FORMALIZING THE AUSTRIAN THOUGHT: A SUGGESTED APPROACH*

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I
INTRODUCTION

In his book *Socialismo, cálculo económico y función empresarial*,[1] Dr. Huerta de Soto suggests that society is a spontaneous, dynamic process of exchange exhibiting an infinite diversity in values. Entrepreneurship is the force that drives this exchange

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[1] «En suma, podríamos concluir definiendo la sociedad como un proceso (es decir, una estructura dinámica) de tipo *espontáneo*, es decir, no diseñado conscientemente por nadie; muy complejo, pues está constituido por miles de millones de personas

process and consists in the creation, discovery and transmission of information. From Hayek, we recognize that such information is coded by what we know as «the price system». And we also know that when the exchange takes place, it does so with the use of an indirect medium of exchange, also known as money.

Oddly, this process remains much ignored. In my personal experience, as soon as one brings it up in polite conversation, a lack of rigorous formalism is pointed out as the main reason behind the ignorance. Austrian economics is considered «soft», and although many have properly answered this observation (i.e. Huerta de Soto), formalization is still absent. Hence, my humble suggestion on how to approach a definitive formalization of the theory.

Presence of formalization in a theory is always preferable to absence. In the paragraphs below, I give two examples that I think illustrate this point. But I also show that formalization of the market process cannot be mathematized. This is due to the fact that behind the market process lies human action, which is creation, and creation is not decidable in the Church-Turing sense. But the result of this creation, economic goods, are. This has strong implications.

If economic goods are the product of information exchanges, they are algorithms,[2] and algorithmic analysis may be applicable.

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con una infinita variedad de objetivos, gustos, valoraciones y conocimientos prácticos; de *interacciones humanas* (que básicamente son relaciones de intercambio que en muchas ocasiones se plasman en precios monetarios y siempre se efectúan según unas normas, hábitos o pautas de conducta); movidas todas ellas por la *fuerza de la función empresarial;* que constantemente *crea, descubre crea, descubre* y *transmite* información, *ajustando* y *coordinando* de forma *competitiva* los planes contradictorios de los individuos; y haciendo posible *la vida* común de todos ellos con un número y una complejidad y riqueza de matices y elementos cada vez mayores…(…)… Consideramos que, en un sentido amplio, coinciden los conceptos de sociedad y mercado, por lo que la definición que damos de sociedad en el texto es plenamente aplicable al mercado.» *Socialismo, cálculo económico y función empresarial*, 2.ª ed., Unión Editorial, Madrid, 2001.

[2] «An algorithm is a mathematical procedure serving for a computation or construction (the computation of some function), which can be carried out mechanically», *Complexity of Agorithms, Lecture Notes 1999,* Peter Gács and László Lovász, Chapter 2. This is a formal definition. For brevity, I choose here not to discuss the historical, yet fascinating origin of the word and concept of algorithm.

However, the algorithmic algebra corresponding to the market process can be peculiar. The paragraphs below will seek to establish some fundamentals concerning the same.

II
WHY IS FORMALIZATION IMPORTANT?

In history, we find examples of how formalization in different fields paved the way to significant further progress. Two cases come to mind: Arabic numerals and Dirac notation, which I understand are also both comparable to the formalization I propose here.

The first case is the introduction of Arabic numerals to Europe in the 13th century.[3] Accounting was developing and Arabic numerals did the trick as from that moment on, these made it easier to calculate ratios.[4]

Another, less famous albeit not less relevant innovation is known as Dirac notation. In an article published in 1939,[5] Paul Adrien Maurice Dirac (1902-1984) introduced what would be known as Bra-ket notation, to describe quantum states. Quantum mechanics henceforth developed into the new paradigm in physics.

Interestingly, there seems to be a parallel in the difference between Quantum mechanics and Classical mechanics and that between Austrian and Mainstream Economics. In Quantum mechanics, energy and matter show wave–particle duality, which together with the uncertainty principle, provide a unifying view of the system. The mathematics of quantum mechanics (braket

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[3] Fueled mainly by Leonardo Pisano, better known as Leonardo Fibonacci, thanks to his *Liber Abaci*, in 1202.

[4] The book presents examples of conversions of currency and measurements, and calculations of profit and interest.

[5] «…the question of notation, while not of primary importance, is yet worthy of careful consideration, since a good notation can be of great value in helping the development of a theory, by making it easy to write down those quantities or combinations of quantities that are important, and difficult or impossible to write down those that are unimportant…», *A new notation for quantum mechanics, Mathematical Proceedings of the Cambridge Philosophical Society*, Volume 35, Issue 03, July 1939.

notation) are abstract, resulting in probability adjusted information.

