A combinatorial and praxeological exploration of the Economic Calculation problem

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The problem of Economic Calculation originally noticed by Ludwig Von Mises[1] arises from the fact that there is no market for and hence no prices for the factors of production in a socialist commonwealth. Consequently, a central planner has no objective means for easily comparing the entire plethora of means and production processes he can apply to achieve his ends, when attempting to solve the problem of how to arrange industrial organisation.

The difference, in the state of social organisation known as the market economy is that the individuals who take upon the task of organising the modes of production, may calculate and appraise their efficacy in terms of cardinal numbers utilising a common monetary denominator[2], in order to figure out the extent to which they are presently satisfying consumer demands. In this framework cardinal number calculations are performed either in assessing the effects of past action, or for the planning of future action. It has already been noted, how clear conceptions of basic economic concepts like capital and income become difficult to attain without resort to such a framework[3]. This can be understood given the subjectivity of the extent many goods can be considered capital or consumer goods, given the multiplicity of their uses, thereby making for an organisational challenge to decide their place in a structure of production.

It is equally important to stress the fact that both applications are aiming toward the future in their evaluations, projecting the future exchange ratios at which costs and proceeds could be exchanged, or the capital and assets gathered in a firm could be exchanged for. This may utilise past prices, but it certainly does not stop there, these are used as a starting point, along with other market data to begin projecting and arranging decisions according to future appraised prices and expectations. Some notable economists have recently clarified how this involves the application of monetary calculation as essentially an intellectual tool, applied within an intellectual division of labor[4][5], according to which different entrepreneurs bid according to how they appraise future consumer demand and resulting supply constraints.

We can reason also, that the incentive structure and selective process logically implied in the construction of a pure market economy also aids the effectiveness of the calculation process, allowing for more efficient allocation with the consistent presence of uncertainty underlying real world conditions. We shall have more to say on this later.

It is clear that the existence of a market economy is reliant on, and virtually equivalent to the existence of the following two attributes:
1.The means of production are privately owned.
2.A medium of exchange is in use.

It may be fair to say, that the existence of the first condition may be praxeologically prior to, and necessary for, the emergence organically of a medium of exchange resembling what we characterise as money[6]. As has been pointed out, various other frameworks involving centralised control, whether they are essentially equilibrium constructions or not[4], utilise a form of medium of exchange that is essentially nothing more than an arbitrary numeraire in which to denote autistic exchange or interpersonal exchanges undertaken in equilibrium conditions.

In any case, the socialist commonwealth, the imaginary construction under which both conditions 1 and 2 are negated, is the topic of this paper's examination. I wish to elucidate the consequences resulting from the existence of these conditions, by contrasting this with the situation in which they are absent, and so shall be utilising the method of imaginary constructions[7]. As calculation is paramount to the entire system of catallactics, one can reason the consequences therefore, to be rather broad.

I shall not be entertaining a discussion the details of the system of market socialism in the course of this paper, though this topic has been tackled in a recent excellent treatment by Machaj[4]. With conditions 1 and 2 negated, we can reason for the purpose of argument, an economic system solely directed by a social planner[8]. This planner may ultimately have a series or set of ends to which he aims and wishes to achieve by application of the various means available to him. We can examine the tractability of the problem faced by such an individual. This will be done step by step, removing simplifying conditions one at a time, making our construction more closely match the conditions faced in the real world economy.

The social planner, not being able to use cardinal numbers and economic calculation, the mental tool specifically peculiar to the operation of a market economy, can only resort to calculation in kind when attempting to solve the problem concerning how to adequately arrange industrial production. As a reminder, this refers to the quantitative cause and effect information relating means and ends that is known technologically.

Mises in Human Action refers to two hypothetical scenarios under which the application of such a procedure would be sufficient to tackle the problem of industrial organisation, before going on to describe conditions prevalent in the real world relating means and ends. This passage is important enough with regard to the discussion of this paper, as well as serving as its inspiration that it merits direct quotation[9]:

However, the mere information conveyed by technology would suffice for the performance of calculation only if all means of production-both material and human-could be perfectly substituted for one another according to definite ratios, or if they all were absolutely specific. In the former case all means of production would be fit, although according to different ratios, for the attainment of all ends whatever; things would be as if only one kind of means-one kind of economic goods of a higher order existed. In the latter case each means could be employed for the attainment of one end only; one would attach to each group of complementary factors of production the value attached to the respective good of the first order. (Here again we disregard provisionally the modifications brought about by the time factor.) Neither of these two conditions is present in the universe in which man acts. The means can only be substituted for one another within narrow limits; they are more or less specific means for the attainment of various ends. But, on the other hand, most means are not absolutely specific; most of them are fit for various purposes. The facts that there are different classes of means, that most of the means are better suited for the realization of some ends, less suited for the attainment of some other ends and absolutely useless for the production of a third group of ends, and that therefore the various means allow for various uses, set man the tasks of allocating them to those employments in which they can render the best service.

Following Mises' identifying description, we can list the three conceivable scenarios governing the relations between means and ends as follows:

a) The means are perfectly substitutable for one another, possibly to different ratios, yet can be used to produce all possible ends.

b) The means are absolutely specific, hence each end is only suitable towards achieving a single end, e.g. $A \rightarrow a$.

c)The means are largely substitutable to an extent and specific to an extent, yet not entirely so of either (note, the possibility of finding absolutely specific means among the collection of means is a perfectly attainable prospect in this scenario).

