long waves “should be understood as much more complex, society-wide processes” (Perez 2002, 23). To overcome the tendency to technological determinism inherent in Schumpeter’s theory of long waves, these latter scholars put forward a theoretical model that stresses the co-evolution of factors including technology, the economy, institutions and so on, and discuss how technological revolutions and institutional innovations promote the formation and eventual replacement of techno-economic paradigms, leading to the “rise and fall” of each “great surge of development.” Mandel too argues that “long waves are much more than just rhythmic ups and downs in the rate of growth of the capitalist economy. They are distinct historical periods in a real sense” (Mandel 1980, 105). In his opinion, the rise and fall of profit rates, constrained by several basic economic variables, represents the major force leading to the long-term economic fluctuations. The inner logic of the law of capitalist movement can explain the transition from an expansionary long wave to a stagnant long wave, but it cannot explain the transition from a stagnant long wave to an expansionary long wave, which requires



fundamental changes in the general historical and geographical conditions of the capitalist mode of production. The SSA School and Regulation School instead emphasize that long-term economic fluctuations within capitalism should be attributed to the extent to which “institutional structure” promotes or impedes capital accumulation. It is obvious that there is room for further discussion as well as the possibility for further synthesis of the above research.<sup>8</sup>

We believe that economic long waves are external manifestations of the process of evolution of the capitalist mode of production, reflecting its long-term tendencies, and that since the mid-18th century this process of evolution has taken the form of the expansion of industrial revolution. Therefore, research on long waves necessarily requires comprehensive investigation and in-depth analysis of the many factors that influence this expansion, as well as of the logic governing the evolution of the capitalist mode of production itself. Only in this way can we perceive the “long-run tendency below the surface of observable economic phenomena” (Eklund 1980, 412). Referring to the basic observation of Marx that “a certain mode of production, or industrial stage, is always combined with a certain mode of co-operation, or social stage” (Marx and Engels 2010a, 43), we take all previous industrial revolutions as the “intermediate-level” category that summarizes the development stages corresponding to all previous economic long waves. In this way, we realize the principle, emphasized by Marx, that “‘the history of humanity’ must always be studied and treated in relation to the history of industry and exchange” (Marx and Engels 2010a, 43).

### **Understanding Economic Long Waves from the Perspective of Industrial Revolution**

In the extensive glossaries of economic historians, “industrial revolution” is probably the term most widely accepted by the public. It is, however, also the term that is most misunderstood by the public in terms of the essence of economic change (Cameron and Neal 2012, 194). People have always had multi-dimensional interpretations and diverse viewpoints on the basic meaning, historical definition and development process of industrial revolution. One popular view is that the essence of industrial revolution is a major change in the technological pattern of production of human society. According to this view, the First Industrial Revolution began with the application of the steam engine to production in the 1760s, initiating the “Age of Steam” of human society. The Second Industrial Revolution, according to this scheme, began with the widespread application from the 1870s of electricity, soon to be followed by the appearance of the internal combustion engine. This created “the Age of Electricity.” The Third Industrial Revolution began with the development and application of computer and information technology after the Second World War, setting off the “Information Age.” Jeremy Rifkin,

who viewed industrial revolution in these terms, pointed out in his 2011 book *The Third Industrial Revolution* that each industrial revolution involves a revolution in energy technology and a revolution in communication technology as well as their mutual integration (Rifkin 2012, 31–32). By contrast, the other popular view identifies industrial revolution by focusing on the organizational mode of production. According to this view, the First Industrial Revolution rested on the “factory system.” Expedited by the mechanization of manufacturing in the late 18th century, this replaced the earlier organizational mode of production that featured family workshops. The Second Industrial Revolution was based around the “Fordist” flow production line created by the “automation” of manufacturing in the early 20th century. This caused “mass production” to become the dominant organizational mode of production in manufacturing. The Third Industrial Revolution has involved the “digitization” of manufacturing, on the basis of which “mass customization” may become the mainstream organizational mode of production in the future (*The Economist* 2012). In addition, there are other scholars who identify industrial revolution by placing emphasis on the dimension of social change. In his 2016 book *The Fourth Industrial Revolution* Klaus Schwab, founder and executive chairman of the World Economic Forum, defined the ongoing or forthcoming industrial revolution as “the Fourth Industrial Revolution,” seeing it as amounting to a profound, comprehensive and systematic social change triggered by the integration of physics, digitization and biotechnology (Schwab 2016).