In Austrian economics, objects are also recognized as subject to an economic duality, as Ludwig Von Mises illustrated when defining the concept of ends and means, in chapter IV of *Human Action*. This duality had already been noted by Eugen von Bohm-Bawerk in his *Kapital und Kapitalzins*, where he acknowledges that something which may be a capital good for someone in particular may not fall under the established (i.e. in National accounting or «*der volkswirthschaftliche Kapitalbegriff*») concept of a capital good.[6] However, Austrian economists have limited themselves to express that this duality intrinsically attached to human action cannot be examined with mathematics. In other words, unlike the founders of quantum mechanics, Austrian economists have not come up with their own «bra-ket» notation. Nobody is to blame, for the subject matter –human action-is still formidably more complex than the wave-particle duality. But I still believe we can find progress to build on.

III
THE PROCESS OF SOCIAL COORDINATION IS NOT MATHEMATIZABLE

Until the 1930's, it was generally believed that as long as a mathematical question found a precise description, it would be possible to solve it. But, what was meant by a «precise description»? Two interpretations were suggested.[7]

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[6] «…Innerhalb des allgemeinen Kapitalbegriffes sind ferner bekanntlich zwei Nuancen zu unterscheiden: der volkswirthschaftliche Kapitalbegriff, der die Mittel zu volkswirthschaftlichem Erwerbe und nur diese umfasst; und der individualwirthschaftliche Kapitälbegriff, der die Mittel individualwirthschaftlichen Erwerbs, d. i die Güter umschliesst, durch die ein Individuum Güter für sich erwirbt, gleichviel ob die ersteren im Sinne der ganzen Volkswirthschaft Erwerbs oder Genussmittel, Produktiv-oder Kon-sumtivgüter sind. So werden z. B. die Bücher einer Leihbibliothek zwar unter den individualwirthschaftlichen, nicht aber unter den volkswirthschaftlichen Kapitalbegriff fallen…» *Kapital und Kapitalzins, Innsbruck, Verlag der Wagnerschen Universitatsbuhchandlung, 1884.*

[7] *Complexity of Agorithms, Lecture Notes 1999*, Peter Gács and László Lovász, Chapter 3.

In the first one, we deal with a yes/no question. The decision here can be proved or disproved from axioms. But, human action, what we understand as creativity, the choice of a mean towards an end or an exchange, does not enjoy the benefit of a yes/no decision. Furthermore, the Austrian mathematician Kurt Godel, in 1931, also discarded this interpretation altogether: Perfectly formulated questions cannot be answered from the axioms of a set theory.

It is the second interpretation that interests me today. The «problem» to solve can be thought of as a family of questions in which case, an algorithm decides them.

Before we examine it, I suggest to the reader that any good exchanged in a market can be conceived as an algorithm, i.e. a set of instructions that make possible the satisfaction of an economic goal. If this definition is correct, the so-called entrepreneurial function is nothing but a process in which human beings seek to discover and build an algorithm that solves a «problem» (even though that «problem» may also have to be discovered or created).

This second interpretation poses a challenge: We must now arrive at the mathematical notion of algorithm. Can we define «algorithmic solvability»?

In separate ways, this was answered by two mathematicians and logicians during the 1930s: Alonzo Church (1903-1995) and Alan Turing (1912-1954). Church developed the notion of recursive functions, while Turing that of what is known today as a «Turing machine».[8] They are equivalent, but I will occupy myself with recursive functions.

In computation theory, a finite set of symbols is called an alphabet. A finite sequence formed from elements of such alphabet is called a word. And an arbitrary set of words is called a language.

Formally, we say that a language £ is recursive if its characteristic function is recursive:

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[8] A Turing machine is a mathematical machine that can compute an output from an input. The equivalence I mention above resides in that if a problem is algorithmically computable, it can be computed by a Touring machine.

$$fL(x) = \begin{cases} 1, & \text{if } x \in L \\ 0, & \text{otherwise} \end{cases}$$

In this case, we can also say that L is *decidable* (If a language L is recursive, its complement is also recursive). But, what does all this have to do with Austrian economics? Here's where Leonardo Pisano's and Luca Pacioli's contributions result relevant, because accounting can be considered a language. If there is a function called *profit function*, with words like «price», «unit cost», «quantity», «overhead costs» and «taxes» such that

profit (*x*) = (*price* (*x*) – *unit cost* (*x*))* *quantity* (*x*) – *overhead* (*x*) – *taxes* (*x*)

