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A Reappraisal of Albert Aftalion's Theory of Structural Transformation in an Era of Decarbonization

Decarbonization is a momentous challenge for capitalism and makes one to ask which changes in its morphology may be necessary to achieve that objective. The contribution by the French economist Albert Aftalion (1874–1956), with its emphasis on intermediate levels of aggregation (the "meso" approach), the differentiated time profiles of economic actoivities, and their differential speeds of reaction to dynamic impulses, provides an invaluable heuristic for conceptualizing the structural transformations required by transition to a low energy regime. Aftalion's analysis of industrial capitalism emphasizes that structural changes occur along multiple co-existing time horizons. This provides tools to analyze the *time constraints* on the sequencing of structural changes for different sectors on a decarbonization trajectory without neglecting the strict *time requirements* for implementing effective climate change mitigation. This interplay of time horizons is central to decarbonization, and it will require a new balance between the invisible hand of markets and the visible hand of states and other public bodies. Moreover, Aftalion's emphasis on material constraints offers a novel approach to conceptualizing the importance of intermediate levels of aggregation in economic theory, thereby offering a new basis for sectoral policymaking and a fundamental challenge to institutionalist accounts of the morphology of capitalism.

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Fifteen years after the Great Financial Crisis (2007–2008), the global economy faces categorically different, yet to business historians perhaps more familiar, challenges. The COVID-19 pandemic, the propagation of supply chain shocks, challenges to globalization, and the growing scarcity of strategic resources in the wake of rapid technological and environmental change, are all more evocative of the 1920s than of the final decade of the twentieth or the first decade of the twenty-first centuries. When these more mundane challenges are coupled with the growing urgency of establishing viable pathways to decarbonization of the energy, transport, and building sectors, long-neglected theoreticians of industrial capitalisms, who were concerned with intersectoral interdependencies, uneven industrial fluctuations across sectors, and the economic dynamics of long-term structural change, need to be revisited.[1] A characteristic feature of those appraisals of industrial capitalism is the view that structural transformations are not one-off novelties, but processes requiring time to work themselves out; they involve changes along manifold dimensions of interrelatedness, such as the patterns of interrelatedness between capabilities, tasks, and materials within production networks. As noted by the economic theorist John Hicks, these transformations take place along transitional paths governed by *sequential causality* (which he calls "traverses"), in which certain changes cannot occur unless *prior transformations* have made those changes feasible.[2] As noted by Erik Dahmén, W. Paul Strassmann, Luigi Pasinetti, and Elhanan Helpman, radical transformations have a pervasive character and involve changes in the patterns of interdependence between and among production activities.[3]

Sequential causality and *interdependence* are central to the transformation of economic structures and cannot be adequately analyzed by exclusively focusing on macroeconomic aggregates and/or on the microeconomic conduct of economic agents. In short, structural change as transformation in the composition of aggregates is a constitutive feature of the history of capitalism, and its study

[1] For a practical example of such an approach to decarbonization that focuses on sectoral interdependencies and intermediate levels of aggregation, see Alberto Quadrio Curzio and Roberto Zoboli, "Decarbonisation: The Next 'Grand Transition,'" *Balzan Papers III 2020* (Firenze, 2020), 219–230.

[2] John R. Hicks, *Capital and Time: A Neo-Austrian Theory* (Oxford, 1973); Hicks, *Causality in Economics* (Oxford, 1979).

[3] Erik Dahmén, *Entrepreneurial Activity and the Development of Swedish Industry, 1919-1939*, trans. Axel Leijonhufvud, (Homewood, IL, 1970); W. Paul Strassmann, *Risk and Technological Innovation: American Manufacturing Methods during the Nineteenth Century* (Ithaca, 1959); Luigi Pasinetti, "The Notion of Vertical Integration in Economic Analysis," *Metroeconomica* 25 (1973): 1–29, reprinted in *Essays on the Theory of Joint Production*, ed. Pasinetti (London, 1980), 16–43; *General Purpose Technologies and Economic Growth*, ed. Elhanan Helpman (Cambridge, MA, 1998).

requires moving beyond macro and micro analysis and considering the different layers of interdependence that characterize the relationship between economic units at intermediate levels of aggregation.[4] This involves opening the black box of macroeconomic aggregates by taking account of the different mechanisms of causation that link economic units at different levels of aggregation. What is needed is bringing to light the "causal mechanisms" that link layers of interdependence both at a given time and across multiple time horizons, as well as the "causal paths" that specific causes follow when producing effects.[5]

The changing morphology of capitalism is an established research area covering varieties of capitalism both across economic systems and over time. In either case, the focus is on changing social and institutional arrangements leading to specific forms of embeddedness in the social sphere and triggering specific dynamic trajectories or "growth regimes."[6] However, at least since the First Industrial Revolution, a distinctive feature of capitalism has been its impact on the material sphere of production. Entrepreneurial and state actions have led to radical transformations in the objective conditions of production and consumption. These transformations affected both individual production processes and the patterns of interdependence between those processes, triggering dynamic trajectories characterized by switches from one structural configuration to another. This relationship between institutional arrangements and material structures is a fundamental feature of capitalism and provides grounds for discussing *both* the material implications of specific forms of capitalist institutions and the institutional changes required to achieve the transformation of a given material structure. The current climate crisis underscores the drawbacks of carbon-based material structures historically associated with industrial development and mass consumption, and thus the conditions necessary to achieve deep decarbonization.

Successful decarbonization involves the shift from one "energy regime" to another.[7] The new energy regime is likely to involve

[4] William J. Baumol, "On Entrepreneurship, Growth and Rent-Seeking: Henry George Updated," *American Economist* 48, no. 1 (2004): 9–16; Luigi Pasinetti, *Structural Change and Economic Growth: a Theoretical Essay on the Dynamics of the Wealth of Nations* (Cambridge, UK, 1981); Pasinetti, *Structural Economic Dynamics: A Theory of the Economic Consequences of Human Learning* (Cambridge, UK, 1993).

