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Integration of Micro and Macro Explanations

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Abstract

Do the parts determine the whole or is the whole more than the sum of its parts? We consider the possibility of unified science in economics, where the macro behaviour is determined from its micro foundations. Classical impossibility results of aggregation deny this except in trivial special cases. When behavioural equations are expressed in change form (instead of levels), the connection between micro and macro formulations becomes a real possibility.

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Integration of Micro and Macro Explanations[1]

Do the parts determine the whole or is the whole more than the sum of its parts? Are the Methods of the Science effective also in the Humanities or are they not as the vitalists and humanists believe? **Integration** in our title refers to mathematics and **explanations** to the philosophy of science. The Grand Unified Theory GUT in Physics and Aggregation in Economics are directed to unify the micro based and holistic views.

The views of parts and the whole, of analysis and synthesis, have divided philosophy and science for two thousand years. Classical separations are materialistic vs. idealistic, descriptive vs. explanatory, mechanical vs. intentional etc. Special terminology is emergence, vitalism vs. reductionism, interaction, feedback and holism. If these are unknown to you, you do not know the subject. Of the general philosophy see e.g. Wilson (1998) and Monod (1971). **The schemes of unified science** (three m's, both Latin and Greek ones) generally, in economics E and in chemistry C are

$$\begin{array}{ccc} M & M(E) & M(C) \\ \mu \uparrow & \mu(E) \uparrow & \mu(C) \uparrow \\ m & m(E) & m(C) \subset M(PF) \end{array}$$

The actual topic of a research area (its macro level) is on the top, a meaningful micro level at the bottom and μ denotes mathematical - logical methods in their integration. Quantitative and exact methods of chemistry $\mu(C)$ differ from those of econometrics $\mu(E)$. The micro $m(C)$ of chemistry is, of course, also part of particle physics $M(PF)$.

Math-logical methods μ cannot be replaced here by semantics of philosophy. Hegel, Kant, Marx or Derrida "do not function", because micro and macro cannot be integrated in ones head easier in Sociology than in Economics or Chemistry. In our interpretation, **integration of parts and the whole is basically a mathematical problem**. Philosophical analysis and mere semantics are not strong enough for it, although humanists think otherwise. Unless we err, we are going to hear several mutually contradictory "good explanations" that this cannot be the case!

Can one write anything new and sensible of a chaotic topic like this? I believe, that it is possible. I have investigated the topic during some years together with several colleagues (AS, EK, HP, JL, JT, MJ, OK, OR, PP, PT). The drafts produced would fill a book or two. I have interpreted the problem in a new and mathematically accurate way. Results have been certified e.g. by simulations and they have appeared in all empirical problems they have been applied at. The main ideas of the project are presented here at the first time in English.

Let's move to Economics. How do incomes and consumption functions, say, of two million households $a \in \Omega$ determine total consumption? For a single agent a, consumer theory specifies its consumption function, which we take for simplicity as function of incomes x(a) only. (Think prices and other input variables as fixed.) We allow the theoretical consumption functions be

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non-linear and agent-specific and incomes arbitrary positive real numbers. At the macro level all the households Ω forms the aggregate (collection, set) under consideration.

In the System of National Accounts SNA, the *total* consumption $\widetilde{c}$ (as a current value or in constant prices) is taken as the macro level output. We consider as the macro output ⟨c⟩ = the average consumption per household = $\widetilde{c}/n$. Averages are easier to investigate in aggregation than totals. As the number of households $n = card(\Omega)$ is either essentially constant (say in time) or slowly changing ⟨c⟩ and $\widetilde{c}$ are practically constant multiples of each other.

Macro output as written in terms of micro inputs is

(1) $\langle c \rangle = \frac{1}{n}\sum_{\Omega} f^a(x(a))$.