Mises states the allocation problem, given conditions a) or b) prevailing in the world as being trivial. One can see this immediately given b), as one can only allocate towards the required end with the means specific to it, so industrial organisation becomes simply matching the desired ends with the given supply of means specific to their achievement individually.

It is not necessarily immediately obvious however, that the allocation problem given a) is trivial, at least in this author's opinion. We can develop an argument to show the correctness of Mises' statement in a fairly straightforward manner however. This is also a useful exercise, as by elucidating further upon this imaginary state of affairs, it offers us a stepping stone on our approach to illustrate the problems faced in the state of affairs described by c) and the real world.

If we imagine at first a very simple state of affairs for such an autistic economy under condition a) as follows:

MEANS 2A $A \rightarrow 2a$ or b 3B $B \rightarrow a$ or $2b$

SCALE OF ENDS

a, b, a, a, b, b, a, b, a, b, b.

We can identify the scale of ends (values) defined above as a prioritised production queue or something of the sort. Mises points out, that given the substitutability of the means for all possible ends, it would be as if only one kind of means-one kind of economic goods of a higher order existed.

Upon initial inspection, we can see that the supplies of our means could be interpreted as either 7a, 8b or any of the set of production possibilities that lies between these two extremes. In this case it is fairly clear to see that the most satisfactory solution results from converting $2A \rightarrow 4a$, $2B \rightarrow 4b$ and $B \rightarrow a$. Whether or not a general optimisation procedure is possible for such problems (I suspect one is) , it is not difficult to see the essential tractability of the problem, that can be solved fairly intuitively in such a simple case, simply scrolling down the scale of values and observing how much of the higher ranked ends can be satisfied utilising a production schedule that allows means to be allocated to their better ends as much as possible. Indeed this problem is highly elementary and does not come close to what could be framed by scenario a), let alone coming close to c).

For the sake of argument we can pursue to enumerate the number of production possibilities, in order to denote in some sense, the complexity of problem a). If we consider the simplest and most absolutely trivial case possibly imaginable, then we could say we have:
MEANS
nA A→b or A→b.

Hence we have a supply of n means of type A and two ends possible to produce from this, a or b, each requiring 1 of A. Without consideration of a scale of values, we may simply enumerate the number of production possibilities. It is not difficult to see we have a situation where we have a range of $n+1$ different production possibilities since these range in values denoting produced ends in the expression (a, b), ranging from $(n, 0)$, $(n-1, 1)$...$(0, n)$.

The slightly less trivial generalisation of this example, would be to include perhaps m different ends being possible to produce from A so:

MEANS

nA

PRODUCTION POSSIBILLITIES

$A \rightarrow a_1, \quad A \rightarrow a_2, \ \ldots \ A \rightarrow a_m,$

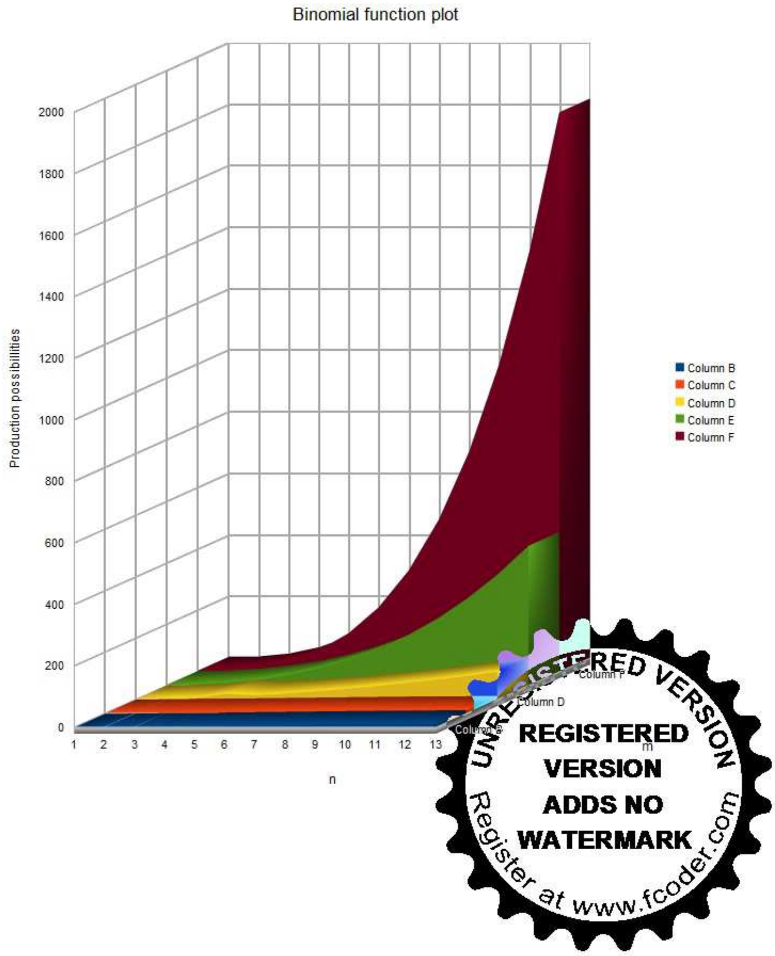
It is perhaps not as immediately obvious how we could effectively enumerate the number of production possibillities in this case. A useful abstraction can however help remove the complications associated here as follows:

X X I X X X I I X X I...