[5] Stuart S. Glennan, "Mechanisms and the Nature of Causation," *Erkenntnis* 44, no. 1 (1996): 49–71; Stuart S. Glennan, *The New Mechanical Philosophy* (Oxford, 2017); Judea Pearl, *Causality* (Cambridge, UK, 2009).

[6] See Peter Hall, "Growth Regimes," *Business History Review* 98, no. 1 (Spring 2024): xx–xx.

[7] Victor Seow describes energy regimes as "social and economic systems defined by the predominant type or types of energy used:" see Victor Seow, *Carbon Technocracy: Energy Regimes in Modern East Asia* (Chicago, 2021), 15. See also E. A. Wrigley, *Energy and the English Industrial Revolution* (Cambridge, UK, 2010); Wrigley, *Continuity, Chance and Change*

constraints and opportunities different from those associated with the old carbon-based regime. It is also likely that the introduction of the new energy regime would be compatible with growth regimes different from those associated with the previous energy regime, particularly given mixed empirical evidence for the carbon intensity of the knowledge economy.[8] The switch from one energy regime to another may be favorable to certain constellations of interests and unfavorable to others. In general: (i) the transition to a decarbonization regime would be constrained by the bottlenecks and opportunities of the previous regime, and (ii) the decarbonization regime would trigger structural constraints that may be compatible with a *variety* of interests, institutional set-ups, and growth regimes. It has been noted that historically energy regimes generated favorable opportunities to certain constellations of interests and social groups while closing off opportunities for others. For example: "[t]he susceptibility [of the coal transportation system through water and rail routes] to disruptions meant that workers involved in the mining and movement of coal were able to take advantage of weak points through sabotage and strike and seize for themselves several key rights and concessions."[9] However, as oil substituted for coal as the main energy source, "flows of energy began to be directed less by human hands and more by carefully calibrated technical structures of pumps and pipes—in part a function of the difference in physical properties between solid coal and liquid oil—so too did workers find themselves increasingly displaced from larger political processes. If the energy regime of coal had, through unintended features of its design, facilitated the rise of modern democracy, then the energy regime of oil was engineered precisely to undermine that promise of participatory politics."[10]

This historical evidence supports findings in multisectoral economic analysis that draw attention to the constraining role of scarcity bottlenecks associated with a given technology and to the systemic empowerment that the differentiated ability to control critical resources assigns to certain constellations of interests, countries, and social

(Cambridge, UK, 2012). A similar point is made implicitly about the advent of coalmining in South Wales in Joe England, *Merthyr: The Crucible of Modern Wales* (Cardigan, 2019).

[8] For contrasting views, see Xinxin Wang, Zeshui Xu, Yong Qin, and Marinko Skare, "Innovation, the Knowledge Economy, and Green Growth: Is Knowledge-Intensive Growth Really Environmentally Friendly?" *Energy Economics* 115 (2022): 106331; and Cüneyt Kılıç, Semanur Soyyiğit, and Seda Bayrakdar, "Economic Complexity, Ecological Footprint, and the Environmental Kuznets Curve: Findings from Selected Industrialized Countries," *Journal of the Knowledge Economy* (2023): 1–26.

[9] Seow, *Carbon Technocracy*, 15.

[10] Seow, 16.

groups.[11] This type of empowerment makes those groups decisive in allowing or blocking the transition from one energy regime to another, since their exclusive entitlements give rise "to some new types of rent connected to various types of progress, affecting the interests that macro-decision makers and particular social groups may have in promoting, hindering, or retarding the introduction of the various types of progress."[12] Energy regimes are powerful triggers of social transformation. On the other hand, the emergence of a new energy regime reflects the range of social structures characterizing the old energy regime from which it arises. This mutual influence calls attention to the interplay between material interdependencies and social structures, to the sequences of change that the transformation of material structures requires (such as the transformation involved in switching from one energy regime to another), and to the different layers of interdependence at which that transformation may take place.

Decarbonization will entail the largest transformation of material structures since the First Industrial Revolution. It is equally likely that it will also entail the most significant transformation of institutions and social structures since that time. The study of the full implications of the switch to a decarbonization structural regime is still in its infancy, as it is the study of the implications of that structural regime for the institutional dynamics of an industrial economy or the post-industrial knowledge economy. In this light, a variety of exploratory devices are required, and analytical tools developed in the past when confronting the impact of similarly wide-ranging transformations of material structures may provide important heuristics. A characterizing feature of business history since the First Industrial Revolution is the interplay between changes in material structures (such as the changes involved in switching from one manufacturing regime to another) and the associated changes in organizations and patterns of firm behavior.[13] Previous phases of capitalist history and previous attempts to understand the relationship between the transformation of material structures and changing patterns of economic dynamics may provide

[11] Wassily Leontief, *The Future of the World Economy: A United Nations Study* (Oxford, 1977); Wassily Leontief, "Natural Resources, Environmental Disruption, and the Future World Economy," *Journal of International Affairs* 31, no. 2 (1977): 267–273; Faye Duchin and Glenn-Marie Lange, *The Future of the Environment: Ecological Economics and Technological Change* (Oxford, 1994).

[12] Alberto Quadrio Curzio and Fausta Pellizzari, "Political Economy of Resources, Technologies, and Rent," in *The Palgrave Handbook of Political Economy*, ed. Ivano Cardinale and Roberto Scazzieri (London, 2018), 700. See also Alberto Quadrio Curzio and Fausta Pellizzari, *Rent, Resources, Technologies* (Berlin, 1999).

[13] Alfred D. Chandler, *Scale and Scope: The Dynamics of Industrial Capitalism* (Cambridge, MA, 1990).

crucial insights into the structural conditions and timing of the switch to a decarbonization regime. In this light, the contribution of the French economist Albert Aftalion (1874–1956) is of unique relevance.

