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The Factual Nature of Resource Flow Accounting in the Calculation in Kind of the “Other Austrian Economics”

Marco P. Vianna Franco*

In the 1910s and 1920s, Austrian thinkers Josef Popper-Lynkeus (1838–1921) and Otto Neurath (1882–1945) ascended as the main advocates of a heterodox, biophysical approach to economic science dubbed the “Other Austrian Economics”. Their ideas included an emphasis on economic planning based on calculation in kind as means to regulate production and distribution processes toward improved living standards for all. Natural resource flow accounting posed as the main method through which they collected empirical evidence in order to develop new policy-relevant economic theories. This paper analyzes in detail what the ontological and epistemological assumptions underlying their resource flow accounting were, as well as how facts and values interplayed in their argumentation for calculation in kind as a key tool for economic science. Based on seminal works of Neurath and Popper-Lynkeus concerning the subject of the factual nature of such socioecological flows and stocks of matter and energy, the empirical character of their assessments can hardly be denied, while a genuine concern for the role played by value-based judgements in decisions about production and consumption is recurrent. They faced head-on the challenges posed by incommensurable values, and believed value-based judgements are political decisions. The more information there is about alternative economic plans, the better these decisions would be, especially in terms of a materially and energetically rational relationship between nature and society.

Keywords: resource flow accounting, calculation in kind, economic planning, Neurath (Otto), Popper-Lynkeus (Joseph)

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La nature factuelle de la comptabilité des flux de ressources dans le calcul en nature de l' « autre économie autrichienne »

Dans les années 1910 et 1920, les penseurs autrichiens Josef Popper-Lynkeus (1838-1921) et Otto Neurath (1882-1945) sont devenus les principaux défenseurs d'une approche hétérodoxe et biophysique de la science économique, appelée "l'autre économie autrichienne". Leurs idées mettaient l'accent sur une planification économique fondée sur le calcul en nature comme moyen de réguler les processus de production et de distribution, en vue d'améliorer le niveau de vie de tous. La comptabilité des flux de ressources naturelles a été la principale méthode utilisée pour recueillir des preuves empiriques afin de développer de nouvelles théories économiques utiles pour les politiques publiques. Cet article analyse en détail les hypothèses ontologiques et épistémologiques qui sous-tendent la comptabilité des flux de ressources, ainsi que la manière dont les faits et les valeurs interagissent dans leur argumentation pour le calcul en nature en tant qu'outil clé de la science économique. S'appuyant sur les travaux fondateurs de Neurath et Popper-Lynkeus concernant la nature factuelle de ces flux et stocks socio-écologiques de matière et d'énergie, le caractère empirique de leurs évaluations peut difficilement être nié, alors qu'une véritable préoccupation pour le rôle joué par les jugements de valeur dans les décisions de production et de consommation est récurrente. Ils ont fait face aux défis posés par des valeurs incommensurables, et ont estimé que les jugements de valeur sont des décisions politiques. Plus il y a d'informations sur les plans économiques alternatifs, plus ces décisions peuvent être dites bonnes, notamment en ce qui concerne une relation matériellement et énergétiquement rationnelle entre la nature et la société.

Mots-clés : Comptabilité des flux de ressources, calcul en nature, planification économique, Neurath (Otto), Popper-Lynkeus (Joseph)

JEL : B14, B31, Q57

In the 1910s and 1920s, Austrian thinkers Josef Popper-Lynkeus (1838-1921) and Otto Neurath (1882-1945) ascended as the main advocates of a heterodox, biophysical approach to economic science that starkly contrasted with the views of the representatives of the traditional Austrian School of Economics. Their set of economic ideas retrospectively received the epithet of the "Other Austrian Economics" (Nemeth, 2013). These ideas included an emphasis on economic planning based on calculation in kind as means to regulate production and distribution processes toward improved living standards for all.

Popper-Lynkeus (1912) sought to assess national economies in terms of the demand for natural resources that would suffice to feed the entire population, using material and energy balances to conclude that population control would eventually become inevitable. His confidence in the role of material and energy flow accounting for the purposes of social planning strongly influenced Neurath's work. A famous

character in the history of economic thought for his involvement in the socialist calculation debate (Uebel, 2005, 2008), Neurath ([1925a] 2004) argued that it was possible to achieve a rational process of calculation in physical units leading to the planning of a socialist economy. A choice would have to be made between several different possible outcomes, and ecological concerns would have to be considered (also in an intergenerational perspective), such as the availability of energy, materials, and human labor.

Martinez-Alier (1987) characterized Popper-Lynkeus and Neurath as left-wing social energeticists. They would have shared a so-called ecological utopian worldview, in which knowledge stemming from the natural sciences led to the rejection of cornucopian outlooks on the future of humanity and fostered more egalitarian forms of social organization as means not to exceed given biophysical boundaries. Despite being labelled “neo-Saint-Simonian social engineers”¹ by Hayek ([1952] 1980), they opposed totalitarian and technocratic agendas and focused on the achievement of social ideals through the conceptualization of energetically and materially sound economic planning programmes.