Then accounting is a recursive, decidable language as far as human action is concerned, because we can say that the composite function: G (*profit* (*x*)) can either return a 1 if *profit* (*x*) is a positive number or zero, if *profit* (*x*) returns is not positive (i.e., the sequence of inputs returns a loss).

$$G(x) = \begin{cases} 1, & \text{if } x \in L \\ 0, & \text{otherwise} \end{cases}$$

Note that by stating that $G(x) = 1$ *if* $x \in L$, we are essentially saying that $G(x)$ returns a profit if x belongs to a going concern, the accounting of the market process related to solving (x).

Indeed, this feature is not unique to Austrian economics. Accounting is simply a language. What is relevant to us is that *profit* (*x*) does not come to exist ex-nihilo.[9] *Profit* (*x*) is the creation of entrepreneurial activity and it raises an ontological question. Is this entrepreneurial activity in itself also *recursive* or *decidable?* To me, it is clear that it is not: When it comes to *deciding* ends, it is not possible to isolate a set of symbols within a language to characterize human action.

The sentence "$x \in L$" is not decidable.

[9] *Profit* (*x*) is also not determined a priori, but subject to uncertainty. I deal with this point later.

The *means* used to obtain certain ends do not necessarily need to return a clear duality {0, 1} to be valid, because means are subjective and ends can also be means, which until a moment ago did not exist. Human action is not decidable.

IV
SOCIETY AS AN INCONSISTENT AND INCOMPLETE SYSTEM

If Human Action is not decidable, it should be easy to show that society or the market process as a system is neither complete nor consistent.

In a strict sense, a theory is called consistent if for no sentence both it and its negation can be a theorem.[10] But a theorem is also a sentence for which there is proof in a theory, while a theory is an algorithm to decide whether for an input the output is an acceptable proof. Thus, a theory can only be complete when there is an algorithm that for each sentence finds a proof for it or its negation.

In the market process, there is no algorithm to prove *a priori*, for each (x), either that $x \in L$ or that $G(x) = 1$ *or* $G(x) = 0$.

On the other hand, a consistent theory is complete if it has no undecidable sentences. Incompleteness therefore means that the theory formulates only certain properties of a system and that other properties depend on the system considered.[11] I will refer back to this point at the end, when I deal with Socialism.

V
SOCIAL COOPERATION AS ALGORITHMIC COMPLEXITY

If human action cannot be mathematized because society represents an undecidable, inconsistent and incomplete system… how can we even suggest that formalization is possible?

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[10] Idem 6.
[11] Idem 6.

Human action is what creates, among other things, the infinity of algorithms whose output are economic goods. Economic goods are therefore algorithms. Algorithms, of course, are subject to mathematic analysis, but the same is sterile because it leaves aside human action. However, social cooperation, also known as «the market process», can be conceived as a network of algorithms and I believe that the study of its complexity is a worthy endeavour.

In Adam Smith's *Inquiry into the Nature and Causes of the Wealth of Nations* it is already clear (in chapters II and III) that network complexity is the engine behind (if not the very same) economic growth. Interestingly, today network complexity, the complexity of algorithms and algorithmic algebra can and are formalized within computer science. Is it possible to profit from the advances made in these areas?

VI
TWO UNIQUE FEATURES OF THE INFORMATION NETWORK

Certainly, I am not the first to suggest a parallelism between society and information networks. However, there are two important characteristics of the information network we call society, that are distinguishable (yet often ignored) and different from a typical information network.

The first characteristic is that human beings, the nodes of this network, not only transmit but also create information. This creative process is also known as entrepreneurship.[12]

The second characteristic is that the exchange of information is not done directly between the nodes, but indirectly, using a medium of indirect exchange called «money».[13]

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[12] Dr. Huerta de Soto calls this process «función empresarial» or «empresarialidad», *Socialismo, cálculo económico y función rmpresarial*, 2.ª ed., Unión Editorial, Madrid, 2001.

[13] Adam Smith already saw the connection between the exchange described above and money.

VII
THE ROLE OF MONEY

If society is conceived as a complex network of algorithms where exchanges (i.e. information exchanges) are of an indirect nature, cooperation should be algebraically represented as the lack of commutative, associative or distributive properties in the network. This means that commuting, associating or distributing (existing) algorithms are <u>not</u> neutral operations.

