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IT IS NOT TOO LATE♣ – ECONOMICS NOBEL PRIZES FOR A TRIO OF PIONEERS UZAWA, SCARF AND NEGISHI

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♣ Tennyson's noble lines in *Ulysses* (italics added) are the inspiration for this phrase:
Death closes all; but something ere the end,
Some work of noble note, may yet be done,
Not unbecoming men that strove with Gods.
The lights begin to twinkle from the rocks;
The long day wanes; the slow moon climbs; the deep
Moans round with many voices. Come, my friends.
'***T is not too late*** to seek a newer world.

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§ 1. A Brief Preamble

> **"**The emotion of art is impersonal. And the poet cannot reach this impersonality without surrendering himself wholly to the work to be done. And he is not likely to know what is to be done unless he lives in what is not merely the present, but the present moment of the past, unless he is conscious, not of what is dead, but of what is already living."
> **T.S. Eliot:** ***Tradition and the Individual Talent***

As befits one who was born and spent his formative years in *Serendip*[1], it was serendipitous that I began studying economics, in *Sweden*, inspired by Gunnar Myrdal's **Asian Drama**, literally as the first Nobel Memorial Prizes in Economics were being awarded to Ragnar Frisch and Jan Tinbergen, then Paul Samuelson, Simon Kuznets, John Hicks and Kenneth Arrow, Wassily Leontief, Gunnar Myrdal and Friedrich von Hayek, in the first half a decade after its inception.

I am old enough to have been just adequately young to have befriended some of these giants who fashioned and moulded the analytical core of twentieth century economics – in particular, Tinbergen, Samuelson, Hicks, Arrow and Myrdal – but also had the privilege to corresponded with some of the others (Leontief and Hayek).

I doubt anyone of my generation, or any of my own teachers or their contemporaries, had too many doubts about the suitability and desirability of honouring these outstanding pioneers of analytical and applied economics, even if some – or even many – of them may have felt such a prize conferred an undeserved parity of status, by an uncomfortable adherence of the name of Nobel, with the more established sciences of physics, chemistry, medicine & physiology[2].

Despite occasional grumbles, I think it is fairly safe to surmise that there was considerable agreement in the discipline at large on the award of the prize to the distinguished recipients till at least 1989 (Trygve Haavelmo). Most of the dissatisfaction in the first two decades was more on the omissions – Joan Robinson, Roy Harrod, Oskar Morgenstern, Piero Sraffa, Jacob

[1] The name by which old Ceylon, now Sri Lanka, was once known, and the word, in the title of **The Three Princes of Serendip**, which inspired Horace Walpole to coin *serendipitous*.
[2] The Nobel Prizes for Peace and Literature, although often controversial, did not claim an anchoring in 'science' – however that word may be defined; the economics prize, from the outset, was supposed to be an award for contributions to 'economic science' ('ekonomisk vetenskap'). Moreover, the Nobel family did not reconcile themselves to granting this new entrant parity of status with the original five.

Marschak[3], Nicholas Georgescu-Roegen, etc., – than on the selections (with notable exceptions, especially on the timing, of the awards to Leonid Kantorovich and Milton Friedman).

Some of the perplexities were on the *joint* awards to Hicks & Arrow, Myrdal & Hayek, on the entirely justifiable grounds that each of these four maestros deserved not just single awards – perhaps, at least in the case of Arrow, even multiple prizes (for initiating the wholly new field of research, Mathematical Social Choice Theory and laying one of the significant foundations for what eventually became Endogenous Growth Theory – quite apart from *General Economic Equilibrium Theory and Welfare Economics*, for which he was actually awarded the prize, shared with John Hicks).

Then, there is the wholly different – more philosophically grounded – criticism, not voiced only by heterodox economists, but also by humanists and other social scientists, who deplore the possible unavoidability of ideological motives in the selection process, the tenuous 'scientific' underpinning of economic analysis, the consolidation of the increasing 'imperialism' of economists and economic theory *vis a vis* the other social sciences and, above all, the inevitable subjective biases of a selection committee unable to transcend visions – in the strict Schumpeterian senses – of an economic theory unable to encapsulate, and to be underpinned, by broader social and political concerns.

These are short-comings which we in economics share copiously with our Literary brethren, where – often – the award of the Nobel Prize for Literature highlights omissions, due, ostensibly, for cultural, historical and political reasons and for the understandable impossibility of creating a 'level playing field' for alternative literary traditions, has bedeviled the award, time and time again.

