Evolutionary Economic Programs

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Introduction

Evolutionary economics is growing in scope, content and influence. That is the good news. The bad news seems to be that there still is no clear cut scientific paradigm that the scientific public - not to speak about the general public – can attach to this label. We do not have common scientific program.

This paper shows why there probably never will be such a well-defined evolutionary economics paradigm. And that this state of affairs is perfectly in line with what the profession – and society – needs in the moment. What follows proceeds in three steps, spelling out the paper title in detail from the right:

Programs, the plural, are to be explained first. They are introduced as anti-thesis to paradigms. The connotation with computer programs, of course, is not accidental.

Economics as a discipline much too often is taken as granted, not further to be discussed. For evolutionary economists evolution in biology is the natural antipode.

Evolutionary finally is an attribute very vaguely defined, though describing our common denominator. Some effort is made to sharpen the concept by working out the background from which it escapes, i.e. the balanced world view.

I. Paradigms or Programs

In his most influential study on the long-run development of theory in physics Thomas Kuhn made the concept of a ***paradigm*** popular as a device for the description of sets of scientists and contents that form some kind of unity – historically and logically [Kuhn T., 1962, 1977]. Paradigms thus go beyond any simple sociological description of the dynamics of the behaviour of individuals doing science, they correlate clusters of content with clusters of such carrier groups. The adaptation of this concept – and its refinements[1] – have been most

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[1] The implied ‘Growth of Knowledge’ approach has triggered numerous contributions (e.g. [Lakatos I., 1978]). See Bruce Caldwell for a roadmap of the philosophy of science [Caldwell B., 1982].

welcome in economic theory, where the prevailing concept of economic schools[2] was somewhat discredited by the scientifically rather disappointing results of the so-called Methodenstreit in the early 20th century[3]. This battle of methods not only marked a shift of epicentre of scientific activity from central Europe towards the Anglo-Saxon scientific communities, it also was a turning point with respect to the scientific fields that a science of sciences derived its abstract concepts from: In modern times[4] advanced scientific behaviour was derived from the practices of natural sciences.

The simplest visual representation of a paradigm distinguishes between a core of true interrelated sentences and a protective belt of supplementary issues meant to be more flexible (see figure 1). While the core sentences have to meet rather strict internal conditions of clarity and consistency, the importance of sentences in the protective belt derives from their ability to immunize core statements with respect to attacks from outside. Attacks should be channelled into changes in the periphery leaving the core intact. In a paradigm of paradigms it thus clearly would be a mistake to consider peripheral sentences as less important than core sentences. The former are pivotal for the survival of a paradigm and Kuhn correctly identifies work in the periphery as *normal science*, i.e. the field where most of the time most of the work is done.

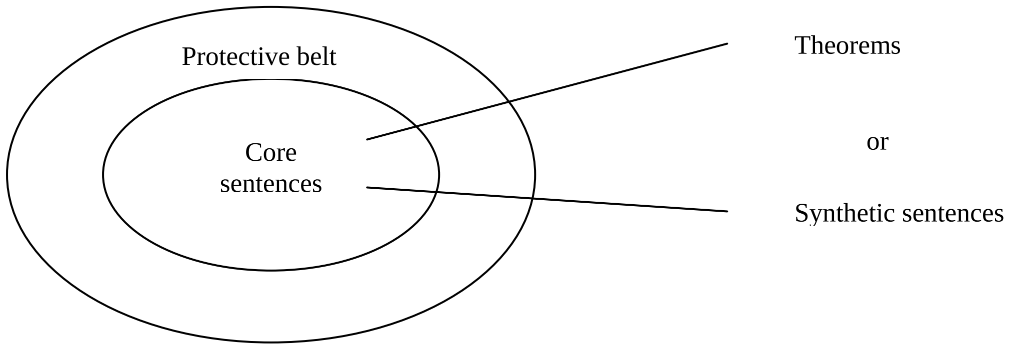

Figure 1: Paradigm

But Kuhn's concept 'paradigm' gains its importance also from its critical perspective on the evolution of paradigms: Historically new core systems emerge in relatively short time spans, a transition he calls *scientific revolutions*. Most of his work is devoted to the task to trace back this suggestion in the history of physics. And his arguments are very plausible. The pulse of science seems to proceed in the form of long periods of normal science interrupted by scientific revolutions. Unfortunately though, he does not really provide insight into the