We can imagine the X to represent a product produced from the means, with the different categories of produced products being separated by the dividers represented by I. Parallel dividers like I I, would represent therefore that zero of a certain category of ends are produced from the means. To delineate m categories of ends in our collection composed of n produced ends (produced from n means) , we can see that we would therefore require m-1 dividers. Hence, our problem to denote the total number of production possibilities becomes essentially a binomial selection problem. We have a set of $n + m - 1$ objects in total, and want the number of unique ways we can pick $m - 1$ to be dividers out of them (or equivalently, n to be Xs) , and we do not place any preference on the order in which we turn these objects into dividers. Hence the binomial coefficient is necessary to represent the total number of production possibilities (N_p) in this case is:

$$N_p =^{n+m-1} C_{m-1} = \frac{(n+m-1)!}{n!m-1!} (=^{n+m-1} C_n) \tag{0.1}$$

Even though the problem is still trivial, and and does not yet represent anything of worth for real economic considerations it is worth noting the growth of the above two variable dependent function, as shown on the graph below:



Note that the columns from B to F represent the number of different types of ends (m) from 1 to 5 (I must apologise for the watermark, as I am using a freeware version of the given software). There is only one type of means in our considerations so far, incidentally a situation entirely equivalent to one where we would have a selection of means with equal substitution ratios, e.g. $A \rightarrow a$, $A \rightarrow b$, $B \rightarrow a$, $B \rightarrow b$...etc. Such considerations do not come close to the Economic Calculation problem.

We could entertain the possibility however, of a general selection of means, like in our initial example, that are perfectly substitutable, though to different ratios. We can begin precisely along these lines, supposing we have two possible types of means A and B of supply n_1 and n_2 respectively, that can be applied to achieve m different possible ends. The coefficients c_k and d_k represent the amount of each end that can be produced using each means. The scenario can be succinctly presented as follows:

Means

$n_1 A$ $\quad$ $A \rightarrow c_1 a_1$, $A \rightarrow c_2 a_2$,...$A \rightarrow c_m a_m$

$n_2 B$ $\quad$ $B \rightarrow d_1 a_1$, $B \rightarrow d_2 a_2$,...$B \rightarrow d_m a_m$

If we want to find the total number of ways these means could be combined, a number I shall denote as N_m, then we may do so as follows (note this is different and generally larger than the total number of production possibilities in these scenarios generally, as will be explained). If we consider that for every production queue of B, we have ${}^{n_1+m-1}C_{m-1}$ ways of permuting this distribution with our production from A, and already ${}^{n_2+m-1}C_{m-1}$ possible production queues possible with B, it is therefore not difficult to see that in this case:

$$N_m =^{n_1+m-1} C_{m-1}^{n_2+m-1} C_{m-1} \qquad (0.2)$$

This can be further generalised, so that we now have l different means:

MEANS

n_1A_1, n_2A_2, $n_3A_3 ... n_lA_l$

SCALE OF ENDS (where there are m types of ends)

a$_4, a_3, a_1 ... a_s$

$PRODUCTIONMATRIX$

$$
\begin{array}{cccccccccc}
c_{11} & c_{12} & . & . & . & c_{1p} & . & . & . & c_{1m} \\
c_{21} & c_{22} & . & . & . & c_{2p} & . & . & . & c_{2m} \\
. & . & . & & & & . & & & . \\
. & . & & . & & & & . & & . \\
. & . & & & . & & & & . & . \\
c_{k1} & c_{k2} & . & . & . & c_{kp} & . & . & . & c_{km} \\
. & . & . & & & . & . & & & . \\
. & . & & . & & . & & . & & . \\
. & . & & & . & . & & & . & . \\
c_{l1} & c_{l2} & . & . & . & c_{lp} & . & . & . & c_{lm}
\end{array}
$$