The work of Albert Aftalion can inform the study of the current transformations in capitalism because of its joint emphasis on the *differentiated dynamic paths* that need to be followed by different industries and on the *sequence-based interrelatedness* between the transformations occurring in the various industries.[14] Aftalion's work is also of central importance for its emphasis on the link between policy interventions and intermediate levels of aggregation in the economy. In this light, he emphasizes that the differentiated patterns of responsiveness to policy measures from individual industries and/or collections of interrelated industries is a critical condition determining the effectiveness of economic policy. Unfortunately, Aftalion is mainly remembered today for his role in establishing the *Revue économique* and for the Aftalion-Clark Accelerator principle, that is, chiefly as a precursor to Keynesian business cycle theory and thus of dynamic Keynesian macroeconomics.[15] However, Aftalion's contribution to the Accelerator principle should be interpreted in the context of the literature (chiefly in French) on structural business cycles from the late 19th and early 20th centuries.[16] In this light, Aftalion is one of the very few economists whose work deliberately theorizes a multi-layered bridge from sectoral to macroeconomic levels of analysis.[17]

[14] Albert Aftalion, "Essai d'une théorie des crises périodiques. La réalité des surproductions générales," *Revue d'économie politique* (1908–1909): 81–117, 201–229, 241–259 (journal articles assembled together in a volume under the same title [Paris, 1909]); Albert Aftalion, *Les crises périodiques de surproduction*, 2 vols. (Paris, 1913). Although this article cites the original French version, an English translation will appear shortly: see Albert Aftalion, *Periodic Crises of Overproduction*, ed. Ivano Cardinale, D'Maris Coffman, and Roberto Scazzieri (London, 2025). English translations are taken from that manuscript.

[15] See Cecile Dangel and Alain Raybaut, "Albert Aftalion's Macrodynamic Theory of Endogenous Business Cycles," *Journal of the History of Economic Thought* 19, no. 1 (1997): 71–92. See also G.H. Fisher, "A Survey of the Theory of Induced Investment, 1900–1940," *Southern Economic Journal* 18, no. 4 (Apr. 1952): 474–494.

[16] See Roberto Scazzieri, "Foreword to Albert Aftalion's Essay," *Economia politica* 89 (2014): 89–92; see also "Part II: Structural Theories of Economic Fluctuations," in *The Economics of Structural Change, Vol. II: Growth, Cycles and Technological Change: Structural Approaches*, ed. Hagemann, Landesmann, and Scazzieri (Cheltenham, 1993). For a criticism of the straightforward importation of the Accelerator Effect into Keynesian macroeconomics, see Alan Hochstein, "The Accelerator Theory in a Keynesian Framework Does Not Work," *International Advances in Economic Research* 24 (2018): 199–200. Schumpeter may have also contributed to the consensus lineage as he dismissively grouped Albert Aftalion and Jean Lescure together "for [their] strict adherence to Juglar's methodological principles:" see Joseph A. Schumpeter, *History of Economic Analysis* (Abingdon, 1954), 1129, n. 14.

[17] For another, more recent, example, see Carlo D'Adda, "An Economy of Industries and Its Aggregate Representation," no. 67, Quaderni-Working Paper DSE, 1989.

The second section of this paper elaborates Aftalion's structural analysis, which includes intermediate levels of aggregation, intersectoral and international transmission mechanisms, and asymmetric effects of macroeconomic policies. He derives from his conceptualization of these linkages the contours of his political economy and his analysis of social welfare (with a focus on productive sectors and social groups rather than social classes). The third section discusses the relationship between Aftalion's contribution and the structural business cycles tradition to which he belongs. This section highlights the specific features of Aftalion's theory as a prototype analysis of the multi-layered interactions between disaggregated production structures and macroeconomic fluctuations. The fourth section explores the bridge between Aftalion's structural analysis and his monetary and credit theory (including his critique of the Fisher equation, his objections to open market operations, and his exploration of the distributional effects of monetary policies). The fifth section considers the implications of Aftalion's visualization of industrial capitalism and of the conditions for effective policy measures under conditions of structural change for the third decade of the twenty-first century, including and especially the transformations required to establish what may be called in Peter Hall's lexicon a new "growth regime," namely the "era of decarbonization.'" The final section discusses the implications of Aftalion's analytical tools for a political economy of transformations in capitalism.

Aftalion's Multi-layered Structural Analysis

Aftalion's analysis of structural transformation is closely related to his approach to identifying relevant units of analysis in the economic system, and of identifying policy measures consistent with the specific causal structure of transformation relevant to any given historical context. His work on periodic overproduction crises is clear evidence of a research methodology that avoids concentration of attention on aggregate magnitudes or atomistic units by focusing on industrial sectors and intersectoral relationships.[18] Intermediate levels of

[18] Aftalion, "Essai d'une théorie des crises périodiques," 81–117, 201–229, 241–259; Aftalion, "La théorie de l'épargne en matière de crises périodiques de surproduction," *Revue d'histoire des doctrines économiques et sociales* (1909): 229–262; Aftalion, "Les trois notions de la productivité et les revenus," *Revue d'économie politique* (Mar.–Apr. 1911): 145–184; Aftalion, "Les trois notions de la productivité et les revenus," *Revue d'économie politique* (May–June 1911): 345–369; Aftalion, "Les oscillations périodiques des salaires et les crises," *Revue économique internationale* (July 1912): 124–146; Aftalion, *Les crises périodiques de surproduction*; Aftalion, "Le rythme de la vie économique', *Revue de métaphysique et de morale* (Apr.–June 1921): 247–278; Aftalion, *Monnaie, prix et change. Expériences récentes et théorie* (Paris, 1927).

aggregation are central to Aftalion's heuristic and characterize his approach to economic dynamics. The movement of any economic system, through time is described in terms of dynamics involving a large but finite number of sectors to be identified by certain common features that keep them distinct from other sectors in the economy.