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[2] Schumpeter's late work, the 'History of Economic Analysis' [Schumpeter J., 1955] still is organized along the lines of economic schools – as was Karl Marx' work on 'Theorien über den Mehrwert' [Marx K., 1974].
[3] Gustav Schmoller's historical school and its opponent, the Austrian School, are just one (economic) aspect of this multi-faceted break. From Weber's sociological approach [Weber M., 1973 (1920)] to Wittgenstein's early work [Wittgenstein L., 1978 (1921)] a wide range of local battlefields can be observed.
[4] The very concept of modernity itself is often defined in terms of this practice.

process of emergence itself – neither during the protective work of normal science, nor during scientific revolutions the sources of new sentences are discussed[5].

An important starting point for this omitted topic is to take a closer look at what constitutes a core sentence. Despite a very intense debate of these issues in the Vienna Circle in the early thirties – the discussion about the status of so-called 'Protokollsätze' (compare [Carnap R., 1974]) – the topic remained almost completely ignored, in particular in economic circles. For the science of sciences, which still took physics as its best practice example, the fact that the theory of physics became more and more indistinguishable from the mathematical apparatus it applied, lead to an inclination to view proposed core sentences as proposed mathematical theorems. Since the physical object of investigation often was hard to observe (atomic physics) formalisms either were taken as the (partly still hidden) secrets behind physical processes or at least so close to the structure of physical objects that a study of the latter seemed necessary to inspire the development of mathematics[6]. But if one tends to identify physical laws with mathematical theorems, then it is only straightforward to identify the emergence of the core of a paradigm with the proposal of a set of theorems. As a consequence the central research activities that drive scientific revolutions are viewed as propositions of a new formal system of theorems. The role of the protective belt then degenerates to a normal science that generalizes core hypothesis as they are questioned in this respect by competing paradigms.

Indeed there is nothing wrong with this type of scientific research – as long as it is clear that it is research in the development of formal languages. Sentences in these scientific disciplines are what Kant called analytic judgements [Kant I., 1980 (1781), pp. 52-64]. The main scientific activity following the proposal of a theorem is to prove that it is consistent with the existing body of language: true, false or – since Gödel's work [Gödel K., 1931] – not decidable. Note that truth in this context only means consistency with the existing formalism. Any claim that science in general is the discovery of properties of formal languages in nature is simply something that cannot be supported or refuted by this type of scientific discipline.

But as Kant forcefully argued, there is a second type of scientific disciplines, namely those concerned with the synthesis of two worlds, the world of (formal) language and the world outside language. These sciences are meant to produce synthetic judgements, i.e. sentences in a (formal) language that go beyond (transcend) the language and are actions in the world outside the language. It is important to distinguish sets of synthetic sentences from sets of

[5] A Schumpeterean economist, of course, immediately would try to plug in Schumpeter's new combinations of old elements.

[6] As John von Neumann remarks: 'The great successes of the nineteenth century, as well as of modern analysis, were in linear problems. We have much less experience with non-linear problems, and we can say practically nothing about the majority of non-linear partial differential equations. We have never been successful with these at all, and therefore we have no idea what the difficulties are.

In those domains where some progress had been made it was usually for different reasons, for instance, because some very usual physical phenomenon was tied up with the mathematical problems and therefore one had a non-mathematical, physical approach.' Von Neumann J., 1966, p.34].

analytic sentences, and a recent label that carries much of the hybrid character of the former set is the concept of a ***program***: It is written in a language but it also performs something outside the language.

At first glance rather innocent, the turn to synthetic scientific disciplines and their programs proves to be a severe shift in perspective, indeed a reversal of many of the features of analytic language developing sciences. Where consistency and timeless generality ruled as ultimate goals to be achieved, they now only figure as partially achievable side-constraints that are dominated by the time-dependent and particular success indicators outside language[7]. Using Peirce's distinctions, semantic and pragmatic aspects dominate, even drive, syntactic aspects in synthetic scientific disciplines [Peirce, 1988].