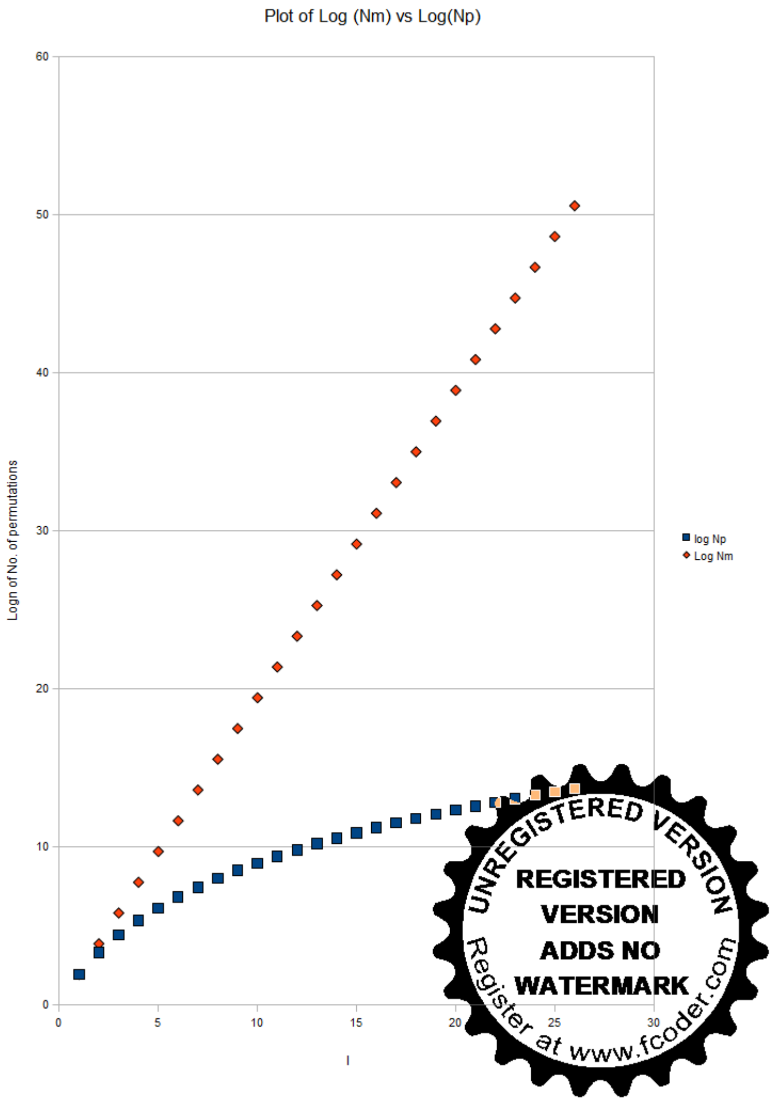
Note I have used the device I have labelled a production matrix to succinctly denote the set of production possibilities for each end given each means. Hence, the value c_{23} denotes the amount of end a_3 can be produced utilising one of the means A_2. Generalising the argument developed in our previous example concerning the way in which the permutations of production queues will increase, we can write for the general case that our value of N_m will be:

$$N_m = \prod_{k=1}^{l} \frac{(n_k + m - 1)!}{n_k! m - 1!} = \prod_{k=1}^{l} {}^{n_k+m-1}C_{m-1} \tag{0.3}$$

It is clear, that for the simple example we dealt with earlier with only a single means, or equivalently several means produced all ends at the same ratios. To state the same thing mathematically is to say $c_{kp} = c_{kq}$ $\forall p, q \in [1, m]$ and $\forall k \in [1, l]$. For this scenario, clearly $N_p << N_m$.

Hence, N_m could be more properly understood as an upper bound for the total number of different ways of producing ends from a given set of means. How close N_p gets to N_m will depend on the relative uniqueness the values of the production possibilities of the different means to the same ends will have with respect to each other. It is not a trivial realisation that both N_m, the upper bound for Np and $N_{p_{min}}$ the lower bound representing the case where we have only one type of means, are both incredibly fast growing functions with respect to either m or n and $\sum_k n_k$ (we can make $\sum_k n_k = n$ to ensure a fair comparison concerning the growth of both functions). An illustration of such growth with sample functions is shown graphically below. Note it is difficult to draw N_m, since it is an l variable dependent function. In this special example, in order to allow the production of a plot I have made the special assumption that there is only one of each type of means. This therefore means that our value of N_m reduces to the special case:

The natural log of $N_m = (\frac{(1+m-1)!}{(m-1)!})^l$ (1) is to be plotted against the natural log of the function $N_p = \frac{l+m-1!}{l!m-1!}$ (2), and $\sum_k n_k = l = n$. Note I have kept m constant where $m = 7$ and plotted the variation against l:



Therefore the orange and blue charts represent functions (1) and (2) respectively, with the y axis representing the log of the number of possibillities for each, and the x axis representing l. Note the very fast growth of function of both functions, but especially that of (1).

We can reason that the amount of symmetry existing between values of c_{kp} and c_{kq} $\forall k \in [1, l]$ and $\forall p, q \in [1, m]$ within our production matrix, that the actual N_p curve lies between both curves. Note the graph is somewhat misleading as the fact that that we have one of each type of means implies that we have a minimal value of the binomial coefficient taken to the power of n to compare against the value of N_p, which is purely a binomial coefficient. Therefore, I have only represented a lower bound even for N_m, that is understandably quite close to N_p for smaller values of n or l. We can expect other functions of the form N_m to therefore be much larger and grow far more quickly, especially those for which $m-1$ and n_k are about the same size.

For the sake of completeness, it may seem reasonable for me to now derive the general expression, even with symmetry considerations, for N_p, the number of production possibilities given a certain set of means. I do not rank greatly at the moment such a pedagogical exercise, though it may be of interest in the future in a more detailed elaboration of the investigation made in this paper.

The same may be said for the goal of finding a generalised mathematical or even computational procedure for solving such a problem. The problem may be considered essentially of a linear nature, and hence can be expressed with the aid of a matrix, with perhaps the only unique feature being the ordinal nature of the scale of values placing a special type of constraint. It may therefore be considered possibly tractable using the methods of linear optimisation, though further research will be needed to either verify or falsify this possibility.