Let's represent an algorithm with the symbol: [*|*|*]

Commutative non-neutrality therefore means that:

$$[*|*|*]\ 1 + [*|*|*]\ 2 \neq [*|*|*]\ 2 + [*|*|*]\ 1$$

This means that the order in which two (or more) algorithms are added (i.e. participate in the market process) is relevant from an economic point of view.

Associative non-neutrality therefore means that:

$$[*|*|*]\ 1 + [*|*|*]\ 2 \neq ([*|*|*]\ 1 + [*|*|*]\ 2)$$

Non-neutrality of association is observed in the markets every week, with the announcement of mergers and acquisitions: From the point of view of human action, merging or spinning-off algorithms (i.e. production processes) creates or destroys value.

Distributive non-neutrality means that, given an operand*:

$$[*|*|*]\ 3^* ([*|*|*]\ 1 + [*|*|*]\ 2) \neq [*|*|*]\ 3^* [*|*|*]\ 1 + [*|*|*]\ 3^* [*|*|*]\ 2$$

Non-neutrality of distribution means that running an algorithm in parallel (i.e. [*|*|*] 3) to others within a market process is not the same as applying the same algorithm at the end of the process. A special case of this non-neutrality is commonly known as "economies of scale".

Therefore, within the sphere of social cooperation, we cannot prove that commutation, association and distribution are neutral. We cannot prove that commuting, associating or distributing instructions with regards to the creation of an economic good will

result in a neutral valuation of the same to the consumer. Furthermore, the very same act of commuting, associating or distributing algorithms, whether these yield lesser or greater complexity in the social network is itself human action.[14]

What role does money play in this context?

Let's define money as the only good that can be bartered against all others. Austrian school Economics has demonstrated that monetary policy as an exercise in central planning is doomed in the long run, because policy makers are deprived from and cannot process all the information scattered among all the participants of the money market.[15] It is further sustained that there is an overwhelming amount of *disperse* information in the money market, that makes central intervention inferior to the spontaneous process of the market, when it comes to assigning resources.

However, as counterintuitive to the notion above as it sounds, *when formalizing the social network, the operator that enables (non-neutral) association or distribution of information should be most effective when it contains the least amount of information about itself*. The good that complies with this condition is commodity money, of course. Fiat money, as all credit instruments, contains two additional information inputs: probability of default by the issuer and loss given default.

Money therefore, as the algebraic operator that allows association and distribution in the algorithmic network, can only be efficient if it is not itself an algorithm. And fiat money is an algorithm.

VIII
UNCERTAINTY IN THE SYSTEM

There is always uncertainty in the process of creating and executing algorithms. This is also recognized in computational science.

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[14] This is consistent with Hayek's hierarchy of complex phenomena.

[15] In this context, by money market, I do not use the lax definition of money market as one of credit instruments with high liquidity. Money, in this context, is not credit.

But we should be clear that with regards to the social network, we deal with uncertainty, and not risk. The concept of entropy belongs to computational science, but not to economics, because entropy is defined by a probability distribution.[16] Human action is therefore not entropic, because the resulting algorithms are not bound by an *a priori* known set (which would allow for the determination of a distribution function).

However, the algorithms that are part of the market process (i.e. we deal with market goods), indeed contain risk. This means that an algorithm can either «survive» (i.e. it is profitable) or «perish», which can be represented as[17]:

$$G(x) \sim p(x)$$

This feature of «market» algorithms becomes all the more relevant when we realize that *tranching* the corresponding risk can be thought of a formal analytic equivalence of distribution among production factors. Just like in structured credit different tranches based on expected losses describe the seniority of investors in a cash flow waterfall structure, the acknowledgment of risk in a market algorithm allows us to represent the participation of all factors involved in the same. *Production factors (except entrepreneurship) are after all algorithms too.*

IX
TIME, SAVINGS AND CAPITAL

If we think of society or the market process as a network where the nodes produce and transmit information indirectly, how can we define a capital good, savings and what role does time play?

I would suggest that a capital good is any algorithm that creates other algorithms. Another way to look at a capital good is this: *a capital good is an algorithm that solves decidable problems*.

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[16] *Elements of Information Theory*, T. Cover, J. Thomas, 1991, Chapter 2.

[17] Perhaps it is not a coincidence that it was Richard Von Mises, who pioneered in 1919 the study of randomness of a 0's and 1's sequence.

The immediate implication of this is that the discovery of undecidable problems is the realm of entrepreneurship, while that of decidable ones belongs to labour (production factor). *It is precisely the feature of decidability that allows the marginal productivity of labour to be discounted (or tranched) and paid in the form of wages*.