This approach leads to what Jean Lhomme, in his essay on Aftalion's heuristic, describes as an attempt to formulate "a positive theory" through "successive approximations": "three tentative explanations are attempted [. . .], of which each one will bring theory increasingly close to reality."[19] At the first stage of approximation, Aftalion's overproduction theory of economic crises can explain "what takes place at the two poles of each periodic cycle, at the point of crisis and at the beginning of expansion"—that is, the fact that "prices fall as a result of excessive production. They rise as a result of insufficient production."[20] However, overproduction theory in itself does not explain an important characterizing feature of modern periodic crises—that is, "the *duration* of [price rises and falls], the duration of the phases of the [economic] rhythm."[21] For lack of sufficient production cannot account for the persistence of the price rise "during the three or four years of prosperity," as it would be unreasonable "to believe in continuing underproduction while production itself is continually increased."[22] For this phenomenon to be explained, one must go beyond the dynamics of general production and focus on the intensity and sequencing of fluctuations in particular industries (the second stage of approximation). In Aftalion's view, moving to this new set of phenomena allows a refocusing of the analysis on "special fluctuations" whose relevance is missed at the macroeconomic level and that could be important in providing an explanation for the duration of cycles and their internal structure.[23] The switch from a macroeconomic approach (fluctuations of general production) to a sectoral approach (special fluctuations in particular industries) is an essential step in explaining the structural transformation of the economic system during business cycles:

> [d]uring prosperity, the general price increase amplifies the demand for fixed capitals and multiplies the orders for instruments, the starts of new processes producing fixed capitals. During depression, the general fall in prices makes demand for

[19] Jean Lhomme, "La méthode des recherches chez Albert Aftalion," in *L'œuvre scientifique d'Albert Aftalion* (Paris, 1945), ed. Gaëtan Pirou (Paris, 1945), 17–32, 29. See also Jean Lhomme, "L'influence intellectuelle d'Albert Aftalion," *Revue économique* (1957): 353–362.

[20] Aftalion, *Les crises périodiques de surproduction*, vol. 2, 40.

[21] Aftalion, 41.

[22] Aftalion, 41–42.

[23] Aftalion, 44.

> capital equipment to contract, brings orders down, and reduces new constructions.[24]

Yet, the special fluctuations in fixed capital industries does not provide a comprehensive explanation for the *intensity* of business fluctuations *in the economic system as a whole*. To achieve that, the analysis of cycle dynamics must switch back to the consideration of a macroeconomic adjustment mechanism (the third stage of approximation). In this case, it is no longer fluctuations of production levels that are brought into focus, but fluctuations of aggregate demand working through changes in the absolute and relative magnitudes of different types of income (wages, profits, rents): "[e]ach fall in the price of a commodity brings about a fall in the incomes and thus in the demand of those who are employed in its production. It is thus a factor determining the fall in prices of other commodities [. . .] Correspondingly, each price rise is a factor contributing to the possibility of a general price rise."[25] In short, each stage of approximation is relevant not only as a step in the process of theory construction, but also as a device essential to understanding a specific layer of the causal process under consideration. Different phenomena can be explained depending on which causal layer is considered. Aftalion practices a heuristic that moves back and forth between macroeconomic and sectoral levels of aggregation by identifying causal factors that can only be singled out by focussing on a specific aggregation level but ultimately produce a cumulative effect. This plural heuristic is a distinctive feature of Aftalion's research strategy and finds applications in a variety of fields, and today may be applicable to industrial and infrastructural policy to support decarbonization, which are considered, respectively, in the fourth and fifth sections below.

Aftalion's Theory and the Structural Business Cycles Tradition

Aftalion's theory belongs to the structural business cycles tradition of Mikhaylo Ivanovich Tugan-Baranovsky, Arthur Spiethoff, Mentor Bouniatian, and Dennis Holme Robertson.[26] However, his work differs

[24] Aftalion, 57.

[25] Aftalion, 242.

[26] Mikhaylo Ivanovich Tugan-Baranovsky, *Crises industrielles en Angleterre* (Paris, 1913 [Russian edn. 1894]); Arthur Spiethoff, *Vorbemerkungen zu einer Theorie der Überproduktion* (Berlin, 1902); Mentor Bouniatian, *Les crises économiques: essai de morphologie et théorie des crises économiques périodiques et de théorie de la conjoncture économique* (Paris, 1922); Denis Holme Robertson, *A Study of Industrial Fluctuation: An Enquiry into the Character and Causes of the So-Called Cyclical Movements of Trade*, no. 8 (London, 1915).

significantly from the other contributions in that tradition. The key difference is that these contributions concentrate on characterizing and sequencing interactions between disaggregate production structures and macroeconomic fluctuations without explicitly theorizing dynamic structural interactions that either preserve or transform the industrial structures so described. The economists mentioned above are principally concerned with measuring these interactions, but generally offer no theoretical approach that can be mobilized to understand or manage structural transformation across the multiple causal layers characterizing each industrial structure.

Aftalion's distinctive features within the structural business cycles tradition are (i) the consideration of the *different layers of interdependence* within each network of productive activities, (ii) the consideration of the *relationship between layers of interdependence and the timing of transformation* (so that transformations at a given layer of interdependence may presuppose, or be conducive to, transformation at a different layer), and (iii) a *policy framework* that brings into focus the relationship between systemic policy objectives and the differentiated dynamics of individual industrial sectors. Aftalion's relationship to the structural business cycles literature should be understood by paying close attention to his sophisticated approach to causality in economics (sequential and multilayered). This approach also situates Aftalion's contribution to Accelerator Theory within the multilayered and historical framework of his overall theoretical conception, avoiding the current consensus narrative, which places Aftalion in a lineage that sees the "Accelerator" as the reciprocal (and thus a supply-side version) of the "Multiplier" found in Keynes and the Cambridge Keynesian Tradition.[27] Both multi-layered causality and Aftalion's analysis of the relationship between investment and aggregate demand are characterizing features of a theory that is "capable of addressing the macroeconomic dimension of fluctuations and crises without losing track of the sectoral differences and of the propagation mechanism of uneven dynamics from one sector to another."[28]

In short, and differently from other contributions to the structural business cycles literature, Aftalion's approach involves a flexible utilization of fundamental units of analysis, *which may be different depending on the problem at hand*. It also involves a flexible approach to levels of causality and types of explanation. Industrial sectors may

[27] John Maynard Keynes, *The General Theory of Employment, Interest and Money* (London, 1936); Richard F. Kahn, "The Relation of Home Investment to Unemployment," *Economic Journal* 41, no. 162 (1931): 173–198.