We have already seen with our earlier numerical example with limited amounts of two types of means to match a given scale of ends that the problem is not too difficult or daunting to solve intuitively as we have effectively only one type of means, as we can view each means according to its specificity towards the desired end. That being said, even though we can reason and reach the same conclusion as Mises with regard to this problem that it is tractable, its complexity, especially as we consider greater quantities and varieties of means and ends certainly cannot be denied.

Indeed it is perhaps important not to dwell too much on the compact presentation I have presented problem a) with so far. Such a straightforward layout betrays revealing the fatal flaws that lie bare with this theoretical construction otherwise.

The flaws can be squarely rooted in the omission of the correlated factors of time and uncertainty. This thereby gives the flawed impression that we have a static problem contrary to the a priori aspects of action, since we cannot even reason action in a world without uncertainty, and the denial of such would be contradicting what we can plainly ascertain from our experience of action in the real world.

The first main objection about the lack of time, could be reasoned by the lack of the seeming influence of time preference with which to meet his objectives our central planner has, coupled with considerations regarding production time for each means, with respect to producing the different ends. Within the framework of our limited construction this problem may be reasoned away, through the process of some sort of aggregation denoting production rates, with respect to ends desired to be achieved within a large unit of time.

Indeed the true reason why such a consideration is dis-satisfactory can be best taken account of, if we now move on to isolate the effect of uncertainty. Indeed, we cannot truly incorporate time without taking uncertainty into account. To be clear, what I am referring to here is what Mises referred to as class probability[10] and has also been called Knightian uncertainty.

The conceptions of probability, both class and case, are unified in the respect that they both delineate two different kinds of incomplete knowledge concerning events analysed by human actors. Within reasonable grounds, even though this does involve subjective elements with regard to classification, class probability can be sufficiently dealt with and considered to be insured against, even within the framework of an autistic economy in this case, according to the assumptions taken thus far.

The unique aspect of uncertainty is the perturbing influence it has on future action perhaps best embodied by the phrase that it truly represents what we don't know, we don't know about the future. This could be simplistically attributed to the potentially wholly unanticipated disturbances that can change the cause-effect, and therefore means-ends relations utilised by actors. These may occur and could be characterised in the following different ways:

I)The discovery of an entirely new set of means, permuting the production possibilities and paths that may be considered for the production of the selected set of ends identified by the actor.

II)The discovery, and therefore a change in knowledge of the relations between known means means and ends, having a similiar effect.

III)The occurrence of an entirely unanticipated event upsetting present supply values.

It may be reasoned how a market which allows for decentralised decision making could tackle each of these issues effectively, though this will not be covered until later.

Indeed the above categories may fool the reader into thinking that these disturbances may only constitute simple rearrangement of what is still a linear model utilising our production matrix, for which we can algorithmically still find an optimum solution. This consideration, though it does help us begin to consider real world difficulties, is still flawed by the fact we are still contemplating the limited problem under the consideration whereby we are utilising construction a).

It also betrays a somewhat more subtle aspect of the complication brought about by I), an understanding of which can help us yield a more useful wide ranging realisation. Note aspects of the following presentation may seem somewhat tautological. Suppose our planner may want to produce a giant treadmill in order that his subjects can exercise, a goal he values because he would like to see them become fit, something he values for what we can perceive is some sort of aesthetically defined pleasure. Hence each end can be described as a psychic means towards a more basic goal, and this can be considered completely outside the sphere of what we can consider economic action utilising the material and quantitative aspects of the universe dealt with at the higher order stages. We may describe this tendency with the aid of the following diagram, that we need not consider to be endless, as the goal of this construction is mainly figurative:

means→end/means→end/means→...happiness.

My attachment of the label happiness is mainly in the recognisably tautological sense Mises characterises the word, and in that sense we can consider it as an ultimate goal of action. To be sure, I am not signifying any kind of serious theoretical consideration that it can be rigorously defined as a final end, neither am I attaching any kind of simplistic Eudaemonic interpretation to the use of the word.

The reader may wonder why I have made an effort to labor such a point. Surely such considerations beyond the ends aimed at by application of means at least tangible, if not material is irrelevant for our considerations in Economics?

I must agree, the reader would be right to an extent, the aim of this construction is to detail another more subtle point ultimately resulting from its employment, if we consider the uncertainty that can effect cause and effect relations in a completely general sense. Given his future state of knowledge when he is informed further about factors he was uncertain or mistaken according to his judgement, our planner may decide exercise was not the best way to get his subjects fit, or may even decide that getting them fit is no longer such a highly ranked concern. Both decisions would affect and negate the production of the treadmill as an end to be aimed at in our scale of values.

Hence we can see, the effect of uncertainty on a real individual acting in the process of time can perturb both his knowledge about available means as well as the relevant ends. I have not included this as an extra statement to the extent every end can also be considered a psychic means.