This has consequences for the very usefulness of the concept of paradigm for these sciences: The (with necessity) preliminary character of all synthetic judgements – 'induction' is the magic word – implies that the 'core program' is nothing to be *discovered* as an eternal law. The bunch of sentences in the 'core program' - in all its spatial and timely finiteness - on the other hand helps to organize, even to constitute social units, research communities outside the world of language. Vice versa, it is the research community as a social unit outside language that to a large part *produces* the 'core program', sustains, tests and improves it. There is not much to be discovered but a lot to be improved, including language[8]. Since the distinction between core and protective belt programs in this context obviously does not make much sense, the label paradigm itself can safely be discarded.

Finally, with programs instead of paradigms a new complication appears: At least some sentences of programs refer to items outside the language, they try to spell out simplified non-linear dynamics that are suggested as a model of essential 'real' dynamics[9]. Since such programs are produced (not discovered) by participants in the real process, these programs contain images of their producers. They even may contain images of their own production processes. In short, the problem of self-referential circuits between real and model dynamics appears. Observers often being part of their observation, model-builders often being part of their models, languages talking about languages, all difficulties calling for concise specification – demanding but surmountable[10].

To see the progress from the most advanced economic theories formulated in the old paradigm of physics, general equilibrium theory (Eric Smith and Duncan Foley in a recent paper provide a convincing parallel to physics' mathematics [Smith E., Foley D.,2002]), just look at time horizons of policy implications: Any possibly beneficial policy can only be

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[7] Note that consistency is itself determined as part of the language.

[8] An interesting, though ambivalent contribution to this debate came from Herbert Simon [Langley P. et al., 1987], who on one side is one of the early practioneers of modern and conscious, synthetic social science, but on the other side is fascinated by discovery processes.

[9] A thorough discussion of the adjective 'real' - Kant's problem of the 'Ding an sich' – goes beyond the scope of this paper. Simply assume for the moment that the world outside language is called 'real world'.

[10] It is this challenge that makes computer simulation so attractive a language for synthetic sciences.

derived from the *limitations* of the generality of equilibrium – just as any theory of living systems can only be described as (limited) neg-entropy counteracting the second law of thermodynamics. Upshot - economists must subscribe to programs.

II. Biological versus Economic Programs

Taking the argument of the preceding paragraphs serious, programs of several synthetic scientific disciplines might be investigated and compared. Real dynamics, in the sense explained above, take place in our non-living environment as well as in the form of living systems. In a previous book [Hanappi H., 1994, p.14] I have labelled the scientific program studying evolution in non-living environments Evolutionary Theory 0, in short **ET0**. To distinguish between living and non-living real processes is, of course, an acute task of evolutionary theory, a fundamental but rather difficult task. As far as the current argument is concerned two contributions, two landmarks, must be mentioned: Erwin Schrödinger [Schrödinger E., 1944] and Stuart Kaufman [Kaufman S., 1993, 1995, 2000]. From the former, a physicist, the importance of qualitative change due to a breakthrough in quantity as a source of life has been highlighted [Schrödinger, 1944,p.], the latter, a biologist, is currently working on the microbiological roots of neg-entropy, discovering traits of early living systems - like oscillatory, pulsating and spiralling behaviour – that should inspire evolutionary economic programs[11].

Ignoring several points still under hot debate, let us assume that living systems are characterized by their primary metabolism. As part of the earth's real dynamics they transform inputs into growth of structure, which in turn produces outputs into the environment (see figure 2).

[11] Many more names, legions, would have to be mentioned to do some justice to all contributors to this debate. One more outstanding contribution comes from the nobel prize winner in chemistry Hermann Haken [Haken H., 1983, 1991] furthering our understanding of adiabatic elimination [Haken H., 1983, pp. 207-234]. On the other other hand, Haken is also an example for the dangers of over-interpretation of evolutionary ET0 findings in social contexts, e.g. [Haken H., 1984].