The development and use of natural resource flow accounting for the purposes of economic planning was first propounded by Ukrainian physician Sergei Podolinsky (1850-1891) (Martinez-Alier, 1987).² In the beginning of the 1880s, based on the laws of thermodynamics, Podolinsky applied the concept of energy efficiency to land use and human labor by means of energetic input-output ratios (Podolinsky, [1881] 2004). In the late 19th and early 20th centuries, the mechanistic school of sociology (Carver, 1924; Sorokin, 1928; Winiarski, 1898) would consolidate social energetics as a scientific field whose aim is to apply the principles of thermodynamics to social systems, analyzing the flows and stocks of energy that shape and condition the functioning of human societies.³ Studies using social energetics are quite diverse in terms of the assumptions regarding the dynamics of energy transformations, of the methodologies employed to understand such dynamics, and of the levels of reductionism in the characterization of energy as the ultimate determinant of cultural development.

¹ Neurath ([1919b] 1973) himself referred to economic planning proposals as utopian social engineering constructions, *i.e.* the exploration of alternative socio-technical possibilities based on historical and theoretical research. Here, ecological utopianism bears a more specific meaning than the concept of scientific (and historical) utopianism, as admittedly shared by Neurath (Uebel, 2008).

² Another pioneer in the application of analytical methods to assess energy stocks and flows in human societies was Austrian science professor Eduard Sacher (1834-1903). However, there is no evidence linking Sacher’s 1881 book on social energetics to the Other Austrian Economics.

³ Energetics addresses the laws governing the many different forms in which energy is transformed or exchanged. Hence, its laws are broader in scope than the laws of thermodynamics, although the terms “energetics” and “thermodynamics” are frequently used as synonyms in the literature.

Such a biophysical approach to social science, and to economic science in particular, entails the need to assess the human economy by means of resource flow accounting, *i.e.* the accounting of the flows (and stocks) of matter and energy that are relevant to concrete production processes.⁴ This view constitutes the cornerstone of ecological economics, a contemporary discipline which focuses on the human economy both as a social system and as a subset of the biophysical universe. Economic processes are seen as life-supporting metabolic processes, comprised ultimately of biological, physical and chemical transformations, subject to constraints on a finite planet (Boulding, 1966; Daly, 1968; Georgescu-Roegen, 1971).

The Other Austrian Economics, therefore, constitutes an important part of the history of ecological economic thought, understood as the historical development of the interlinkages between economics and ecology, which, in turn, are assessed through the analysis of the flows and stocks of matter and energy and their economic implications for the processes of social provisioning and cultural development. Between the 1880s and the 1930s, social energetics acted as the foundation of ecological economic thought (Franco, 2018). Natural resource flow accounting posed as the main method through which such a biophysical approach to economics collected empirical evidence in order to develop new policy-relevant economic theories. This method is still employed today with a great potential to empirically enlighten issues related to the interface between nature and society (Fischer-Kowalski, 1998).

This paper analyzes in greater detail how this specific process unfolded in the case of the Other Austrian Economics. What were the ontological and epistemological assumptions underlying the resource flow accounting of Neurath and Popper-Lynkeus? How did facts and values interplay in their argumentation for calculation in kind as a key tool for economic science? In order to provide answers for these questions, the paper delves into seminal works of Neurath and Popper-Lynkeus concerning the subject of the factual nature of such socioecological flows and stocks of matter and energy as represented in the form of flow accounting data.

Section 1 presents the context in which the Other Austrian Economics emerged and their main ideas pertaining to calculation in kind. Section 2 brings the specific ontological and epistemological assumptions adopted by Neurath and Popper-Lynkeus related to natural resource flow accounting when making the case for calculation in kind. Section 3 discusses to what extent Neurath and Popper-Lynkeus saw flow accounting data as an accurate representation of reality, and what role

⁴ The aggregation of flows of matter and energy in social systems is often described as social metabolism. For a review of the historical development of the concept of social metabolism, see Fischer-Kowalski (1998).

values played in their use of such data for the purposes of calculation in kind and, in turn, of economic planning. Section 4 brings some final remarks.

1. The “Other Austrian Economics” and Calculation in Kind

The main theoretical contributions of the Other Austrian Economics pertaining to the epistemology of economic science were mostly established before World War I, although their ideas would retrospectively be more closely linked to the socialist calculation debates of the 1920s and 1930s. It was in the 1900s and 1910s when the conceptual and methodological assumptions of the Other Austrian Economics came to life. In the first decade of the 20th century, “debates on methods and value judgements in social science [*Werturteilsstreit*] were still going on and polarized many of the younger generation of social scientists in the German speaking world” (Nemeth, 2013, 341). Otto Neurath was one of the rising scientists of this younger generation, at least until his turn to political activism in 1918.