[28] Roberto Scazzieri, "Foreword to Albert Aftalion's Essay," *Economia Politica* 31, no. 1 (2014): 89–91.

empirically be identified in a plurality of ways, and this may in turn lead to a plurality of intersecting and not mutually exclusive explanations of dynamic processes. For example, some industrial sectors, such as steelmaking, might be characterized by their supply chains, which include backward linkages to iron ore extraction and energy production, as well as by forward linkages created by the use of steel in the fabrication of automobiles or alternatively in industrial equipment, which is an input into other manufacturing sectors. They are thus vulnerable both to supply shocks from backward linkages and demand shocks from forward linkages. Therefore, alternative sectoral specifications are likely be associated with different patterns of interdependence between sectors and different transmission mechanisms of economic triggers or policy decisions throughout the economic system. Aftalion's acknowledgement of multiple, and not mutually exclusive, ways of identifying the relevant sectors of the economy can be closely associated with his interest in economic structures as flexible patterns of interdependencies between sectors. In Aftalion's framework, the choice of units may determine the relevant pattern of interdependence, so that multiple and partially overlapping causal layers can be detected depending on which units are chosen. The implications of this point of view are far reaching, as any given economic system would be conducive to manifold specifications of relevant units (manifold specifications of its structure). Plurality in causality is inherent to Aftalion's structural analysis and makes his approach to dynamics especially interested in the specific overlap of causal layers that characterizes each historical context.

Monetary Policy in a Multilayered Causal Framework

Aftalion's analysis of monetary policy and criticism of central bank monetarism is a response to the monetary disturbances of the 1920s and 1930 and addresses those disturbances in terms of the theoretical framework he had developed when investigating the recurrent crises of an industrial economy.[29] In Aftalion's view, monetary policy can produce effects through multiple transmission channels and the structure of any given economic system determines which transmission channel would be the most influential under specific conditions. This makes it extremely difficult to undertake "a general action on prices through credit policy."[30] One important reason for this difficulty is

[29] Aftalion, "Essai d'une théorie des crises périodiques"; Aftalion, *Les crises périodiques de surproduction*.

[30] Aftalion, *Monnaie et industrie. Les grands problèmes de l'heure présente* (Paris, 1929), 101.

the time-differentiated responses of different industries to the phases of the business cycle:

> [I]n a period in which the growth of many industries and their price increases start looking excessive, a general credit restriction risks endangering other industries, which may at that time suffer from real depression. Should we make the crisis of the cotton industry worse to check the excessive expansion of the automobile industry? Are we going to increase the already severe unemployment in the former industry because of excessive overtime and demand for labour in the latter?[31]

In his account, different sectors of the economy are likely to respond in different ways, or at least with different time lags, to any given macroeconomic intervention. However, there is broad coincidence of business cycle phases across different industries, due to "the participation one is generally observing in practice of a great number of industries to the alternating cyclical movements, so that we may refer to periods of general expansion or contraction."[32] This situation suggests that macroeconomic interventions should not be excluded, while highlighting the need of a prudential approach to monetary and credit policy and to macroeconomic policy in general. Macro policies should be sensitive to context and timing for they may otherwise backfire and lead to outcomes opposite to the wanted ones. The early phases of expansion are especially vulnerable in this respect, seeing that, at that time, the general tendency is not yet fully established, and signs of monetary restriction may thwart the upward movement of the economy.[33]

Monetary and credit policy work through distinct transmission channels due to the heterogeneity of industrial sectors, and primarily to the lack of synchronization in their responses to dynamic impulses. For this reason, Aftalion envisages substituting the "new banking policy" (*nouvelle politique bancaire*), which is what became known as central bank monetarism, with a banking policy which he describes as "subtle and nuanced" (*subtile et nuancée*). The aim of this banking policy should be to provide specialized credit—that is, to provide credit facilities "by following the special conditions of each one of the

[31] Aftalion, 101-102.

[32] Aftalion, 102.

[33] As Aftalion posits: "the persistence of exceptions [to the synchronisation of business cycle phases across different industries] suggests [. . .] great prudence in the application of general measures, particularly at the beginning of phases of prosperity when the general movement is not yet neatly defined:" see Aftalion, 102.

industries under consideration."[34] Provision of liquidity would in this case be adapted to the differentiated liquidity needs of different sectors, and macroeconomic policy would aim at coordinating, through liquidity provision, the heterogeneous dynamics of industrial sectors in the business cycle. This open-ended causal mechanism is at the core of Aftalion's criticism of the "new banking policy," which demands from central banks that they "manage the economic activity of a country" so as to "'direct the money' in such a way as to achieve the stability of its purchasing power, the stability of the general price level."[35] This policy makes the general price level into a measure of the purchasing power of money independently of the absolute and relative movements of individual prices:

> The objective is to maintain more or less fixed the purchasing power of money, the general price level. The prices of commodities can vary in different directions, increase or decrease depending on the condition of each industry. However, compensations should take place so that the general price level, as expressed by the general price index, would only show weak oscillations. If this index starts increasing or decreasing in any significant way, the central bank should intervene to prevent this development to continue.[36]

To conclude, Aftalion's discussion of monetary policy is consistent with his emphasis on structural transformation as a fundamental constitutive feature of capitalism. His critique of the aggregate price level as a meaningful policy target derives from his view that monetary and credit policy should reflect actual and/or desired patterns of transformation within the network of interrelated activities rather than mirroring the dynamics of macroeconomic variables whose economic meaning can be entirely different depending on the direction followed by changes in the internal composition of aggregates. Aftalion's consideration of the links between structural transformation, layers of causation, and the means and ends of economic policy provides a unique economic policy framework in times when structural transformation objectives (such as decarbonization) require means capable of triggering and sustaining a pervasive transformation of the structures of interrelatedness in the economy.

[34] Aftalion, 102.
[35] Aftalion, 79.
[36] Aftalion, 80.