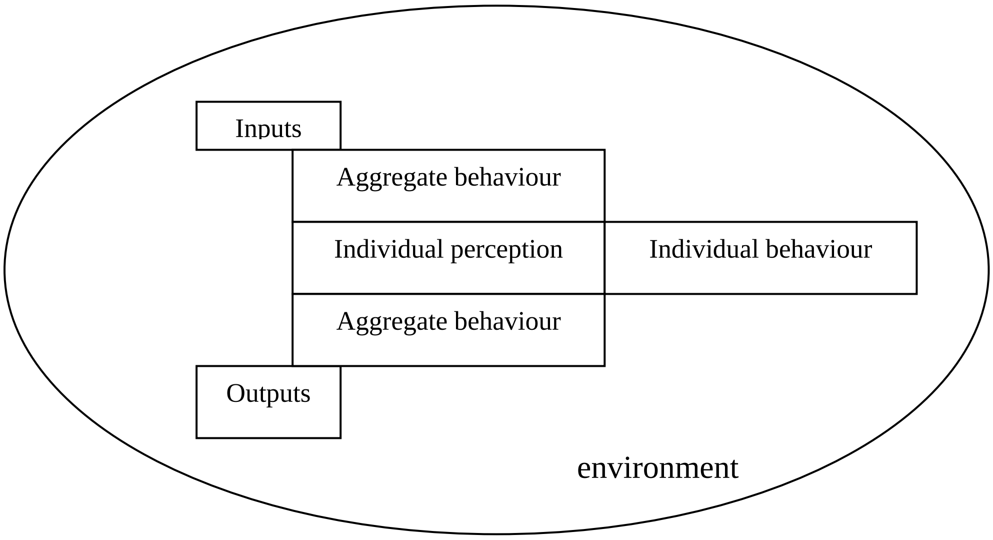

Figure 2: Primary metabolism

The first striking fact is that living systems come in well differentiated varieties, species, which prima facie remind on the quest for elements in physics. Darwin's theoretical blow, the foundation of modern ***biology***, was explicitly directed against the assumption of such a first and unchanging order – *evolution* is the name of the game [Darwin Ch., 1985 (1859)].

Since then the interplay between environment and species is the core topic of (evolutionary) biology, call it **ET1**. Examine several interesting general features:

- A *variety* of species reproduces itself for *some time*. It does so on an *individual* level with *shorter* time horizon as well as on an *aggregate* level with *longer* time horizon.
- Reproduction means that certain entities (individual, species) *maintain* essential parts of their *structure* – or even *grow* - by adding appropriate similar or complementary sub-elements that substitute or even surmount the sub-elements they loose.
- The *probability of survival* of an entity (gene, individual, species), vulgo *fitness*, may increase by the way of *variation*[12] (sometimes mutation) and *selection*. Call this process *biological evolution*.
- After some time, with biological evolution working *fast* relative to environmental changes, entities will have adjusted themselves to environmental conditions. The structure of their constituting smaller elements thus will *reflect* the process of historical adaptation. In other words, elements of environmental dynamics (including the dynamics of other entities) will be mirrored in this structure, i.e. this

[12] Note that variation is only possible if there is enough room for more than one variant to survive under current conditions. This redundancy with respect to current survival under prevailing conditions enables selection if conditions change. This space to manoeuvre can itself be thought of as evolutionary selected with respect to the speed of changes in the environment.

structure can be considered as a forerunner of a *model*, a model ‘an sich’ and not a model ‘für sich’ as Hegel would have said[13].

- The program of biology thus consists of ***describing***, that is using a feature *not available to all* living systems, those dynamics that concern *all* living systems. So while these observers - as living systems - are themselves part of the described object of investigation, they use an activity (language) that is *partially external* to this object[14].

The last point in this list is the starting point to introduce **ET2**, evolutionary theory of the human species. What seems to constitute the human primary metabolism is the ability to raise the primitive modelling capacities implicit in the structure of populations of earlier species to a level that allows for exchange of models in brains (internal models) and models in common language (external models). The primary metabolism now is enhanced and evidently proved to be extremely successful (see figure 3).