Neurath's early economic theories aimed at, among other things, finding middle ground between the subjective theory of value associated with Austrian economics (and its call for methodological standards in economic science) and the empirical approach—including demographic and cultural elements—of advocates of the German Historical School. He also attempted to broaden the subject of economics by shifting focus away from markets and price formation mechanisms as its sole concern toward the study of economic behavior and welfare (in terms of real income) also in non-market settings. His calculation in kind would constitute a new way of addressing economic issues, with an emphasis on the satisfaction of needs rather than on prices, wages, or any other monetary variable. He set out from the methodological principle in which economic categories such as wealth, labor, or welfare needed to be considered as composed of irreducibly heterogeneous elements which were, therefore, not subject to value aggregation or calculation in terms of prices, labor time, or even pleasure. In the 1910s, Neurath was not yet Hayek's academic adversary, but the proponent of a new approach to economic science:

[Neurath's] fresh look conceived of the subject matter of economics as an ensemble of pleasure and displeasure which is influenced by an ensemble of actions and institutions. ... In such a framework economists would be able to investigate the effects markets have on the quality of life of particular populations and compare them systematically with the effects which other economic orders would produce (Nemeth, 2013, 347).

His earlier theoretical views on economics would gradually evolve into an alternative conceptual structure of economic science and eventually into a framework for the planning of a socialist economy in the 1920s

and 1930s. Neurath's course of action would be aided by his empirical studies on war economies (e.g. the Balkan wars and WWI),⁵ culminating in a more pragmatic stance toward policies which could enable the development of a centrally planned economy based on calculation in kind. Such a universal economic accounting would be composed of estimates of social demand and available supply generated through reports by producers and governmental agencies. A directive planning would entail a political decision for the actual determination of a desired plan; an indicative planning, on the other hand, would point to the possibilities given by empirical evidence. In the latter case, planning agencies would have full autonomy, as an indicative planning is more strictly related to operational issues of in-kind economic accounting (Uebel, 2004).

As a result of the theoretical backlash prompted by his *Economic Plan and Calculation in Kind* (Neurath, [1925a] 2004), which stemmed from Austrian and Marxist economists alike, Neurath would later argue in favor of a conceptual and programmatic separation between economy in kind (*Naturalwirtschaft*) and calculation in kind (*Naturalrechnung*). There would be a need for the latter even if the former remained only as a theoretical possibility, as in the case of environmental concerns and incommensurable values involving the physical basis of the supply of energy and raw materials, an issue that served as one of Neurath's main arguments against Ludwig von Mises and Friedrich von Hayek in the socialist calculation debate (O'Neill, 2004; Uebel, 2005, 2008).

The rejection of the existing economic order and its social maladies, especially of its monetary character, was a belief Neurath shared with his father, Wilhelm Neurath (1840-1901), despite the anachronistic philosophical idealism of the latter. In this regard, Neurath was more in line with the "Viennese Enlightenment"⁶ and the philosophy of science of Ernst Mach and Popper-Lynkeus, a "combination of a tough-minded empiricism in science and an engaged attitude towards the practical problems of social life" (Uebel, 1995, 88). In more specific terms,

Neurath's inspiration came from outside the tradition of Marxian socialism altogether: Josef Popper-Lynkeus' ... ideas for a minimum income for all, guaranteed by universal conscription to a national service for its provision; Karl Ballod's statistical computations of the efforts needed to sustain such

⁵ To Neurath, war brought with itself a different economic organization worthy to be studied as a separate discipline. War economies resembled centrally planned economies, with peculiar production and distribution arrangements and priority given to real needs over monetary variables. They would constitute evidence, even though imperfect, that an economy in kind would be workable (Uebel, 2004).

⁶ "The ideational-ideological superstructure of various mostly liberal social and educational reform movements in late 19th and pre-WWI 20th century Vienna" (Uebel, 1995, 87-88).

a welfare state *avant la lettre* ...; and his own father's idiosyncratic proposals for a pan-cartelism to obviate the crises of overproduction (Uebel, 2008, 477).

Popper-Lynkeus, the other main representative of the Other Austrian Economics, was a contemporary of Wilhelm Neurath and also a fierce critic of economic science and its lack of ability to foster social reform. However, unlike Neurath, he was not particularly interested in economic methodological questions, preferring to tackle existing social problems than sustaining a protracted debate about the theoretical shortcomings of economic science.

Popper-Lynkeus worked as an engineer for most of his life, engaging in research in different fields of the natural sciences, such as thermodynamics, mechanics, electricity, and aerodynamics. He was also interested in matters of social reform and philosophy, to which he turned full-time attention after retiring from his career in engineering in 1897 due to health issues. He was a friend of many prominent German-speaking intellectual figures of the time, among them Ernst Mach, Wilhelm Ostwald,⁷ Albert Einstein, and Sigmund Freud, who influenced and were influenced by Popper-Lynkeus's views on the philosophy of natural and social sciences.

The *Allgemeine Nährpflicht* (1912) is commonly held as the most important contribution of Popper-Lynkeus to social science, although his *Das Recht zu Leben und die Pflicht zu Sterben* ([1878] 1903) is also a relevant work in social philosophy in which he anticipated many of the economic views set forth in 1912.⁸ He argued that, to ensure that every person is granted a minimum income which allows for a continued existence, a universal conscription to a nationwide service for the production of vital goods (food, clothing, shelter, basic education, health products etc.) was in order. To him, there would ideally be two economies functioning in parallel: a planned one focused on basic needs and a market one for the allocation of luxurious goods. Once an individual fulfills his duty toward the supply of basic goods, he would be free to take part in the market economy. Nevertheless, this proposal for social reform would depend on the ability to calculate, plan, and match supply and demand for labor and natural resources (in particular for

⁷ Ostwald was one of the main representatives of the social energetics branch of the mechanistic school of sociology and the president of Haeckel's Monist League between 1911 and 1914, holding a reductionist stance on the link between energy, natural selection and cultural development to which Popper-Lynkeus was firmly opposed (Franco, 2018).