[3] On reading my *Obituary* of Herbert Simon, in February, 2001, my old friend and former colleague, Michael Intrilligator wrote me that Mrs. Marschak had mentioned, in a casual conversation, that 'they' thought Jacob Marschak was to share the Nobel Memorial Prize in Economics with Herbert Simon, in 1978. Intrilligator added that it was the unforeseen death of Marschak that thwarted this shared honour. I am not entirely sure the dates 'add up', although it would certainly have called forth yet another usage of the word serendipitous, had it materialized (and given me even more professional pleasure as a current member of the economics department at NSSR, of which Marschak was a distinguished past member!).

Had Joyce written *Ulysses* or *Finnegans Wake* in Irish, could the Nobel Committee have had the competence to judge an award very easily? Why were Borges and Casares passed over for the award, in an era that saw the rise and celebration of Latin American literary magic realism? Why Kawabata and not Mishima? And so on, as we ask, in Economics too, why not John McCall rather than – or before, or jointly with[4] - Diamond, Mortenson and Pissarides, why not Armen Alchian, at least jointly with Ronald Coase or, why not Masahiko Aoki, jointly with Elinor Ostrom and Oliver Wiiliamson, why not Oskar Morgenstern, long before Harsanyi, Nash[5] and Selten or, indeed, why not Shapley for *Cooperative* Game Theory before celebrating *non-cooperative* game theory[6].

§ 2. Three Non-Nobel Nobles

> "The most remarkable achievements of modern microeconomic theory are the proof of the existence of an equilibrium and the First and Second Theorems of Welfare Economics which establish the relation between equilibria and Pareto efficiency.
> **David G. Luenberger** (1994), *Optimality and the Theory of Value*, Journal of Economic Theory, Vol. 63,# 2,, p. 147.

If, as Luenberger – and countless others – are substantially correct in their evaluation of the 'remarkable achievements of modern microeconomic theory', and if the profession has already paid formal homage to the acknowledged architects of these 'remarkable achievements' (Arrow and Debreu, above all), then, surely, it is also time we acknowledged those who have made these achievements *computationally* meaningful.

I aim, therefore, to make a case for awarding the *Nobel Memorial Prize in Economic Sciences* to two outstanding Japanese economists – Hirofumi Uzawa[7] and Takashi Negishi –jointly

[4] Perhaps there is a rule against four awardees for any one Prize, at any one point in time?
[5] Many of us, of my generation of graduate studies in the early 1970s, felt – when Kantorovich and Nash were recognized as having contributed sufficiently original work which had decisive importance in economic analysis – that Bruno De Finetti, too, should have, eventually, been awarded the Economics Nobel. Such thoughts would have also applied to Frank Ramsey, George Dantzig and Leonard Savage – and who, in economics, would have begrudged an Economics Nobel to von Neumann?
[6] Shapley, serendipitously, is our most recent Economics Nobel, but awarded the Prize for his contributions to *"the theory of stable allocations and the practice of market design"* - not for his celebrated work on the 'Shapley Value', whose ramifications, even in ostensibly mundane applications like imputing joint costs by accountants, aircraft landing fees, production under conditions of alternative land ownership regimes, and so on remain almost inexhaustible.
[7] Uzawa's age cannot, of course, be held against the award of the Prize to him. After all, our current Nobel Memorial Prize winner in economics, Lloyd Shapley, was born in 1923 – and Uzawa in 1928;

with Herbert Scarf. The case I try to make is for their pioneering contributions towards making it formally possible to underpin the purest of pure economic theory - general equilibrium theory in the Walras–Arrow–Debreu tradition, supplemented by the two fundamental theorems of welfare economics – *computational*[8] in a rigorous, yet applicable sense.

It will not be considered an exaggeration to claim that one of the research frontiers in economics – both from theoretical and applied points of view, and from microeconomic, macroeconomic and game theoretic[9] vantage points – is the search for computational foundations for the concepts, formal framework and entities of basic economic theory. The computational core of dynamic stochastic general equilibrium theory can be traced back to Scarf's pioneering work on Computable General Equilibrium theory (Scarf, 1973), which, in turn, had as its own analytic foundations in Uzawa's remarkably original equivalence theorem[10] (Uzawa, 1962).

Almost simultaneously with Uzawa's 'rigorous' derivation of his equivalence theorem, Negishi (1960) developed an alternative to the Scarf approach by devising a method to compute (approximately) the traditional Arrow-Debreu equilibrium, starting from the *first fundamental theorem of welfare economics*, via a concentration on a mapping of the set of weights of a social welfare function to itself.

A characterisation of the *difference* between the standard approach to proving the existence of an Arrow-Debreu equilibrium, and its computation by a *tâtonnement* procedure - i.e., algorithm - of a mapping from the price simplex to itself, and the alternative Negishi method

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Scarf and Negishi were born in 1930 and 1933, respectively. Compared to Shapley's age, the latter three are mere younglings!