Each of the above understandings of industrial revolution has its unique perspective and value, but these understandings are either too narrow, viewing industrial revolution as technological or organizational change, or else excessively broad, interpreting it as social change and basically staying at the level of phenomenal description, thus failing to satisfy the operational requirement of theoretical construction and policy analysis required for economics. From the perspective of political economy, we argue that industrial revolution is the evolutionary process of the capitalist mode of production, and that if its essence is to be accurately understood, its basic features need to be grasped in terms of three aspects: its systematic character, its process of evolution, and its volatility.

Industrial revolution is a process of systematic change, with many factors interacting with each other as both cause and effect. This systematic nature of industrial revolution necessarily brings about huge changes in the paradigms of the divisions, industrial structures, global patterns and even survival modes of human society. That is to say, industrial revolutions make their impacts not only in the industrial field, but also in the commercial, agricultural and other fields of a society. Perez, Freeman and others have thus always believed that without the simultaneous emergence of deep social, organizational and institutional innovations, a systematic “industrial revolution” will not occur, while Schwab also

interprets “industrial revolution” as involving profound, comprehensive and systemic social change. Nevertheless, if we are to avoid a generalization of the concept that might cause it to lose its operability, we must be careful to distinguish between industrial revolution and its impacts. The essence of industrial revolution, as the evolutionary process of the mode of production, is systemic change in the technological and organizational mode of social production. From the perspective of the technological mode, industrial revolution is a systematic change in the interconnection technology, power technology and manufacturing technology of social production. Interconnection technology, including primarily communication and transportation technology as well as information technology, has been an important force promoting all previous industrial revolutions and defining the course of human progress, but it is nevertheless easily ignored. Reviewing the history of industrial revolutions, we find that interconnection technology has played the key role at each stage. The development process of industrial revolutions is also the process that promotes “interconnection”; without the prosperous trade and cultural communication brought about by progress in the connections between human beings, between human beings and things, and between things, human society cannot make significant progress. From the perspective of the organizational mode, industrial revolutions are the sum of systematic changes in the relationships between labor, between labor and capital, between blocs of capital, and between the state and capital. Obviously, industrial revolutions involve not only systematic changes in the technological and organizational modes of social production, but also processes of change in which the two modes coordinate with and complement each other.

A second consideration is evolution. As various critics have pointed out, although the word “revolution” highlights the huge and irreversible impact that industrial revolution has had on the economy and society, it can readily lead people to ignore the consistency of the historical process and to misunderstand industrial revolution as a process that can more or less instantaneously sever the relationship with the “old times” (Cameron and Neal 2012, 194–195). Since industrial revolution involves systematic changes to the technological and organizational modes of social production, changes in any one of its elements, and in their integration, necessarily require a lengthy and gradual evolution process. The radical changes that people observe as occurring suddenly, such as the sudden rise of a series of new technologies and emerging industries, are actually the result of continuous evolution and of the long-term integration of a constellation of technological and organizational innovations that have been closely entwined together. As Douglass North (1981, 163) remarks, the process that leads “from initial conceptualization to establishment of technical feasibility—that is, from invention to commercial feasibility, innovation to subsequent diffusion” is often long and intricate. Even dramatic

inventions may take almost a hundred years to replace their predecessors. John Bates Clark, one of the founders of the American Economic Association, concludes from his empirical research on Germany and the United States that the maturation process of a new mode of production would need as long as 45 years (cited in Freeman and Louçã 2001, 144). The American economist Robert J. Gordon, basing himself on historical observations, has also pointed out the existence of a comparatively long time-lag between the emergence of the great inventions of the Second Industrial Revolution and the point where they began to have important economic impacts. For example, electricity and the internal combustion engine, the core inventions of the Second Industrial Revolution, emerged between 1870 and 1900, while it was not until the 1910s that they were widely used in the industrial field, and only from the 1920s that they had a significant impact in enhancing total factor productivity. The same is true of digital technology in the Third Industrial Revolution. Although mainframe computers were already being used in some large companies in the 1960s, and personal computers began gradually to be popularized in the 1980s, their strong impact on total factor productivity occurred primarily during the period between 1994 and 2004 (Gordon 2018, 550–551). It is precisely for this reason that Freeman and Louçã describe the industrial revolution process as “continuously emerging industrial revolution,” and that scholars including Thomas K. McCraw, Kristine Bruland, von Tunzelmann, Chandler, Perez and others are inclined to consider each previous industrial revolution as a “one-hundred-year cycle” (cited in Jia 2013).