Structural Transformations in the Era of Decarbonization

In the third decade of the twenty-first century, there is an emerging consensus that the scale of resource consumption which enabled global economic growth in the post-war period and the associated negative environmental externalities (chiefly but not exclusively greenhouse gas emissions, air pollution, and biodiversity loss) threatens planetary boundaries. As James K. Galbraith, among others, has recently observed, classical political economy was well aware of the natural limits of the productive capacities of the primary sector; others have argued for decades for an incorporation of resource economics into multisectoral models, largely to no avail.[37]

Neoclassical climate change economics, as established by 2018 Nobel Laureate William Nordhaus, represents both a significant achievement and a flawed attempt to understand and model the interactions among the macro-economy, the energy system, and the climate system. In his Nobel lecture and in subsequent publications, Nordhaus argued that a global temperature rise of 4°C would be optimal, balancing equally the trade-offs between the costs of climate change mitigation and those of adaptation, even as the 2016 Paris Agreement had committed to limiting global median temperature rise to 1.5°C.[38] Nordhaus' approach, classified as an aggregate cost-benefit model, posits that climate change would only directly affect certain sectors of the economy, and that the macro-economy as a whole would not be affected by the propagation of intersectoral shocks, even if it would be by aggregate supply and demand shocks. Nordhaus' original Dynamically Integrated Climate-Economic (DICE) model was consistent with the neoclassical consensus and, therefore, amenable to adoption as the underpinning of global climate governance via integrated assessment models (IAM) that incorporate both natural and social sciences.[39] Although Regionally-Integrated (RICE) models with their regional extensions improved upon DICE models by consideration of spatial interactions, they still have no place for structural dynamics at the sectoral level.[40] This is especially alarming as

[37] James K. Galbraith, "Economics and the Climate Catastrophe" in *Economics and the Climate Emergency*, ed. Barry Gillis and Jamie Morgan (London, 2022); Alberto Quadrio Curzio and Fausta Pellizzari, *Rent, Resources, Technologies* (Berlin, 1999).

[38] William Nordhaus, "Climate Change: The Ultimate Challenge for Economics," *American Economic Review* 109, no. 6 (2019): 1991–2014.

[39] William Nordhaus, "The 'Dice' Model: Background and Structure of a Dynamic Integrated Climate-Economy Model of the Economics of Global Warming," Cowles Foundation Discussion Papers, no. 1009 (1 Feb. 1992).

[40] William D. Nordhaus and Zili Yang. "A Regional Dynamic General-Equilibrium Model of Alternative Climate-Change Strategies," *American Economic Review* 86, no. 4 (1996): 741–765.

integrated assessment modeling consists not only of the damage models discussed above, which explore aggregate cost-benefits, but also IAM employs process-based models to establish optimal decarbonization pathways.[41] The absence of intersectoral interdependencies in damage models is alarming, but to omit them from the consideration of climate change mitigation scenarios and associated shared socioeconomic pathways is troubling as it assumes structural economic change to be exogenous rather than an outcome of deep decarbonization itself.

Subsequent academic literature has confirmed that Nordhaus' approach has led to significant underestimation of the economic costs of adaptation to climate change, chronically unreliable carbon pricing, and increasingly doubtful estimates of the wider societal costs involved in missing key climate targets.[42] Yet it is not immediately evident how to improve these models within the existing framework, and the 2020 rework of the damage models performed by the Potsdam Institute for Climate Impact Research (PIK), although better grounded in climate science and with more realistic social discounting, made no fundamental changes to the economic modelling approach.[43] Grubb et al. are concerned to improve these models by introducing dynamic aspects, and they identify "induced innovation" (encompassing endogenous innovation between high and low carbon technologies, economies of scale, and knowledge diffusion), frictions ("inertia"), and path dependencies as the "few, key dynamic assumptions that affect optimal abatement."[44] Although they construct their "dynamic features of emitting systems" somewhat narrowly and maintain an aggregate approach, this represents a significant step forward and appears more tractable than agent-based client models developed by some evolutionary economists, which are nevertheless helpful in establishing the limitations of market-based solutions (carbon taxes, green subsidies) in inducing green transitions and thereby in providing support for the role of industrial policy.[45] What evolutionary approaches cannot offer is a heuristic for

[41] Christoph Böhringer and Thomos F. Rutherford, "Integrated Assessment of Energy Policies: Decomposing Top-Down and Bottom-Up," *Journal of Economic Dynamics and Control* 33, no. 9 (2009): 1648–1661.

[42] Steven Keen, "The appallingly bad neo-classical economics of climate change," in *Economics and the Climate Emergency*, ed. Barry Gillis and Jamie Morgan (London, 2022).

[43] Martin C. Hänsel, Moritz A. Drupp, and Daniel J. A. Johansson, Frikk Nesje, Christian Azar, Mark C. Freeman, Ben Groom, and Thomas Sterner, "Climate Economics Support for the UN Climate Targets," *Nature Climate Change* 10 (2020): 781–789. For a further discussion of the limitations of the PIK approach, see Michael Grubb, Rutger-Jan Lange, and Nicolas Cerkez, "Dynamic Determinants of Optimal Global Climate Policy," Tinbergen Institute Discussion Paper, 2020-083/VI (2023), 2.

[44] Grubb, Lange, and Cerkez, 2–4.

[45] Francesco Lamperti, Giovanni Dosi, Mauro Napoletano, Andrea Roventini, and Alessandro Sapio, "Faraway, So Close: Coupled Climate and Economic Dynamics in an

understanding the mutual dependencies, indirect effects, and feedbacks associated with industrial policy that is designed to accelerate specific sectoral decarbonization pathways.