⁸ Belke (1978) provides a detailed account of Popper-Lynkeus's original (and not sufficiently appreciated by historians of thought) propositions for social reform amid Austrian contemporary socialist movements; Wachtel (1955), in turn, offers an extended summary of such works and discusses how they are interrelated, although the issue of resource flow accounting is omitted.

nonrenewable resources, given the problem imposed by their exhaustibility on the viability of a permanent economic system).

Popper-Lynkeus agreed with Neurath that money was not a proper unit of account; matter and energy would themselves constitute more adequate units in the process of economic planning. However, the fact that Popper-Lynkeus presupposed the maintenance of a market system for non-vital goods and services cleared him from many of the theoretical criticisms suffered by Neurath (e.g. how to account for production factors, such as manufacturing capital). In any case, both argued for the creation of a central economic accounting institution.

In a short piece celebrating Popper-Lynkeus's achievements by the occasion of his eightieth birthday, Neurath ([1918] 1981) described his propositions for social reform as utopian, in the sense of a relentless pursuit of human happiness, although attainable by means of his innovative method of calculation in kind. According to Neurath, Popper-Lynkeus's ideal social system sought to secure minimum living standards for all regardless of changes in individual behavior. Monetary calculation was not a relevant approach in this case, as it was also not a priority in times of war.

It is worth mentioning the role played by Latvian economist, statistician, and demographer Karl Ballod-Atlanticus (1864-1931) in the development of calculation in kind. In fact, if not for his nationality or for the fact that he was based in Berlin during most of his academic life, Ballod-Atlanticus would unquestionably deserve to be included as one of the leading members of the Other Austrian Economics. He exerted great influence over Neurath, whom he had met in Berlin in 1905, and also over Popper-Lynkeus. In *Der Zukunftsstaat*, Ballod-Atlanticus ([1898] 1919) employed calculation in kind to explain the role of technical progress and material efficiency for the satisfaction of basic needs of present and future human generations.

The social reform proposed by Ballod-Atlanticus, as stated above for Popper-Lynkeus, did not entail the elimination of markets; it anticipated a mixed economy in which survival was to be guaranteed by the State and operationalized by calculation in kind in physical units, whereas more superfluous needs were to be met through market transactions. In this regard, the *Naturalwirtschaft* of Neurath is a more radical proposition; yet, calculation in kind as a tool for securing a minimum standard of living for all remains as a unifying element.

Martinez-Alier (1987) characterized Neurath, Popper-Lynkeus, and Ballod-Atlanticus as representatives of a left-wing ecological utopianism in early economic literature on energy-related issues. The acknowledgement of the existence of biophysical limits to economic processes, as stated by the entropy law and the postulated inexorability of energy degradation in isolated systems, led to social implications such as the need for a more rational use of resources and for a planned production

and distribution of basic goods so that everyone could have their minimum living standards met.

The biophysical approach to economic science of the Other Austrian Economics would be based on calculation in kind, which, in turn, would depend on empirical evidence stemming from “physical statistics about energy use, material use and so on” (O’Neill, 1993, 111), here referred to as resource flow accounting.

2. Resource Flow Accounting and its Ontological and Epistemological Assumptions

In order to understand the factual nature of the resource flow accounting of the Other Austrian Economics, it is necessary to ask what the ontological and epistemological assumptions underlying this analytical method were in the context of their call for calculation in kind.

At the dawn of the 20th century, Neurath and Popper-Lynkeus gravitated toward a Machian philosophy of science (Mach, [1893] 1919), based on which they sought to describe social phenomena in accordance with methods employed by the natural sciences, but which would be themselves conditioned by subjective social relations.⁹ Mach opposed Kantian aprioristic idealism in favor of the role of experience in processes of knowledge construction; however, it would be impossible to make perfectly accurate statements about reality through human sensory lenses. Measurements can only be interpreted in comparative terms, *i.e.* in relation to a sensorially determined standard. Hence, a sort of physiological subjectivity is always an element of empirical research, which does not mean experimentation is to be discarded, but taken critically in the process of unveiling the nature of reality based on the ideas that empirical evidence suggests. Although in favor of direct and immediate experience for understanding the world, Mach would be heavily criticized by orthodox materialists for depriving science of its objectivity.