Indeed without uncertainty underlying the known cause and effect relations, it becomes clearing that we are dealing with a sort of autistic final state of rest problem, such that the future is entirely tended towards and predetermined into a static or evenly rotating equilibrium that our planner is doomed to revolve around. The static perfect state of an equilibrium, is an information equilibrium simply steps away from defining an ultimate state of equilibrium. There are other considerations against such an idea, but as Mises has pointed out[11], we are at variance to even conceive of action in such conditions with the absence of uncertainty. Action is always made with an underlying uncertainty regarding its consequences, otherwise we would simply be describing an endless utility maximising and deterministic endless loop.

Since we can conceive of uncertainty, then we can conceive of disruptions to disturb and effect the development of our imaginary economy a), even in the case that production decisions can be easily calculated. Despite the fact we can describe the effect of uncertainty in situation a), our illustration is somewhat limited and misleading, hence it is time we take the results we have garnered so far to examine the nature of the problems faced under scenario c).

With the state of affairs where c) describes the relations between means and ends, we can see that this may entail far more complex considerations for the task of optimising industrial organisation. First, we may consider an example of such a set of processes, illustrating only one stage of production.

$A \to A_a a$, $A \to A_b b$, $B \to B_b b$, $C \to C_a a$, $C \to C_c c$,

These production possibilities could be displayed more succinctly as follows, attempting a production matrix representation:

	a	b	c
A	A_a	A_b	_
B	_	B_b	_
C	C_a	_	C_c

Where the coefficients denote how much of an end can be produced employing the given means, e.g. with A_a representing the amount of a that can be produced employing one of A. Such a presentation is no longer very elucidating. Note that underlines has been placed in the matrix, in place of putting zeros, since it is misleading to assert somehow A is consumed in the effort to produce c, of which it makes none. All we know is that A cannot produce c.

Even in this simple example, an increase in demand for a, may or may not entail a reduction or diversion in the process of production concerning the ends b and c, while possibly upsetting the production processes proceeding from all three means.

Even with such a simple example, worthy of Robinson Crusoe, such multiple sets of comparisons between ends and alternative processes of producing them must be made. It is with these types of considerations even for what we may consider barely sophisticated enough to represent a Robinson Crusoe economy, that we see the true utility of the application of a mental tool that allows us to utilise cardinal numbers to compare multiple production processes according to a single common monetary denominator. That denominator is money, and the tool is economic calculation.

This difficulty can possibly be better appreciated if we take the time to consider a far less trivial example of the same phenomena, this time considering a far greater multiplicity of means and ends:

MEANS are of the form $n_k A_k$ where $k \in [1, l]$.

SCALE OF ENDS

a_3, a_1, $a_7 ... a_s$

INCOMPLETE PRODUCTION MATRIX

$$\begin{array}{ccccccccccc}
c_{11} & - & c_{13} & . & . & . & - & . & . & . & c_{1m} \\
c_{21} & c_{22} & c_{23} & . & . & . & - & . & . & . & - \\
- & - & c_{33} & . & . & . & c_{3p} & . & . & . & - \\
. & . & . & . & & & & . & & & . \\
. & . & . & & . & & & & . & & . \\
. & . & . & & & . & & & & . & . \\
- & - & - & . & . & . & c_{kp} & . & . & . & c_{km} \\
. & . & . & . & & & & . & & & . \\
. & . & . & & . & & & & . & & . \\
. & . & . & & & . & & & & . & . \\
- & c_{l2} & - & . & . & . & - & . & . & . & c_{lm}
\end{array}$$

The fact cannot be mistaken, that complexity of the problem now, has been increased considerably. Changes considering the increase in one end must consider not only the changes they may entail in the resulting supply of other available ends, they will this time have to be considered with complex interfactoral comparisons between an entire plethora of different sets of production processes that must be selected for and against.

This can be demonstrated by the fact that N_{IIp}, the number of production possibilities between any two means among the subset of ends they share will lie somewhere between the following:

$$\frac{(n_r + n_s + u - 1)!}{(n_r + n_s)!(u - 1)!} < N_{IIp} \leq \frac{(n_r + u - 1)!}{n_r!u - 1!} \frac{(n_s + u - 1)!}{n_s!u - 1!} \tag{0.4}$$

With this many different production paths between two means along their shared ends, not considering how they permute the rest of the interlocked possible production processes, as well as their ultimate effect on the supply of available ends; we can begin to see efficient industrial organisation of means into a complex structure of production, even in this world consisting of one stage production processes, becoming a nigh-on Sisyphean task.

This is without even introducing the possibility of multiple stages of production. For such considerations we can completely dispense with our previous troubled construction of a production matrix. It is now entirely redundant, and cannot even serve the task of a primitive pedagogical tool.

Our considerations must now consider a kind of feedback in the sense that one of our ends/means may be an nth stage means in another or all sorts of other production processes. Hence changes in the projection of certain means into the future must necessarily perturb considerations regarding production for the rest of the means and ends in order to satisfy our scale of aimed ends. Such progression despite the complexity it may add to our problem in the sense that our planner must forsee the consequences of production decisions on the further alternative modes of action, it does not yet truly represent time because our construction lacks uncertainty. We can now see the organising influence this limited notion of time may have on the development of a structure of production, and it is uncertain whether or not it could simply be aggregated away into production rates this time due to the interlocking nature of the resulting structure of production, and the fact certain means may only begin to be produced having passed several stages of production. This would make an additional challenge in terms of comparing the consequent results of different processes, having to stretch mathematical analysis further forward in stages and therefore 'time.' An interesting observation, that would be worth reflecting on later is the increased sensitivity the resulting processes may have on changes in market data as a result.