[8] I would like to emphasise that it is their contributions towards making aspects of core areas of economic theory *computational* – not *computable* – that is of relevance here. The difference between the two terms is outlined in careful detail in many of my writings of the last decade, or so.

[9] I have in mind, here, the recent burgeoning interest in, and contributions to, varieties of algorithmic game theory. The methodology here is exactly analogous to that followed by computable general equilibrium theorists – i.e., to devise procedures, implementable as meaningful algorithms on digital computers, to compute, even if only approximately, equilibria; in the one case, approximations to the traditional (Walras)-Arrow-Debreu equilibrium and the other case concentrates on Nash and related game theoretic equilibria.

[10] The equivalence Uzawa demonstrated, formally, was that between the Brouwer fix-point theorem and his – i.e., Uzawa's – formulation of a version of what he referred to as the Walrasian Equilibrium Existence Theorem (WEET).

of iterating the weights assigned to individual utility functions that go into the definition of a social welfare function which is maximised to determine - i.e., compute - the equilibrium, captures the key innovative aspect of the two approaches.

Essentially, therefore, the difference between the standard approach to the proof of existence of equilibrium Arrow-Debreu prices, and their computation, and the Negishi approach boils down to the following. The standard approach proves the existence of Arrow-Debreu equilibrium prices by an appeal to a fixed point theorem and computes them - the equilibrium prices - by invoking the *Uzawa equivalence theorem* (Uzawa, *op.cit*.,) and devising an algorithm for the excess demand functions that map a price simplex into itself to determine the fixed point (Scarf, 1973).

The Negishi approach proves, given initial endowments, the existence of individual welfare weights defining a social welfare function, whose maximization (subject to the usual constraints) determines the identical Arrow-Debreu equilibrium. The standard mapping of excess demand functions, mapping a price simplex into itself to determine a fixed point, is replaced by a mapping from the space of utility weights into itself, appealing to the same kind of fixed point theorem (in this case, the Kakutani fixed point theorem) to prove the existence of equilibrium prices.

In other words, the method of proof of existence of equilibrium prices in the one approach is replaced by the proof of existence of `equilibrium utility weights', *both appealing to traditional fixed point theorems* (Brouwer, 1910, von Neumann, 1937, and Kakutani, 1941).

In both cases, the computation of equilibrium prices on the one hand and, on the other, the computation of equilibrium weights, algorithms are devised that are *claimed*[11] to determine (even if only approximately) the same fixed points.

[11] I use the word 'claimed' guardedly and deliberately because none of the frameworks used by Uzawa, Negishi or Scarf are based on either computability or constructivity theories (both interpreted in their strict mathematical senses). Even an 'approximate computation' of an uncomputable or non-constructive configuration, to be meaningful, requires significant departures from the 'paradise' that is conventional real analysis.

If the critera for an award of a Nobel Memorial Prize in economics depends on contributions to the research (and teaching) frontier of a subject, and if these frontiers have themselves emerged from the pioneering contributions of identifiable works by reputed scholars, whose overall *oeuvre* is of the highest caliber, then to jointly award the prize to Uzawa, Negishi and Scarf cannot be anything but an obvious and non-controversial decision. The significance of this particular set of works by Uzawa, Negishi and Scarf can also be gauged by the fact that they are now also contained in advanced graduate textbooks – and copiously applied in all kinds of policy applications, even in the context of development economics.

That few recognize the direct line from Uzawa, Negishi and Scarf, to the bridges they built to use the building blocks of the formalism of Walras, Hicks, Arrow and Debreu, to smoothen the applied economist's journey from theory to computation, is no excuse for neglecting their pioneering contributions. After all, not many recognize, each time they use a GPS system, that the implementation of the technology that makes such things almost indispensable in daily journeys and commuting, depends on one of the most esoteric theories of physics in the twentieth century.

§ 3. Endorsing a Past, Celebrating the Future

> "What might have been and what has been
> Point to one end, which is always present.
> Footfalls echo in the memory
> Down the passage which we did not take
> Towards the door we never opened
> Into the rose-garden."
> **T. S. Eliot**: *Burnt Norton*

The various committees evaluating candidates for the Nobel Memorial Prize in Economics have, over the years, made conventional and obvious choices – but also courageous and innovative recognitions. In particular, in recent years, the recognition granted to experimental and behavioural economics with awards to Vernon Smith and Daniel Kahneman (2002), for mechanism design theory to Leonid Hurwicz, Eric Maskin and Roger Myerson (2007), to George Akerlof, Michael Spence and Joseph Stiglitz for their outstandingly pioneering work on analyzing markets with asymmetric information (2001) and, much earlier, to Simon Kuznets (1971) and Herbert Simon (1978).