Neurath’s and Popper-Lynkeus’s flow accounting method was based on a holistic component of Mach’s philosophy of science, namely a need to understand physical and psychical phenomena as a set of organized and ordered experiences, as opposed to a sum of particulars. Such a presentation of the world would come in the form of physical or physiological flows or processes, even if relatively fixed, from which one is supposed to draw systematic observation-bound correlations,

⁹ In Machian philosophy of science, objectivity—as opposed to subjectivity—is discussed in terms of the neutrality of the scientific method (how phenomena are experienced) and not of the character of knowledge *per se*. According to Cohen (1968, 135), “[t]he method of science, to Mach, is neither subjective, as that of metaphysics, nor objective as the old empiricism claimed, but impersonal.” Here, the term “objectivity” is used in a more straightforward sense, referring to the factual nature of flow accounting data as an accurate representation of external reality.

not imaginative hypotheses or dogmatic certainties (Cohen, 1968). Resource flow accounting in the Other Austrian Economics constitutes an instance in which representation of reality is given in terms of physical and physiological elements: facts experienced through the senses which can be used not only to theorize, but above all to instrumentally understand and control the natural world, integrating the aforementioned physical and psychical phenomena.

In their economic science, production and labor were historically determined phenomena depicted by the experience of social organization of human life. Historical comparative studies would be useful in this regard, as they would allow for an expanded set of experiences, encompassing phenomena hitherto absent or overlooked in experimentation and leading to new theoretical formulations. Machian ontology and epistemology would provide a suitable philosophical framework, as assessments of production and labor in terms of resource flows could be deemed as attempts of systematization of commensurate and interconnected facts based on sensorial experience. Mach's "method of variation" precisely stresses the relevance of such interconnections—how changes in one element are intertwined with changes in other elements of a system—and points to the ability to provide meaning to the particulars from observations informed by the whole. For Nemeth (2013, 348), the Machian method of variation is a "promising candidate for future research into the question how far and in what respects Neurath's methodological and epistemological approach to economics followed Mach as its main model". In the case of his and Popper-Lynkeus's resource flow accounting, the link is quite clear.

While Neurath sought to "modernize the holistic conception of economics he had inherited from the Historical School by re-formulating it from a Machian point of view" (Nemeth, 2013, 346), Popper-Lynkeus was less concerned with the scientific character of his social reform proposals, notwithstanding his positivistic-empiricist approach supported by an extensive use of statistics. Their calculation in kind asked for a flow accounting that could enlighten decisions about alternative uses for resources according to the needs of a given society and, hence, achieve higher levels of economic efficiency, understood as the capacity to produce a higher quality of life for the greatest number of people.

According to the terminology used by Neurath ([1917a] 2004), natural resource flow accounting is part of the calculation necessary for assessing the external conditions (*Sachlage*) of life (e.g. food, housing, heating etc.), which, in turn, must be compiled along with social variables, such as education, health, creativity, or personal relationships, so as to amount to an inventory of the conditions of life (*Lebenslagenkatalog*). Despite the measurement difficulty imposed by these social variables, they would be just as important as the *Sachlage*, and also subject to surveys based on household descriptions. The best possible

conditions of life would be bounded by the basis of life (*Lebensboden*), which refers to the actual state of the world enabling the actualization of qualities of life (*Lebensstimmungen*). Such qualities of life—subjective experiences of human beings—would be the ultimate set of variables of interest for Neurath’s calculation in kind, although, for the purposes of “concrete investigation, the relief map of qualities of life is therefore replaced by an inventory of conditions of life” (*ibid.*, 420):

[it] could, for example, start by finding out which raw materials are available at a certain time and at which places, how much water power, how much and which kind of labour power, inventive power, stupidity, diligence, etc. ... If a whole people is the subject of the study, the movement of the raw materials can be followed through their various stages by taking account of the production, consumption, storage, import and export. ... [F]acts which do not lend themselves to being stated in amounts, as inventive power, etc., must not therefore be considered to be of absolutely indifferent character. If inventive power could be measured in horse power like working power, it would be added to the other powers. The pure impossibility of such measurement must not induce us to overlook that the gift of invention can, for example, replace other powers in certain circumstances (*ibid.*, 327).

Such a “movement of raw materials”, the “paths taken by the raw materials and the end products” (Neurath, [1931] 2004, 499), or the transformative character of the basis of life into conditions of life—“food into human body, other things into machines, etc.” (Neurath, [1917a] 2004, 327)—consist in flows not only of materials and energy, but also of other external conditions, such as climate, disease, and other environmental elements. Hence, a unit of account is not to think of from start; Neurath’s calculation is far too encompassing to allow for a common denominator. There would be “no ‘universal unit’ of calculation, but only specific units: kilogrammes, days of labour, acres of fields, etc.” (*ibid.*, 486) which necessarily call for a multi-criterial representation and analysis of a given economic order.

Nevertheless, broad categories such as materials and energy, given their importance for the determination of the conditions of life and their practicality for measurement purposes, would make the accounting of their socioecological flows the first step in the wide-ranging process of calculation in kind. It “takes its start from the given fields, swamps, forests, waste land, machines, stores of all kind, people, etc.” (Neurath, [1917a] 2004, 337) and moves on to subjective variables which, according to Neurath, can be objectively assessed and compared over time only in terms of ordinal rankings of “pleasantness” (Neurath, [1925a] 2004, 416).