Despite its shortness, this is a very complicated function of the input vector $x = (x(a_1),...,x(a_n))'$ when n is large and f^a are non-linear *a*-specific functions. Anyhow, we are asking, whether it is possible to write this relationship **in terms of some familiar macro variables**, such as average income, income inequality and average marginal propensity to consume.

Problems of similar complexity have been considered in statistical physics but without heterogeneity of behavioural functions. Klein (1946), Leontief (1947), Nataf (1948), Gorman (1959), Theil (1954), Arrow (1963), Green (1964) and other almost Nobel-level classic experts of aggregation in economics have shown, that desired solutions are impossible except under unrealistic special cases. **The problem of aggregation** has been almost bypassed during the last 30 years, although according to the classic experts e.g. the **macro economics of text-books is contradictory** without unrealistic homogeneity assumptions, see Allen (1964, last chapter) or van Daal & Merkies (1984). Luckily this impossibility result deals with level relations only.

Our main result is as follows. According to function theory the macro difference of the consumption satisfies

(2) $\langle \Delta c \rangle = \frac{1}{n}\sum_{\Omega} \overline{m}(a)\Delta x(a) = \langle \overline{m}, \Delta x \rangle$,

where $\overline{m}(a)$ equals the marginal propensity to consume of the household a at the appropriate mean value of the income. Is it possible to express the inner product $\langle \overline{m}, \Delta x \rangle$ in terms of meaningful macro characteristics - unlike the level equation? Surprisingly this is possible. Its desired representation is of the form

(3) $\langle \Delta c \rangle = \langle \overline{m}, \Delta x \rangle = MC \cdot \langle \Delta x \rangle + \varepsilon$ = systematic + unsystematic parts

It can be shown, that arbitrary changes of income decompose into its *Uniformly Absolute* and *Uniformly Proportional* parts as follows $\Delta x(a) = \Delta x^{UA}(a) + \Delta x^{UP}(a) + u(a) = A + P\overline{x}(a) + u(a)$. Here orthogonality applies: $u \perp \Delta x^{UA}$ and $u \perp \Delta x^{UP}$. Hence, as ⟨u⟩=0,

(4) $\langle \Delta x \rangle = \langle \Delta x^{UA} \rangle + \langle \Delta x^{UP} \rangle$.

Dividing both sides by ⟨Δx⟩ gives the weights $1 = w^{UA} + w^{UP}$. They sum to unity, but need not have the same sign.

It took a long time to realize (proof was easier) that the following equations summarize essential things

(5) $\langle \Delta c \rangle = MC \cdot \langle \Delta x \rangle + \mathrm{cov}(\overline{m}, u)$, where

(6) $MC = MC^{UA} \cdot w^{UA} + MC^{UP} \cdot w^{UP}$.

Effective marginal propensity to consume MC is an **affine combination** of its components MC^{UA} and MC^{UP}. Only for positive weights it is a weighted average of them and between them.

Conclusions of the Keynesian consumption function are as follows. The effective marginal propensity to consume MC_t for a given quarter t is not time invariant but varies from one situation to another. Its changes depend on the income distribution, especially on the increase or decrease of the relative income inequality. This all can be calculated using the micro level information; **no separate macro modelling or estimation is needed**.

Also the well-known unreliability of macro models is explained. In them parameters which do not actually exist (because they change from one situation to another) are tried to be estimated and by using too few observations. These reasons do not disappear anywhere and thus the **knowledge does not increase**. This kind of modelling is equally hopeless than estimating the difference of green and leftist parties (in Finland) in terms of 160 Gallup interviews. Supporters of these parties in the sample would be only 20±4, which is too little to get any significant differences. Here 160 refers to the number of quarters of 40 last years. Older past would be probably irrelevant ancient history. The current **macro modelling is thus a weak strategy**.

Unreliability of macro models arises while micro information, like panel series, is not properly utilized. The main fault is **Neglected Information Bias**. The proper way of integrating micro and macro information will minimize these problems and gradually leads to a new level of accuracy in macroeconomics.

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