Before considering uncertainty, it may be worth noting also the effects of rather more amorphous non-specific factors of production like labor. This factor can move from one area to another, become partitioned and specialised, as well as disengaged from one area to another, according to how they best match the demand constraints. Such a continuously transformable variable, may yield a certain degree of non-linearity to a previously linear, several stage, but essentially static problem. Indeed this is totally aside of the recognisable dangers treating this factor this way may yield. The labor force is not an anonymous blob or jelly that can be melded as we please in reality like other continuous variables, as useful as such aggregation may be for conceptual purposes. Efficient coordination of specialisation presents the challenge of identifying the best suited traits for each activity, not a trivial task. This is before we can even consider the changes the levels of different parts of the work force may have on the entire plethora of other functions in an economy that require industrial organisation.

An important and sobering reflection is possibly to consider how labor is not alone in the above respect, given the subjectivity of the concept of capital, and how many goods may be considered part of the same class, yet vary and are arranged in grades with different categories. This is a problem of subjective interpretation and judgement that must be arrived at and solved, even before further considerations can be made.

Indeed, even despite the great amount of complications we have gathered and recognised concerning the characteristics governing industrial organisation, it may still be regarded that a solution or equilibrium state may be possible to find. There may conceivably be a range of debate regarding the answers to the question of whether this is a possibility. Some aspects of the problem may take on the possibility of representation as a linear or non-linear optimisation problem, a class of problems that are still an active area of research in mathematics, within which certain classes of problems that despite being recognised as soluble in principle, are nevertheless in practice insoluble. The economic calculation problem for an autistic economy may be such a problem. Even if the purely computational problem is somehow tractable however, it does not change the fact that such considerations are however largely besides the point.

I have so far ignored and neglected in my description of c) what the reader may already guess is the most important and fatal assumption taken: the absence of uncertainty. Without allowing for uncertainty with regard to the knowledge of cause and effect relations between means and ends in a completely general sense, as already identified; we are assuming in a sense an information equilibrium. In making such a wholly unrealistic assumption, contrary to the very category of action itself, we are essentially assuming away the central economic problem. It is only by assuming uncertainty and the possibility of error that time[12] becomes a true factor in our considerations, rather than simply describing a set of successive stages definitively leading towards an equilibrium state.

With the twin prospects of time and uncertainty such a complex structure of production made utilising such a complex computational procedure, relying on considerations with a sensitive dependency on changes in different categories and kinds of market data, may soon be reasoned to dismember and fall apart, unable to cope with the multifaceted effects of the disturbances it encounters. Indeed given the multiplicity and wide range of disturbances; even small changes in market data, may prove fatal, compromising organisation along an autistic equilibrium aiming and approaching method, due to the already illustrated multiplicity and the inter-related nature such a structure of production would necessarily take, assuming the real world conditions we have assumed to describe means-end relations. It may well be in this respect, that we could properly characterise this problem as chaotic, although the way in which it could be called so is drastically different to the same titled problems encountered in the natural sciences.

Indeed, given the nature of the fully fledged problem encountered by the director of an autistic economy, it may be reasonable to ask: How on God's Green Earth could a pure market economy fare any better at tackling this perplexing industrial organisation problem? Indeed, even some economists who may be considered part of the Austrian tradition[13], who were correct in identifying the problems of an equilibrium approach to Economics, and recognised some of the real difficulties I have been able to identify so far during the course of this paper; nevertheless erred in concluding all means or frameworks of industrial organisation, including the free market would face this problem.

To answer the above question, it is perhaps important to first make note that in the description of the market economy, no special assumption regarding the constancy of market data needs to be taken. The lack of constancy regarding prices and all other consequences resulting from the consideration of uncertainty prevalent in all action, need not be an inhibiting factor for the management of individual action. Indeed action all action is subject to such permutations.

What the market economy does offer, is the greatly simplifying organisational tool of economic calculation. This tool is facilitated and enabled due to the existence of conditions 1) and 2) cited at the beginning of this essay, and previously negated when describing the conditions of an autistic economy. The advantage presented in such a framework, is that the individual decision makers of a market economy can make use of simple cardinal numbers in evaluating past actions and future plans according to the simple categories of profit and loss, cost and yield, capital and gain etc. The exchange ratios according to which their assets are appraised in are subject to change and not definite. Hence for the same reason all such valuations and appraisements are aiming toward the future, as estimations based partly on past market prices and data, as well as thymological considerations regarding where these prices may be tending.

Indeed, the next and possibly most critical consideration regarding the unique character of the market economy, can probably best be recognised in the surmising epithet: *Action is a lever of change.*[14] The market economy may be considered like a consistent multi-directional bubbling pot, promoting many different approaches and methods that could be adopted as major methods of production. Indeed in so far as such changes are not contrary to consumer preferences, and therefore inhibited regarding future production along these lines as those engaging in them suffer losses; we can see that the onset of profits gained along those successful lines already enable the first steps of their own equilibration along the new direction.[15] This may be followed by entry and replication of these positive changes by competitors aiming to capitalise on these evident profit opportunities, thereby finalising the equilibrating tendency and steering of the market along this direction. This is totally aside of other future fluctuations in market data.