In relation to production, calculation “provides information about the way in which resources of raw materials, land, work power—animal and human—are to be combined to get a definite result in the conditions of life”; on the other hand, when focused on consumption, calculation “shares out parts of the conditions of life after it has been

decided what is to be kept in store" (*ibid.*, 425-426). The accounting of production and consumption must be, naturally, intertwined:

Many of the factors concerned and their connections can be expressed in terms of statistics. For example, we can show the amounts of raw materials that enter a total economy, how they are employed in production with the help of machines, animals and human labour and then move on to the particular branches of the economy, only to enter circulation again either as means of production or as conditions of the life of human beings (housing, food, clothing, education and amusements, health, enlightenment, etc.) or to be discarded as useless waste. In the case of agriculture, its input chart would show us the amounts of artificial fertiliser, machines, human work force, etc. that enter into this branch of the economy and its output chart what we get in terms of meat, milk, fodder, etc. (*ibid.*, 444).

Other accounts would be added to those of production and consumption, such as imports, exports, and stock-keeping. While there would be a strong focus on consumption, given its more direct link to the qualities of life, an empirical investigation into the accessible stock of means of production and the demand for each of them would also be urgently required. Once a clear picture of such flows became available, distribution issues could be tackled within the context of a determined—politically driven—economic plan (Neurath, [1917b] 2004).

Neurath gives due importance to material and energy flow accounting in a report written to the 8th plenary session of the Munich Workers' Council in January 1919:

It is not enough to know the possibilities of production and consumption as a whole, one must be able to follow the movement and fate of all raw materials and energies, of men and machines throughout the economy. Alongside the balance for raw materials and energy which deals with production, transformation (consumption), stockpiling, import and export for the whole country, and will be set out according to individual raw materials such as copper, iron and so on, we must also have the balance for individual branches of industry, agriculture, etc. One must be able to recognize what quantities of coal, iron, chalk, etc. machines, men, etc., are used by foundries, how much ore and slags are produced, what goes into industry and what goes into agriculture (Neurath, [1919a] 1973, 140).

Nonetheless, while Neurath offers a social justification, a detailed theoretical conceptualization, and a programmatic outline for calculation in kind, he in fact neither pursues an extensive statistical work or in-depth case study, nor attempts to assess the external conditions of life by means of resource flow accounting.¹⁰ In this regard, he limited himself to mentioning the empirical efforts of Popper-Lynkeus and Ballod-

¹⁰ In *The Current Growth in Global Productive Capacity*, Neurath ([1931] 2004) provides a few economic statistics in pictorial form and anecdotally compares calculation in kind with calculi in monetary units, without a real attempt to statistically organize data for economic planning.

Atlanticus.¹¹ Therefore, a more illustrative analysis of the flow accounting of the Other Austrian Economics can come from the statistical calculations undertaken by Popper-Lynkeus.

In *Das Recht zu Leben*, Popper-Lynkeus ([1878] 1903) had already argued in favor of an *in natura* distribution of basic goods as means to safeguard a minimum standard of living for all. In 1912, he would detail his social programme, *Die Allgemeine Nährpflicht*, and support it with thorough statistical data on the flows of such basic goods. Popper-Lynkeus divides his calculations by sector: food, housing, housing infrastructure (e.g. lighting and heating), clothing, health care, public services, and transportation, which are necessary for “a physiologically and hygienically comfortable life standard” (Popper-Lynkeus, 1912, 333, translated by the author).

As a result, he deems himself to be accurately portraying sectors producing basic goods and services in the German economy between 1908 and 1912. He presupposes a German population of 70 million by 1916 or 1917 and, based on resource flow accounting, calls for the formation of a *Nährarmee* of 7.2 million men and 4.64 million women working in these sectors respectively for 13 and 8 years, between 7 and 7.5 hours a day.

Popper-Lynkeus is very thorough in his flow accounting of human nutrition. He divides the human body physiological needs into minimum levels of water, minerals, protein, fat, and carbohydrates, although realizing that cultural elements, such as German eating habits and taste, must also play a role in the planning of the food sector. He goes through the available data to assign a reasonable minimum level of food intake (in kilograms) to a German full-grown working man (children, women and the elderly would have their food consumption calculated as a factor thereof), choosing to include the following in his in-kind calculation program: meat, bread, potato, butter, cheese, milk, and sugar. Coffee and tea would preferably be avoided, given their lack of nutritional value; however, an in-kind trade agreement with producing countries could be arranged if people demanded it as basic goods. Fruits and other secondary products were not accounted for by Popper-Lynkeus, as he believed the production amounts involved could easily be planned for in a subsequent improved version of his statistics.

From this set of food products, Popper-Lynkeus obtains the mass of protein, fat, carbohydrates, and minerals per person per day to be accounted for. Analogous calculations are undertaken for housing, housing infrastructure, clothing, health care, public services, and

¹¹ Neurath refers to the works of Popper-Lynkeus and Ballod-Atlanticus as “impressive sketches” which show that in-kind economic plans are feasible (Neurath, [1925a] 2004, 445-446). For him, their work “had purely practical purposes and did not really have any theoretical backing” (Neurath, [1916] 2004, 302), a deficiency which Neurath believed overcoming was his own contribution to the cause.

transportation, using physical units such as housing floor area, cubic meters of gas, pieces of clothing, and number of transport vehicles, among others.