A third consideration is volatility. Since all previous industrial revolutions were one-hundred-year processes, an industrial revolution obviously cannot be an evolutionary process consisting of linear development. Throughout the development history of industrial revolutions, we see that one industrial revolution often corresponds to two Kondratieff long waves. Referring to the studies by Perez, by Freeman and Louçã, and others, we contend that all previous industrial revolutions can be divided into four stages: a period of introduction (start-up), an expansion period, a coordination period and a maturation period. Each industrial revolution has begun when the potential of the preceding industrial revolution has been exhausted, so that the economy is in the depression stage of the long wave. This is a “transition period” of structural adjustment, a time when the old and new economic paradigms experience continuity and alternation, and it is the period during which each of the previous industrial revolutions has been introduced. “Divergence between the new and the old characterizes this phase” (Perez 2002, 50). This period is the infant stage of the new technological and organizational systems, and also the stage of decline of the old systems, a time when economic operations are characterized by slowly growing output, but more important, when the rapid growth of a constellation of new technologies brings about structural adjustment.

The expansion and growth of the emerging industries contrasts sharply with the stagnation and contraction of the existing industries (Freeman and Louçã 2001, 257). With the gradual diffusion of the emerging technologies, however, and the continuous development of “forerunner industries,” the industrial revolution enters its expansion period. “Centrifugal tendencies” are an important feature of this period, in which emerging industries that are not yet fully developed are liable to expand excessively, impelled by the frenzy of capital and driving the economy into an expansionary long wave. “Structural imbalances,” however, necessarily result as other related technologies and industries, as well as arrangements in the organizational system, fail to effectively follow up. The industrial revolution will be forced to shift from the expansionary phase of the long wave to the depression phase, and will enter a coordination period. Coordination is “in essence the coupling carried out for the purpose of expansion,” and the coordination period is an “age of turbulence” during which constellations of dominant and secondary technologies, as well as the corresponding institutional arrangements and organizational systems, will experience further development and integration with each other, reshaping the “balanced structure” of social production (Hu and Liu 2013). With the establishing of the new “balanced structure,” the industrial revolution will again surge upward and finally enter the maturation period. This is the “Golden Age” of economic growth, a time when the benefits of the techno-economic paradigms of all previous industrial revolutions will be fully released, and which will finally move toward depression.

### **Three Industrial Revolutions and the “W-Shaped” Tendency of Long Waves**

As a summary of the above analysis, we provide Table 3 that explains all the previous industrial revolutions and economic long waves. As Table 3 shows, until now human society has experienced three industrial revolutions, and the development process of each industrial revolution is manifested in two Kondratieff long waves, revealing a “W-shaped” trend.

The First Industrial Revolution began with the British cotton textile industry in the 1760s. James Hargreaves invented the “Spinning Jenny,” triggering a chain reaction of machine invention and technological innovation, and initiating the period of introduction of the First Industrial Revolution. With the advent of manufacturing technologies such as water frame technology, coke smelting and so on, and equipped with steam power technology as well as the corresponding productive and organizational modes of the factory system, the British cotton textile industry began to cast off the constraints of the old mode of production.<sup>9</sup> As the “forerunner sector,” it led the First Industrial Revolution into its “expansionary period,” setting off the upswing of the first Kondratieff long wave. After 1790 the

British cotton textile industry developed rapidly, with a growth rate several times of that of other industrial sectors, and caused the British economy to show continuous and unprecedented growth. However, the overproduction caused by the excessively rapid expansion of the cotton textile industry, and the full-blown crisis as a result of the structural imbalance caused by this overproduction, ended this round of the long wave in 1825. The First Industrial Revolution then entered the coordination period of structural adjustment, and the downswing of the second Kondratieff long wave began. During this period the development of the steam locomotive and the railway network, of mechanical printing and of interconnection technology such as the telegraph significantly improved the quality and efficiency of transportation and communications, promoting the expansion of the market and enhancing productivity. The synergistic effect that combined iron, coal, the steam engine, railway equipment, machinery and machine tools was strengthened, causing the industrial revolution to spread into industries and areas that had not yet been significantly affected by the first Kondratieff long wave. The First Industrial Revolution thus entered its maturation period in the late 1840s, at the same time initiating the upswing of the second Kondratieff long wave.