It is precisely the way in which the market economy can be associated with the always changing conditions underlying action and industrial organisation that its true strengths come about however. Rather than reacting and having to rearrange a complex structure of production after the fact, it is rather composed of individual entrepreneurs looking to and constantly attempting new lines of production. In so far as they are successful, their lines of production are promoted through competitive replication as well as through additional gain and prioritisation they receive with a raised position and market share demonstrating their superiority in matching consumer preferences.

Indeed, due to this characteristic and tendency, another efficiency regarding the superiority of market organisation may be anticipated. As success ultimately belongs to those who based on their superior anticipations of consumer demand and market data, are better able to utilise the factors available to them, it may be reasonable to anticipate that they are better able to anticipate further future changes. This could have the effect of smoothing out and stabilising what could otherwise occur with more violent fluctuations and irregular price patterns. This could indirectly improve economic calculation, and enable a more stable environment for future capital accumulation.

The market sheds no tears however at such disturbances and the fluctuations as a result produced, since established entrepreneurs did not anticipate them. It readily promotes those who profit on the opportunities missed and losses made by existing entrepreneurs. This is its very mode of operation. The structure of production then inexorably and justly shifts in order to match consumer preferences quite organically with the use of this selection mechanism, promoting production along the lines of these new profit making entrepreneurs. This is the beauty of creative destruction at work.

A further advantage of the market economy is the space within which it allows individuals to deal with future uncertainty, interestingly via the same mechanism from which it allows further investment and capital accumulation.

In the space of the market economy, money functions not only in the sense it fosters interpersonal trade and the development of a specialised division of labor. It also serves a dual purpose as a store of values to hedge against the uncertainty prevalent in the market. This is noted with the caveat, that this is only true to an extent, recognising that money, like all other goods is subject constantly to the inevitable permutations in its exchange value with respect to other goods in the market. Hence it is and cannot be entirely stable. Without political intervention in monetary matters however, we can expect those commodities expected to gain the highest stability to be those selected to best serve the function of money on the free market.

The scope this allows for individual decision makers in the face of uncertainty with regard to future resource and capital allocation is not arbitrary. Each individual does not have to directly consume or invest in production processes like Robinson Crusoe or the dictator of a socialist commonwealth. He may choose to keep or save his funds while awaiting further, better opportunities. Such decisions can be expected to change and re-equilibrate all manner of money prices in order to better match this tendency. In this respect it can be considered a truly social process.

In the framework of a sound banking system, it may help produce the market price known as the interest rate, thereby conveying social information about what is socially considered the optimum rate of capital accumulation given current assessment of the dangers of uncertainty, along with the entire constellation of other determining factors like time preference and supply constraints. There is no reason to surmise that this tendency will not be selective too, rewarding those who better perceive the truly dangerous uncertain factors, and can more efficiently engage in the market in the future.

Some may fear a tendency toward endless deflation, with the risk of such hoarding.

Refutations of such nonsensical fallacies have already been provided[16]. What is important to note is the role such hoarding plays in correcting inflationary and artificial expansions of the price and capital structure, stopping when the funds and capital as a result can be allocated towards the more highly desired processes of production. This is communicated and expressed by the resulting price structure of the market.

Hence we can see the way in which problems of industrial organisation can be tackled and allow for the creation of a complex structure of production, or even an economy at all, to put it in Mises' terms. Note that the market economy deals with also a problem of a different nature, arranging production along the lines and demands made by many individuals as opposed to one.

Also, despite the fact I have made some progress characterising and delineating different parts of this problem, along the lines of those encountered in linear and non-linear programming, much more work will be required to investigate this specific aspect of the problem. This may be left for further papers and research.

In conclusion, it may or may not be possible to generate an algorithmic or computational procedure allowing for equilibration according to the simplifying conditions I have identified as information equilibrium, thereby arranging industrial production according to this procedure in order to match autistic demand and supply constraints. This paper has hopefully highlighted some of the considerable difficulties that must be supplanted to even attempt to solve such a problem. Even this problem may be so complex, it could be considered like others of a similar nature as utterly intractable.

Yet in the regime of uncertainty prevalent in the real world, it is truly foolhardy to expect a complex, stable structure of production even designed solving this incredibly complicated equilibrium approach, to survive given limitations of its framework, the incredible sensitivities of its components to changes in market data, and ultimately too its inability to utilise the dynamic factors that can only emerge in the competitive framework of decentralised decision making guided by a positive incentive structure that emerges on the free market. Only such a construction, that cannot be designed by any mortal man, despite its flaws resulting from the same uncertainty affecting all action, can even hope to face the daunting challenges involved in producing a survivable and stable complex structure of production.

Hence to speak of a socialist economy is a logical contradiction in terms. The market succeeds not because it picks out a single equilibrating approach, but because in its framework many are adopted on a smaller scale, with no reliance on a priori equilibrium considerations; sorting, selecting and adapting those processes that best approach current market data through the profit-loss mechanism. How could a single decision maker match such a feat without omniscience of both the present and the future?

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