Of course, there is also the difficult criterion of recognizing a contribution as the harbinger of a 'new and firm', as well as one that may lead to a new codification of an innovative method and awarding the Prize in advance of consolidation in the profession. The hazards of this line of thought are recognized in the 'official' sciences – but less well adhered to in the criteria that seem to have been applied, rather more frequently than desirable, for the Peace prize.

A characteristic feature of an award seems to have been a recognition of the 'permanency' of an innovative contribution[12] – say 'mechanism design theory' or 'asymmetric information in the analysis of the functioning of markets' – or the codification of a method in the standard repertoire of economic analysis – say as in 'behavioural' or experimental economics. It is obvious that the permanency of an innovative contribution or the codification of a new method takes time, before it can be absorbed by the advanced textbooks and contribute to the education and formation of future generations of economists, both theoretical and applied.

It is in this fertile sense – *of a new and permanent codification of a method* - that I make my case for awarding the Prize to Uzawa, Negishi and Scarf. I have no doubts whatsoever that their work has propelled our subject's scientific status to new heights of recognition, even as participants in a comprehensive *zeitgeist* – the age of information, underpinned by a theory of computation. If Walras and Pareto, in an earlier age, and Arrow and Debreu in our own times, were the economic heritages these three were refining for a new generation to create new vistas, then they were also bringing the subject closer to the methods pioneered by Brouwer (with his intuitionistically underpinned constructive mathematics), Turing (computability theory) and Shannon (computationally underpinned information theory).

To have made it possible for economists of a new generation to build on the foundations laid by Walras and Pareto, Arrow and Debreu, Brouwer, Turing and Shannon, is no negligible feat. It is, indeed, an outstandingly pioneering achievement, whose scope in widening and deepening economic analysis could not have been foreseen by the profession at the dawn of the 1960s – fully over a half-a-century ago.

[12] Robert Oppenheimer is reputed to have looked straight into the eyes of a promising young Physics PhD visitor and asked him, unflinchingly: '*What is new and firm in Physics, these days?*'

Surely it is just the right time to recognize their remarkable achievement, by the award of the Nobel Memorial Prize in economics to this trio – before it is too late in a trivial, mortal, sense!

'Footfalls' always 'echo in the memory', especially 'down the passage which we did not take'. Eliot's doors 'we never opened' are the dual of Frost's 'road not taken'. Mercifully, however, there are times when it is not too late to open doors we never opened and to try roads and passages we did not take.

This is one of them and it is our duty, as economic theorists and applied economists, to pay homage to three who straddled both divides with sustained distinction for almost half a century.

Recognising the pioneering and enduring nature of the interrelated contributions by Uzawa, Negishi and Scarf is, in my opinion, only the first step in opening the door and walking into 'the rose garden' – where Nelson and Winter, McCall and Malinvaud, Taylor[13] and Day, planted their saplings, now in full bloom. Evolutionary growth theory, non-equilibrium search theory, the conundrums of the transversality problem, social accounting in the Petty-Stone-Johansen[14] tradition, paying meticulous attention to the one indisputable economic principle of double-entry bookkeeping and exotic disequilibrium nonlinear dynamics were among the seeds that the above six pioneers sowed, in fertile soils. We, their followers, adherents, successors and disciples, reap the benefits of the fragrance emanating from the rose garden, the clarity they induce in minds grappling with the unruly contours of the economic world of evolution, change and – the resulting morphogenesis.

[13] I am, of course, referring to *Lance Taylor*.
[14] Leif Johansen, if not for his untimely death at an early age would, surely, have adorned the list of Nobel Memorial Economic prize winners with distinction?

References

Brouwer, Luitzen. E. J (1910), *Über eineindeutige, stetige Transformationen von Flächen in sich*, **Mathematische Annalen**, Vol. 69, pp. 176-180.

Kakutani, Shizuo (1941), *A Generalization of Brouwer's Fixed Point Theorem*, **Duke Mathematical Journal**, Vol. 8, # 3, pp. 457-9.

Negishi, Takashi (1960), *Welfare Economics and Existence of Equilibrium for a Competitive Economy*, **Metroeconomica**, Vol. XII, pp. 92-7.

Uzawa, Hirofumi (1962), *Walras' Existence Theorem and Brouwer's Fixed Point Theorem*, **The Economic Studies Quarterly**, Vol. 8, No. 1, pp. 59 - 62.

von Neumann, John (1937, [1945-6]), *A Model of General Economic Equilibrium*, **The Review of Economic Studies**, Vol. 13, # 1, pp. 1-9.

Scarf, Herbert (1973), **The Computation of Economic Equilibria** (with the collaboration of Terje Hansen), Yale University Press, New Haven.