All modes of production have the dynamic characteristic of connecting the present with the past. Previous industrial revolutions are not separated entirely from the current revolution, and the stage that sees the fruits of the previous industrial revolution exhausted is precisely the gestation period of the new industrial revolution. After 1870, at the same time as returns to the dominant industries of the First Industrial Revolution were obviously decreasing, the introductory period of the Second Industrial Revolution began, and the downswing of the third Kondratieff long wave was initiated. During this period the “lock-in effect” of the old mode of production that had become established in the First Industrial Revolution came to confront the “expansion effect” of the emerging industries, including the electrical industry, the iron and steel industry, and so on.<sup>10</sup> This had the effect of making stagnation the norm for economic performance in Britain and the United States. Nevertheless, continuous innovation and the spread of steel manufacturing technology, the internal combustion engine and electric power technology, along with the emergence of large companies and of the productive and organizational mode of Taylorism, saw the conditions for a new set of investment opportunities based on cheap steel and electricity gradually emerge. The Second Industrial Revolution thus entered its expansionary period in the early 1890s, initiating the upswing phase of the third Kondratieff long wave. This was a “gilded age” when emerging sectors of industry including chemicals, steel, electric power, petroleum, automobiles and so on expanded rapidly, at the same time creating serious imbalances in the economic and social structures and even in the international landscape. With the outbreak of the 1913 economic crisis, the Second Industrial Revolution ended

Table 4. Industrial Revolutions and Kondratieff Long Waves (Each Industrial Revolution Contains Two Rounds of Technological Revolutions)

<i>Industrial revolution</i>	<i>Landmark event</i>	<i>Core input</i>	<i>Forerunner industry Dominant industry</i>	<i>Technological mode</i>	<i>Organizational mode</i>	<i>Downswing/upswing</i>
First Industrial Revolution	Hargreaves invented “Spinning Jenny” (1764) Liverpool and Manchester Railway (1831)	Cotton Pig iron	Cotton manufacturing Ironwork	Hydraulic machinery Toll roads Canal boats	Factory system Partnerships	1760–1790/1790–1825
Second Industrial Revolution	Carnegie’s Bessemer Steel Works (1875)	Pig iron Coal Steel Copper Alloys	Railways and railway equipment Steam engine Steel Electrical equipment Heavy machinery	Steam power Railway Telegraph Electrification Steel rails	Joint-stock companies Large enterprises Taylorism	1825–1848/1848–1873 1873–1893/1893–1913
Third Industrial Revolution	Assembly line of the Ford Highland Park plant (1913) Intel processor (1971) IBM’s Watson defeated human champions in an American quiz (2011)	Petroleum Natural gas Synthetic materials Chips	Automobiles Petrochemicals Household appliances Computers Telecommunications equipment Microelectronics Robots Intelligent telecommunication equipment Intelligent equipment manufacturing	Automation Aviation and expressways Radio Information superhighway (internet) Wireless networks Artificial intelligence Blockchain Internet of things Smart grids 3D printing	Giant corporations Fordism Transnational corporations Post-Fordism Decentralized, networked, platform-type organizations	1913–1945/1945–1973 1973–1992/1992–2008 2008–2030(?)

its expansionary period, which was replaced by the chaotic and turbulent coordination period in which disastrous wars, widespread revolutions and serious crises became intertwined with one other, and the downswing of the fourth Kondratieff long wave began. During this period, the revolution in power technology caused by the widespread application of petroleum and electricity; the revolution in manufacturing technology brought about by electrification and automation; new information and communications technology such as the telegraph, telephone and broadcast television; and communications and transportation technology including aircraft, automobiles and so on promoted the diffusion of the Second Industrial Revolution in various industrial fields and regions. In addition, the popularization of the corresponding assembly line production and modern corporate system gradually established the dominant position of the productive and organizational modes of Fordism. After the Second World War the Second Industrial Revolution thus quickly entered its maturation period, initiating the expansionary phase of the fourth Kondratieff long wave.

In the early 1970s the advent of “stagflation” ended the “Golden Age” of the Second Industrial Revolution, initiating the introduction period of the Third Industrial Revolution and the downswing of the fifth Kondratieff long wave. Continuous development of electronic chip technology, electronic computer technology and internet technology, together with the post-Fordist mode of production and organization, promoted the “rupture” represented by the “new economy,” and prefigured the end of the old production mode created by the Second Industrial Revolution. In the early 1990s the Third Industrial Revolution entered its expansionary period, during which a frenzy of financial capital drove the rapid expansion of the “new economy,” and the upswing began of the fifth Kondratieff long wave. The outbreak of the 2008 financial crisis brought the frenzy of capital to an end, initiating the coordination period of the Third Industrial Revolution and the downswing of the sixth Kondratieff long wave. Connection technologies such as artificial intelligence, the internet of things, blockchain and so on; manufacturing technologies such as 3D printing; new energy technologies; and the corresponding decentralized, networked and platform-type productive and organizational modes are now becoming deeply integrated and widely diffused. After the deep structural adjustments that are accompanying this round of the long wave, the Third Industrial Revolution may perhaps welcome its own “Golden Age” in the 2030s.