In this context, savings would be the set of those algorithms available in the network, which create other algorithms (i.e. which transform undecidable problems into decidable ones). What is interest in this paradigm? The interest yielded by any algorithm that creates other algorithm(s) is precisely the said created algorithm(s).

It is clear to me that chronological time in this formalization, plays no role. This, I find, is consistent with Dr. Huerta de Soto's observation that in the sphere of human action, time is subjective, not chronologic.[18]

What we understand as the inter-temporal exchange rate or interest rate is simply the relationship between the «time demand» of comparable algorithms.[19] In other words, interest rates are simply a ratio between the numbers of steps involved in different algorithms.

X
THE IMPACT OF FIAT MONEY

Earlier, I wrote that fiat money contains information. Like any other credit product, fiat money has an expected loss, which is a function of a probability of default and the so called «loss given default». Central banks these days provide this information openly, as they carry on with inflation targeting. When they tell us that they target a 2% annual inflation rate, they are candidly telling us that

[18] Time is not a dimension, not even an independent variable. What we call a second is simply the Earth's orbital average distance of 149.6 million kilometers divided by 31.56 million units or a sidereal year (i.e. 365.26 days) multiplied by 86,400 units called seconds (i.e. 24 hrs x 60 min/hr x 60 sec/min). A second is therefore another way to express an average of 4.74 orbital kilometers.

[19] In computational science, time demand is defined as the maximum number of steps taken by a Turing machine over all possible inputs of a certain length «n».

according to their calculations, the expected loss of fiat money will be 2% per year. This new piece of information will affect the exchange process and introduces chronological time in our economic calculations, displacing the subjective time that results from a comparison between the time-demand of a pair of algorithms.[20]

In addition to the expected loss of fiat money, the institution of fractional reserve banking leads to the definitive coercive establishment of chronological time, as the lenders of last resort set their respective benchmark/window rates.

Thus, fiat money and fractional reserve banking introduce additional information in the social network that strongly affects the association or distribution of algorithms (i.e. exchange of economic goods).

XI
SOCIALISM

If society is an undecidable, inconsistent and incomplete system, and if we define socialism as any institutional aggression on entrepreneurship or human action,[21] it is clear that socialism is the attempt to make the system decidable at least and consistent and complete at best.

As stated earlier, a consistent theory is complete if it has no undecidable sentences. *By attacking entrepreneurship, socialism therefore consists in the belief that it is possible to transform society into a decidable system, only populated by static algorithms that can therefore be neutrally associated or distributed by the central planner.*

Socialism is also formally equivalent to introducing axioms in the system that can either prove or negate a sentence, according to the theory of a central planner, therefore making the system decidable, consistent and complete.

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[20] Another piece of information eternally present in economic calculation is taxation, which can also be represented as a coercive loss. Because it establishes an arbitrary chronological fiscal period, it also displaces subjective time from economic calculation.

[21] *Socialismo, cálculo económico y función empresarial*, 2.ª ed., Unión Editorial, Madrid, 2001.

Interestingly, when this attempt at decidability, consistency and completeness succeeds, the system loses complexity. Complexity is also lost as a result of both the information fed into the system by fiat money and taxation (including chronological time and besides the additional axioms[22] introduced by the central planner in the name of «social justice»). In the course of human history, this loss in complexity is what is known in lay terms as the «fall of civilization». It occurs every time a severe amount of axioms are introduced in the system, leading to a complete loss in complexity. Historians call those systems that suffer such loss in complexity «self-sustained economies».

XII
FINAL CONSIDERATIONS: ECONOMIC GROWTH AS COMPLEXITY

Formalization of human action is desirable and cannot be undertaken with mathematics. The market process can be described as a network different from that studied in computational sciences: The nodes (humans) not only transmit but also produce information (i.e. entrepreneurial function) and the same is not exchanged directly, but with the use of money. If every economic good is an algorithm, money is an operator within this unique algorithmic algebra.

This production of information takes place in a context of uncertainty. If an algorithm makes a problem decidable, entrepreneurship is therefore the action of discovering and transforming previously undecidable problems into decidable ones, in the Church-Turing sense.

The role of Economics should therefore be the study of this unique algorithmic complexity: What decreases it and what enhances it. A new notation and algorithmic algebra is still to be created, which would, I believe, lead to impressive advances in the analysis of social cooperation.

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[22] Huerta de Soto would call these axioms «mandatos coactivos».