He then moves on to assess how many people would be needed for the required production of food, housing etc., either in farms, industries, or service sector. His discussion on agriculture is quite illustrative. He mentions how productivity gains might ease the burden over the *Nährarmee*, presents statistical data on current agricultural production and imports, and compares the figures obtained with the calculated nutrition needs of the German population. The same goes for housing and the other above-mentioned sectors of the in-kind economy.

Energy needs are also computed for each of these sectors, either in terms of Tons of coal and other fuel sources or of electric machinery (in horse-power units). In a chapter entitled “The Future of the State of the future” (Popper-Lynkeus, 1912, 702, translated by the author)—a reference to Ballod-Atlanticus's *Der Zukunftsstaat*—Popper-Lynkeus asks whether Germany could become an energetically independent country while meeting its demands for heating, lighting, electrical power, and so on. Again, he devises many different possible scenarios, each one based on potential new energy sources and current energy consumption and production data. The exhaustible character of coal is a central concern, and, hence, he employs flow accounting to assess the energy costs of substitution between coal and other sources, such as peat and petroleum, but especially renewables, such as biofuels, hydro, wind, and tidal power. His results were in general pessimistic, which led him to call for an increasingly diminished dependence on exhaustible resources and eventually population control.

3. Flow Accounting Data as a Representation of Reality and the Role of Values

There are two distinct moments in the flow accounting of the Other Austrian Economics pertaining to its factual nature. One must differentiate between the accounting of existing flows—the initial conditions of life or the initial basis of life, in Neurath's terminology—and the accounting of possible economic plans. Both were deemed as objective (in a Machian sense, highly impersonal in terms of how phenomena are experienced), as they are based on household descriptions and related data and observe socioecological constraints acting as limits to flows of matter and energy. However, choosing between alternative economic plans entails value-based judgements, while each envisioned scenario is constructed only as one of many possibilities to be subjected to the analysis of decision-makers in accordance with varying expected levels of quality of life. Thus, Neurath asserts that calculation in kind is about facts. One does not need to agree with the selection of a given

economic plan, but the predicted flows themselves would not be in question: “it is entirely irrelevant whether the final outcomes are judged to be good or bad; the in-kind calculus is an entirely objective matter” (Neurath, [1916] 2004, 303).

In the example of whether more oats should be cultivated by a farmer, Neurath argues that the answer to this question must consider the whole set of implications of increased oats production, such as a decrease in horse numbers and, consequently, in horse dung, animal work capacity, and, in turn, in oats production itself. Also, more time dedicated to oats means less time on improvements on the land (e.g. draining swamps) or on the cultivation of other products. Every impact on the final conditions of life of the farmer must be considered. He must choose among the different possibilities. The planner, on the other hand, “can try to imagine, by sympathetic feelings or by questioning, in which of these cases the farmer feels more comfortable, happier, better, in which he is ‘better off’” (Neurath, [1925a] 2004, 416). A thorough method of questioning would lead to a complete picture of the conditions of life and, hence, of the qualities of life resulting from an increased cultivation of oats or any other decision made by the farmer.

Neurath ([1917a] 2004, 327) goes on to affirm that calculation in kind uses “purely empirical data without at first knowing anything about the conditions of [goods] transfer”. The same set of initial conditions may lead to different effects in different economic plans, which also means that successive shifts in conditions of life can be studied in order to theorize about economic processes:

What complex of statements is it at all possible to make about conditions of life [*Lebenslage*] and distributions of the conditions of life (theory of conditions of life) and what empirical conditions of life can be ascertained for definite groups, at definite places and time (research into conditions of life)? ... It is for example possible to describe and compare the distributions of conditions of life of two economic orders, without entering into the question of how these orders are constructed or what circumstances determine these distributions of conditions of life, in much the same way that it is possible to ascertain and compare the performances of two engines without even knowing whether they are steam engines or electrical engines (Neurath, [1925a] 2004, 410).

Calculation in kind would allow for the acknowledgement of material and energy losses during economic activity which were not properly taken into account in market economies. Given the initial conditions, the practice of flow accounting would make such losses transparent and count as important factors in the decision among economic plans, since they would impact the qualities of life at a given point in time (thus, an intergenerational perspective is assumed). “Savings in coal, trees, etc., beyond amounting to savings in the displeasure of work, mean the preservation of future pleasure, a positive quantity” (Neurath, [1925b] 2004, 470). Conversely, “capitalism cuts down the forests

even if the consequence may be karstification in a hundred years. In the tropics, and elsewhere, capitalism engages in over-exploitation without any care" (*ibid.*, 471).

Thus, material and energy flow accounting would provide a thorough representation of the relations between the basis of life and processes of production and consumption, *i.e.*, a representation of reality which embeds transformations in the biophysical world into the understanding of economic processes. In this sense, Uebel (2004, 45) credits Neurath with a keen eye toward "issues of environmental sustainability and intergenerational ecological concerns precisely by allowing for judgement concerning incommensurables in the reasoning employed."