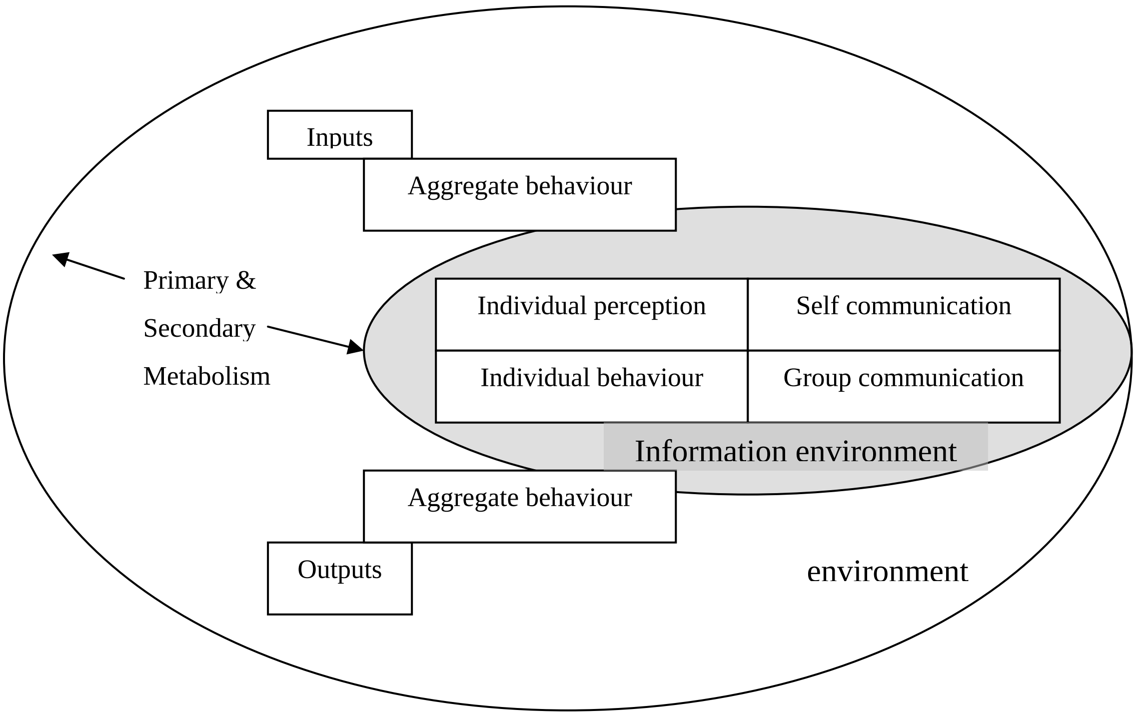

Figure 3: Human Metabolisms

Indeed the human species managed to become the dominant species on earth, turning co-evolutionary dynamics partially already existing in pre-human populations into many *dominated* co-evolutions favouring mankind.

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[13] In German the word ‚Model’ is also used for forms in which adobe or other plasticine is put to assume the (negative) form of it. With roles mirrored (i.e. form correlates to environment, plasticine correlates to entity structure) this is a perfect metaphor for this ancestor of human models.

[14] Missing this distinction leads to a biological interpretation of all human activity, a scientific impasse usually called reductionism.

As shown in figure 3, language – or one could also use the concept consciousness – enables a second, embedded metabolism. This second metabolism is a world in which the dynamics of the primary metabolism can be simulated. And these shared and externally and internally memorized simulations foster the emergence of tribes, of behaviour regulating sign systems, figure as means of power substituting crude coercive power, … . In short, they produce a plethora of phenomena, one of them being the scientific economic program of our days. The strand of evolutionary theory studying this development, ET2, therefore is fully endogenous to its own object of investigation and hence always must address the language process explicitly: We, scientific model-builders, have to build models of model-builders.
The tools of our language that we developed till now are far from being adequate. We experienced a specialization of social sciences into sub-disciplines that rather resembles a Diaspora these days. But integration into ET2 is not easy to achieve. Three remarks seem to be appropriate:

- An integration of social sciences into ET2 has to be considered as a program of *political economy* – the classical name of economics. This is so because only economics traditionally treated the secondary metabolism together (as embedded system) with the primary metabolism.
- The large variety of tasks and tools becoming available makes it necessary to split the common work on integration into several economic programs rather than one unifying overall program. To single out these most relevant research frontiers *for integration* is an urgent task.
- There is a revolution in methods in the making. Computer simulation breeds language and implies new approaches to previously untreatable problems. Extending our toolbox of methods is one of the utmost immediate tasks.

Looking back at the title of this paper we are now left with the result that *economic programs* – in the sense discussed so far – are on the agenda. But why should one subscribe to *evolutionary* economic programs? Is this additional adverb only a reminder hinting at the fact that our own existence is the result of evolution? If that was the case, one could easily drop it.

III. Balanced Economic Programs versus Evolutionary Economic Programs

In fact, the term ‘evolutionary’ has been discussed again and again in recent contributions as well as in some historical works, like Veblen and Schumpeter, and still seems to be the most attractive and most exciting element of ‘evolutionary economic programs’. A quick positioning of the concept might explain the excitement about it.