While formal approaches to intersectoral modeling of climate change risks are rare in the literature, initiatives such as the Intersectoral Model Impact Comparison Project (ISIMIP) were promising in their attempts to model the consequences of intersectoral interdependencies for magnifying or mitigating climate damage.[46] Unfortunately, to the extent this approach has achieved traction at all, it mainly used to model trade-offs in the primary sector (agriculture, land use), where data quality is higher due to the near-universal presence of agricultural subsidy regimes. These models are not more widely employed, although the earth-systems science literature notes ISIMIP as one approach that respects the interdependencies of climate risks.[47] Perhaps not surprisingly, the greatest support for these approaches comes from climate scientists, to whom the logic of material interdependencies is obvious, and the greatest resistance comes from adherents to Nordhausian climate change economics and its assumptions that market-based solutions are axiomatically sufficient. As resources like the Carbon Emissions Accounts & Datasets (CEADS) develop and become more widely used in the estimation of optimal sectoral decarbonization pathways, revisiting intersectoral interdependencies between them will be possible, thereby providing policy support for coordination of sectorally-targeted industrial policy.[48]

A more intersectorally nuanced approach to climate modeling would also yield better monetary policy recommendations for the decarbonization era. Quantitative easing (QE) has been the standard policy approach to macro management since the 2007 subprime crisis, first in the US and the UK, then also in the Eurozone, culminating in the role that QE played in managing the exogenous shock of the COVID-19 pandemic. This approach has entailed exclusive reliance on monetary

Agent-Based Integrated Assessment Model," *Ecological Economics* 150 (2018): 315–339; Lamperti, Dosi, Napoletano, Roventini, and Sapio, "Climate Change and Green Transitions in an Agent-Based Integrated Assessment Model," *Technological Forecasting and Social Change* 153 (2020): 119806.

[46]Cynthia Rosenzweig, Nigel W. Arnell, Kristie L. Ebi, Hermann Lotze-Campen, Frank Raes, Chris Rapley, Mark Stafford Smith, Wolfgang Cramer, Katja Frieler, and Christopher P.O. Reyer, "Assessing Inter-Sectoral Climate Change Risks: the Role of ISIMIP" *Environmental Research Letters* 12, no. 1 (2017): 010301.

[47]James A. Rising, Charlotte Taylor, Matthew C. Ives, and Robert ET Ward, "Challenges and Innovations in the Economic Evaluation of the Risks of Climate Change," *Ecological Economics* 197 (2022): 107437; James Rising, Marco Tedesco, Franziska Piontek, and David A. Stainforth, "The Missing Risks of Climate Change," *Nature* 610, no. 7933 (2022): 643–651.

[48]Tianyang Lei, Daoping Wang, Xiang Yu, Shijun Ma, Weichen Zhao, Can Cui, Jing Meng, Shu Tao, and Dabo Guan, "Global Iron and Steel Plant CO2 Emissions and Carbon-Neutrality Pathways" *Nature* 622, no. 7983 (Oct. 2023): 514–520.

instruments in a macroeconomic framework. Recent debates have highlighted the dangers of relying exclusively on quantitative easing through aggregate monetary policies; but concerns that QE could produce inflationary pressures have only recently received empirical support and have yet to be demonstrated as a global phenomenon.[49]

Meanwhile other voices have questioned the climate impacts of recent QE, highlighting the extent to which such interventions retard decarbonization efforts, by prolonging existing economic structures and effectively subsidizing older industrial sectors in order to maintain full employment.[50] Proponents of the view that classic QE is unhelpful to decarbonization have instead promoted "green" quantitative easing, as if establishing the principle that central banks should preferentially buy green bonds would be sufficient to ensure the effectiveness of green QE as long as there is adequate transparency and accountability.[51] This is specialized credit policy through the backdoor, but falls short of what is required to effect deep decarbonization, as it merely classifies industries as "green" or "brown" and does not consider how to manage the intersectoral dynamics required to achieve the traverse, let alone the intersectoral trade-offs, of having done so. A reconsideration of Albert Aftalion's intellectual project suggests that more rigorous approaches to harnessing a specialized credit policy to support multi-sectoral decarbonization are possible, but the implementation of such a regime requires central banks to take seriously the intersectoral interdependencies of embedded carbon flows in the economy, not only in the energy and transport sectors, but also in the built environment and in agriculture and mineral extraction. Recent methodological innovations in environmentally-extended input-output analysis have established that tracking these flows is possible, but time lags in the production of reliable data are a major impediment to making such analysis routine.[52]

[49] Elad Harison, "In Search of a Remedy for Disruptions: Assessing the Effects of Inflationary Pressures on Supply Chains During the COVID-19 Era," in *Managing Inflation and Supply Chain Disruptions in the Global Economy*, 1–9. IGI Global, 2023.

[50] For example, see Daniel Bailey, "'Building Back Better' or Sustaining the Unsustainable? The Climate Impacts of Bank of England QE in the Covid-19 Pandemic," *British Politics* (2023): 1–20.

[51] Muchammad Chanif Chamdani and Bramanda Sajiwo Santoso, "Central Bank's Policy Justification In Mitigating Climate Change," *Journal of Central Banking Law and Institutions* 2, no. 1 (2023); Nora Laurinaityte and Annie Yihuizi Liu, "Combating Climate Change through Policy Instruments: A Meta-Analysis of Carbon Taxation," *Bank of Lithuania Occasional Paper Series* 45 (16 Jan. 2023).

[52] For example, see Qing Xia, Guiliang Tian, and Zheng Wu, "Examining Embodied Carbon Emission Flow Relationships Among Different Industrial Sectors in China," *Sustainable Production and Consumption* 29 (2022): 100–111; Cheng Lu, Qiang Du, Jingtao Li, Yi Li, and Xiaoyan Wang, "Trade Embodied CO2 Transfers from Transportation Sector: A Nested Multi-Scale Input-Output Perspective," *Transportation Research Part D: Transport and Environment* 119 (2023): 103727.

Rebuilding and expanding the capacities of state and other public actors to make evidence-based policy at the sectoral level is urgently needed to deliver deep decarbonization, in terms of guiding both specialized credit policy by central banks and coordinated sectoral support in infrastructural and industrial policy. This would also be the fullest realization of Aftalion's intellectual project.