Moreover, if the flow accounting of the Other Austrian Economics was a truly empiricist endeavor, the reality revealed was, on the other hand, too complex for drawing a complete account of socioecological flows. Neurath was, nonetheless, optimistic about the possibility of an in-kind calculation which encompasses enough data to allow for meaningful policy propositions:

As soon as one directs some principled attention to the questions of an economy in-kind, the material starts flowing in. Suddenly facts are related which were isolated before and the wealth of phenomena of which we get a clearer picture is enlarged significantly; furthermore, the theory is prompted to more detailed development by economic reality (Neurath [1916] 2004, 309).

Popper-Lynkeus agreed with Neurath that flow accounting was a promising tool for enabling social reform. The necessarily simplified numerical analysis is discussed by the author, who adopts conservative margins and attempts to explain and justify his data on a case-by-case basis. His data comes mostly from secondary—and often diverging—sources; data from reference years as early as 1895 are used as proxies for the period 1908-1912. Yet, Popper-Lynkeus (1912, 493, translated by the author) does not expect or demand any "absolute exactness and completeness", arguing that there is no reason for significant criticism; his calculations would be, as far as economic policy is concerned, valid and illustrative of the workability of a planned large-scale economy, and in particular of his social reform proposition.

Furthermore, Popper-Lynkeus acknowledges that dealing with average quantities brings issues related to the factual character of his account, as there are cultural elements and local production fluctuations involved. However, according to the purpose of his program (minimum living standards for all), the calculated average material values are in fact what each individual is planned to receive (food, housing, clothing etc.). Thus, such averages are not a construction detached from reality, which, according to Popper-Lynkeus, was not the case for a market-based economic science, in which the average of aggregate

variables such as production and consumption does not correspond to the living standards of the majority of the population.

Therefore, although his methods and results differ from those of Ballod-Atlanticus and other contemporary social scientists,¹² he sees his own flow accounting as a statement of facts, even though he concedes that some level of judgement is required, starting with what constitutes a basic good or service, which is culturally determined, up to the choice among materials and energy sources which ought to be included in the process of calculation in kind. The qualitative, subjective character of his flow accounting is clearly present, for example, in the discussion whether tea and coffee would be basic goods; how particular tastes for food need to be considered; or how inventive power and intellectual labor are important elements in an in-kind economy, as they would lead to qualitative shifts in production and consumption (*e.g.* new energy sources, improved machinery, synthetization of fertilizers, etc.).

It is noteworthy that, while the indicative planning of Neurath proposes to calculate the potential supply and then to move onto distribution—*i.e.* from the basis and conditions of life to the qualities of life—Popper-Lynkeus calculates the individual and aggregate demands for basic goods and services before establishing the necessary supply and, finally, assessing how resources are to be attained so as to meet demand. Notwithstanding these differences, the subjective character of demand is an issue which the authors do not try to hide or discard; the factual nature of flow accounting does not neglect the role of values. As stated by Uebel (2008, 478) about Neurath:

[his] scientific utopianism remains value-free in that other Weberian sense of refusing to mask value judgments as factual ones. Accordingly, scientific utopianism pursues but instrumental rationality: with certain aims (values) specified, various ways of their implementation are indicated given certain initial conditions.

As a scientific method informed by a Machian philosophy of science, the flow accounting of the Other Austrian Economics constitutes a holistic approach in which an economy is concurrently seen as a physical and psychical organization; in order to act upon it, it is necessary to systematize commensurate entities by means of their interconnections. There would be an array of possibilities for calculation in kind in a given time and place, conditioned by physical and psychical properties. Objective and subjective data could be assessed through sensorial experiences—in the latter case, by means of questionnaires. However,

¹² Popper-Lynkeus also mentions diverging data and results in the works of August Bebel (1840-1913), Theodor Hertzka (1845-1924), Edward Bellamy (1850-1898), Hermann Losch (1863-1935), Franz Oppenheimer (1864-1943), and others who used flow accounting for the purposes of social reform, whether in utopian settings or not.

choosing among planned flows of resources would be a political issue which would be beyond the scope of calculation in kind.

4. Final Remarks

The analysis of the interplay between facts and values in the resource flow accounting of the Other Austrian Economics provided here transcends issues such as the availability and accuracy of data or the comprehensiveness of the method as a representation of a large-scale in-kind economy. The empirical validity and instrumental rationality of such assessments of flows of energy and materials in social systems can hardly be denied.

Conversely, Neurath and Popper-Lynkeus do not assume a reductionist position in relation to the subjectivity embedded in their resource flow accounting. They express a genuine concern for the role played by value-based judgements in decisions about production and consumption, which, for example, entail choices among available resources and cultural elements related to the composition of human needs.

More importantly, their ecological utopianism does not attempt to objectify or dismiss subjective properties of social systems. Above all, they face head-on the challenges posed by incommensurable values, as opposed to monetary calculations. In fact, they believe value-based judgements are political decisions, and the more information there is about alternative economic plans, the better these decisions would be, especially in terms of a materially and energetically rational relationship between nature and society. On the other hand, the lack of such information would lead to an economic order in which social values cannot be fully exercised, as possible combinations of resource availability and human needs remain unknown. Hence, while values change over time, calculation in kind supported by thorough flow accounting schemes endures as a useful tool to represent reality, enlighten policy decisions, and plan economic activity accordingly.

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