## Conclusion

Schumpeter once pointed out that “people who fail to grasp historical facts, and who do not possess an appropriate sense of history or so-called historical experience, cannot be counted on to understand the economic phenomena of any time



including the present” (Schumpeter 1991, 28). Similarly, economics divorced from its historical framework cannot be expected to yield valid scientific theories. In a sense, political economy is a science that studies the historical process of transition from capitalism to socialism, and as a result, it cannot and should not be divorced from the historical process of the development and evolution of the capitalist mode of production. It is a pity that the theoretical tradition of “unity of logic and history” established by Marx has long been neglected, and has not been effectively followed. Marx developed a subtle analysis of how history and theory combine, an analysis that takes as its theme the production of absolute and relative surplus value while also taking into account the development of capitalist productive forces, the contradictory movement of productive forces and relations of production, and the process of evolution of the mode of production. But this analysis is either condensed into an abstract and rigid “textbook model” that omits all historical content, or else is “deepened” to become specific research, devoid of theoretical abstraction, on trivial special subjects. If we are to revive Marx’s theoretical tradition and to revitalize and rejuvenate political economy, long-wave theory is a theoretical framework for reference. However, although numerous Marxist-oriented scholars have participated in the early exploration and subsequent development of this theory, the framework of Marxist political economy for the long-wave theory has not yet been established. Although the Regulation and SSA schools provided the “institutional” analysis of the long-term change of the capitalist mode of production by means of “intermediate-level” construction, they knowingly or unknowingly ignored the historical role of technological change. Mandel grasped the basic direction of the contradictory movement between technological revolution and institutional innovation through discussing the evolution of the mode of reproduction, but he failed to develop a stage-based interpretation with “intermediate-level” analysis at its core. In order to construct a comprehensive methodological foundation for the long-wave theory from the perspective of historical materialism, it is therefore necessary to synthesize the intermediate-level analysis of the Regulation and SSA schools with Mandel’s focus on the importance of technology. Rostow once pointed out that “It is a simple fact that, from Adam Smith to the present, the structure of formal economic theory has not absorbed satisfactorily the process of technological change” (Rostow 2014, viii). Technology is the “fuel” of the engine of capitalist development, and the self-development of productive forces has its inner reason and law of development (Ma and Wei 2013). The future development of Marxist long-wave theory must absorb satisfactorily the process of technological change, the development of the productive forces, and the related laws.

The tendency of mainstream research on long waves to display a technologism that ignores the essence of history needs to be overcome, while the descriptivism

that allows research on long waves to become trapped in historical details should also be avoided. The central goal of research on long waves does not lie in describing and reproducing history, but in finding, through “recurrent sequences” (Perez 2002, 59), the dynamic law of the evolution and development of the capitalist mode of production and its future direction. Economic long waves, as external manifestations of the way in which trends within the mode of production are evolving, are syntheses of the roles played by multiple factors at various stages in the development of the capitalist economy, and each social subsystem, including technology, the economy, politics, culture and so on, is an important factor for understanding these waves. Research on long waves should therefore not only reveal the “ultimately” decisive role of productive forces and the interactive mechanisms of technology and the economy, but should also reveal the long-term changes within politics and culture and the laws that govern them. Eric Hobsbawm once proposed the following hypothesis: social conflicts have always clustered around the upper and lower turning points of long waves, around the points at which developments have prompted a wave of strike activity among workers (Freeman and Louçã 2001, 355–363). Perez, meanwhile, argues that “the sequence technological revolution–financial bubble–collapse–golden age–political unrest recurs about every half century,” and that *laissez-faire* and state intervention will alternate every 20–30 years (Perez 2002, 5). Similarly, Marxist scholars of long waves, including Mandel and those of the Regulation and SSA schools, also attempt to discuss structural crises, class struggle, interactive mechanisms of political power and the laws governing their roles. The future development of the Marxist theory of long waves depends on completely overcoming the clichés concerning the mechanical determination of the superstructure by the economic base. It will require scientifically revealing the laws of evolution of power structures, ideology and social culture, and demonstrating the outstanding advantages that, as North acknowledged, the framework of Marxist theory has for analyzing long-term change.