A Political Economy of Transformations in Capitalism

In addition to its relevance for understanding a new growth regime inaugurated by a global push for decarbonization, Aftalion's multilayered analysis of industrial dynamics has significant implications for the morphology of capitalism under structural transformation. In Aftalion's view, industrial interdependencies generate conditions for evolutionary trajectories that must be satisfied independently of the institutional context. In other words, institutions and policies must be embedded in a wider framework of which material structures are a fundamental constitutive element.[53] This approach finds a remarkable expression in Aftalion's belief that the alternating phases of expansion and contraction characterizing capitalist institutions are a direct consequence of the technical conditions of production technology, and would therefore be effective also in a different institutional context (as in a socialist economy): "[m]y principal thesis is that the chief responsibility for cyclical fluctuations should be assigned to one of the characteristics of modern industrial techniques, namely, the long period required for the production of fixed capital."[54] Conversely, Aftalion's approach lends itself to the view that, independently of the institutional context in which transformations take place, certain conditions regarding the interrelatedness and time sequencing of structural change need to be satisfied for any transformational trajectory to be successful. Aftalion's conceptualization also helps explain why economic development cannot be reduced to a matter of setting the institutional framework and expecting structural transformation to flow from it.

There are several implications of Aftalion's line of reasoning. First, it is possible to read Aftalion as pre-figuring Luigi Pasinetti's "Separation Theorem," distinguishing "natural" from "institutional" levels of analysis, as there is a sense that incomes arising from capital, land, and interest would exist under socialism, because they are "natural" (that is, technologically determined) rather than the result of a particular property

[53] For a related view of embeddedness, see Adrian Pabst and Roberto Scazzieri, *The Constitution of Political Economy: Polity, Society and the Commonweal* (Cambridge, UK, 2023), esp. chap. 7.

[54] Aftalion, "Essai d'une théorie des crises périodiques," 209.

regime.[55] Secondly, it becomes necessary to disentangle the "natural" from the institutional aspects of transitional paths. In this light, Aftalion distinguishes between the "natural" (that is, structural) and the institutional meanings of distributional categories such as profits, rents, and forms of interest:

> [C]apitalist revenues, rent, interest, profit do not constitute, at least in their essence, albeit with some exceptions in fact, exploitation, but represent a creation of value, representing a share in the (embodied) value of things. They are not a consequence of legislation (positive law), nor an effect of private property, but instead stem from economic realities. Embellishing the demonstration further, we can add that capitalist incomes have such a natural economic character, independent of the force of law, that under pain of serious inconvenience, they should be maintained even in a socialist system— except that [incomes] are received only by the State, as sole owner of the means of production.[56]

The above argument leads Aftalion to distinguish between the "natural" profits, interests, and rents arising from the objective (mainly technological) conditions of production and the actual distribution of those incomes to particular individuals or social groups according to the existing institutional set up.[57] This point of view calls attention to the

[55] Pasinetti argues that, in economic analysis, it is necessary to introduce a distinction between a "natural" and an "institutional" level of investigation: "[t]he former type of investigation [. . .] are aimed at discovering basic relations, which the Classical economists called 'natural,' i.e. in their view aimed at determining the economic magnitudes at a level which is so fundamental as to allow us to investigate them independently of the rules of individual and social behaviour to be chosen in order to achieve them [. . .] This is a stage kept free from specific geographical and historical circumstances. Then, one is able to proceed to a second stage of investigation, which concerns how the economic magnitudes are actually determined, within the bounds and constraints of the institutions characterizing the economy at the time it is investigated:" see Luigi Pasinetti, *Keynes and the Cambridge Keynesians: A Revolution in Economics to Be Accomplished* (Cambridge, UK, 2007), 275. In his most recent work, Pasinetti introduced the distinction between "capitalistic" production arrangements and "capitalist" institutions, where the former expression refers to capital-using methods of production while the latter expression refers to a particular set of economic institutions: see Luigi Pasinetti, *A Labour Theory of Value* (Cambridge, UK, forthcoming). In his book on the foundations of socialism, Aftalion had introduced the distinction between the "natural" and the institutional level of investigation arguing that it is necessary to separate, from among phenomena, "[those] that have a natural, purely economic, character, and those that have a legal foundation [since] they derive from the legal institutions in force:" see Aftalion, *Les fondements du socialisme, Études critique* (Paris, 1923), 25.

[56] Aftalion, *Les fondements du socialisme*, 289–290.

[57] Here too we find an analogy with Pasinetti's distinction between the "natural" profit rates (the profit rates allowing the accumulation of capital to take place at full employment and full utilization of productive capacity under conditions of structural change) and the

distributional dynamics associated with the transformation of economic structures; and it suggests the need for distinguishing between the distributional changes required by the structural transformation and those changes that reflect existing institutional arrangements and the relative influence of social groups, and which are not necessarily aligned to the former.[58] This provides an alternative view to the one implicit in Peter Hall's formulation of growth regimes, which takes an institutionalist approach to both material and social realities. Given the material constraints at the base of the climate crisis, Aftalion's approach offers a particularly helpful heuristic for understanding the challenges and opportunities associated with the era of decarbonization. Lastly, Aftalion's approach suggests that economic policies successful in driving a structural transformation as a systemic policy objective presuppose the identification of the relevant units of analysis, patterns of interdependence, and patterns of sequential causality required for the transformation to take place. This framework may allow several degrees of freedom to policy actions, which may accordingly adjust to specific institutional and political contexts. However, no transformation objective, including that of deep decarbonization, would be feasible unless its structural prerequisites are first identified and met.[59] Aftalion's contribution provides essential building blocks to the construction of a historical and structural political economy rooted in the multi-layered structures and multiple time horizons involved in structural dynamics.

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actual profit rates achieved in industrial sectors, which may be different from the former: see Pasinetti, *Structural Change and Economic Growth*.

[58] For example, as Aftalion points out, capitalists accrue profits and landowners accrue rents beyond that period of current productive activity, thereby contributing to the intergenerational transmission of entitlements: see Aftalion, *Les fondements du socialisme*, 291. This may not be aligned with the intended transformation trajectory.

[59] See Ivano Cardinale, "On Means and Ends in Structural Economic Analysis: Broadening the Field of Enquiry," *Structural Change and Economic Dynamics* 61 (2022): 450–457; Ivano Cardinale, "Collective Objectives, Particular Objectives, and Structural Conditions: On Pasinetti's Natural Economic System and the 'Institutional Problem,'" *Structural Change and Economic Dynamics*, 70 (2024): 202–210.

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