Political economy is not solely a theoretical field, but one whose studies are meant to be put into practice. Research on long waves in China must provide theoretical support for socialist economic construction with Chinese characteristics. Perez has pointed out that one significant misconception affecting research on long waves is the assumption that economic long waves must be simultaneous world phenomena (Perez 2002, 60). In fact, economic long waves are an external manifestation of the development process of industrial revolutions, and are never an economic phenomenon that takes place simultaneously in all countries. Industrial revolutions and economic long waves are in the first place economic phenomena of dominant countries. The dominant country of the First Industrial Revolution, i.e., of the first and second long waves, was Britain, and the dominant

countries of the Second Industrial Revolution, i.e., the third and fourth long waves, were the United States, Germany and so on. For less-developed countries, the introduction and coordination periods of industrial revolutions are an important “window of opportunity” for catching up with and overtaking the leading countries. After Britain established its dominance in the introduction period of the First Industrial Revolution, the United States overtook it precisely in the introduction period of the Second Industrial Revolution. At present, the world is in the coordination period of the Third Industrial Revolution and in the downswing of the sixth long wave, which is an important period of deep-going structural adjustment when less-developed countries have the opportunity to catch up with and outstrip the developed states. Historical experience has shown that whether less-developed countries can grasp this opportunity depends on their ability, through strategies of scientific and technological progress and institutional innovation, to promote a mode of production that can break away from the “lock-in effect” of the old power and realize continuous “structural upgrades.” They need to promote various sub-systems of society that can complement each other and provide a complete “supporting structure” for key technologies, so as to enhance the ability of forerunner sectors to impel progress. These countries need to promote emerging technologies and emerging industries, moving swiftly to win control of commanding positions in global competition and to spread their influence around the globe so as to expand their “development space.” To ensure the future development of the Marxist theory of long waves in China, scholars must make an in-depth analysis of the law of the expansion of industrial revolution and of economic long waves, as well as of the path by which less-developed countries can catch up with and outstrip the developed world. In this way, the Marxist theory of long waves can aid in the successful implementation of the “two-step strategic plan.”<sup>11</sup>

## Notes

1. Many scholars including Schumpeter regard Marx and Engels as the precursors of research on long wave. We believe that although Marx and Engels were aware of the law of the alternate rise and fall of capitalist development and of the accompanying large-scale structural changes, they did not directly discuss economic long waves (see Freeman and Louçã 2001, 71–77).
2. The definition of a “mode of production” is subject to debate. Here we refer to Cohen’s viewpoint that defines the mode of production as the technological and organizational methods of social production, i.e., the “techno-economic paradigm.” See Cohen (2008, 98–101).
3. Engels stated that “there are thus innumerable conflicting forces, an infinite number of parallelograms of forces, productive of one result—the historical event which itself may be seen as the product of a power operating unconsciously and involuntarily as a whole” (Engels 1890 [2010], 35).
4. It should be pointed out that expansions, crises, depressions and cyclical phenomena in commercial capitalism should not be regarded as special issues and thus be excluded from the framework

- of the Marxist theory of economic crisis. Research on economic long waves should be extended to the period of mercantilism.
5. See also Meng (2012).
  6. For detailed data, see Gao (2018).
  7. See <http://www.imf.org/external/datamapper/datasets>.
  8. For reviews of various theories of long waves, see Zhao (1988), Liu et al. (1997) and Mandel (1980).
  9. The woolen textile industry had been the most important industry in Britain since the 15th century, and was protected by the feudal guild system. Fierce competition and conflict between the new and old modes of production within the wool and cotton textile industries was thus an important feature of this period. See Weber (2007, 215–218).
  10. A typical example of the effects of this confrontation can be seen in the relative decline of Britain and the rise of the United States. Many studies contend that it was precisely the “lock-in effect” of the old mode of production that caused Britain to fall behind, while the “expansion effect” of emerging technologies and industries allowed the United States to advance. See Freeman and Louçã (2001, 249–256) and Zhao (1988, 176–180).
  11. It was pointed out in the “Report to the 20th National Congress of the Communist Party of China” that to build China into a great modern socialist country in all respects, a two-step strategic plan will be adopted, i.e., basically realize socialist modernization from 2020 through 2035; and build China into a great modern socialist country that is prosperous, strong, democratic, culturally advanced, harmonious, and beautiful from 2035 through the middle of this century.

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