When Newton (1643-1727) invented the differential calculus[15] the world seemed to be describable in a consistent and complete formal way:

$$\frac{dx}{dt} = f(x)$$

If a certain configuration in the real dynamics could be represented in time t by a vector of essential, quantitatively measured variables x, then any future point in time is determined by a set of laws f(x). Science thus simple has to *discover* what the *key variables* are and how the *functions* f(x) look like. One should not underestimate the force of this vision, in particular, it is *not* static. To see this simply assume that some elements of x are growth rates, or that they are growth rates of growth rates, and so on.

The attribute ‘deterministic’ thus sounds a little bit misleading, since the vast majority of such systems due to their size and difficult functional forms (left alone the problems of discovering the correct variables and functions) cannot really be used to determine future states. Furthermore the somewhat later introduced theory of probabilities, compare the work of the Marquis de Laplace (1749-1827) [Laplace, 1951], made available a formal instrument for dealing formally consistently with a variable *escaping* direct regularity – as long as some regularity in the sequence of escapes can be found.

Given all that flexibility of this modern formal apparatus of the 19th century it is rather surprising that a challenging evolutionary view could develop at all[16].

Still, this type of formal reasoning mainly supports what I would call a ***balanced world view***. To use an example: Consider n balls thrown with one strike onto a landscape. Let the landscape contain m local basins of attraction, where balls after some time might end up. Assume further that the landscape reacts a little on the weight of balls, basins becoming somewhat more attractive if there are already many balls in them (interaction with the environment). Give some life to the balls, assuming that they can sense each other and can manage to change their trajectories while they fall (game theory and utility theory). Throw them group after group and study if sets of basins change for certain types of balls (evolutionary stable solutions). Let the wind blow and hard rain fall (stochastic elements). After introducing all these complications one might wonder what type of result was aimed at when the whole enterprise started. And then, suddenly realizing that one is left with an infinite number of possible sets of trajectories (compare the recent fad in game theory), then comes the snag: the assumptions on the relative speed of involved processes. Or more precisely, the assumptions on *infinite* relative speed of some processes to ensure a *single* well-defined

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[15] For an excellent account on Newton’s laws and the methodological implications see Richard Feynman [Feynman R., 1965].

[16] Perhaps it is significant that the founding fathers of evolutionary theory had ***not*** been to involved with the advanced mathematical apparatus of their time. This is even valid for Schumpeter [Schumpeter, 1964 (1911)].

outcome[17]. Application of this trick usually comes under the header of ‘equilibrium analysis’, a forteriori general use of the trick in economics is called ‘general equilibrium theory’. A special subset, namely the one that assumed

- relative speed of utility change and deviation from constant technological progress to be zero,
- all price changes (including interest rate and wage rate) to be infinitely fast and
- accumulation of all possible knowledge of agents already accomplished from the start,

was named for some time ‘neoclassical economics’[18]. Since its re-launch in the early eighties the emerging main competitor, ***evolutionary economics***, has tried to consolidate its different streams by defining itself negatively, just being *not* neoclassical economics. Unfortunately enough, the narrow Perkrustes bed of neoclassical assumptions soon lead former neoclassical theorists to disperse into the wide space of possible ventures with less stringent limitations, so that evolutionary economics lost its defining mirror image. After years of struggle with that problem, this loss could finally prove to be an advantage, since it forces evolutionary economics to spell out a sharpened definition: As described above, even abandoning neoclassical assumptions not necessarily leads to a rupture with the balanced world view. Processes might be more complicated, outcomes less unique and stable[19], but there still might be a result similar to the second law of thermodynamics in physics, i.e. a result not concerned with the emergence of agents, their activities and emerging (temporal) regularities. It is the development of the dimension and the content of the vector of essential variables x that has to be endogenized. The defining characteristic of the term evolutionary thus has to aim exactly at that, just mentioned area.

But how to proceed to get some insight? John von Neumann in his last book [von Neumann J., 1958] shows one possible track: Look at processes in the brain very closely and you will get hints how to shape a language that is able to describe human thought. Evolutionary economics so far has almost completely ignored this research frontier – though it surely is extremely important if one tries to model model-building individuals[20]. Let’s call it the ***brain research frontier***.

Closely linked to this research agenda is the use of computer simulation. The task here is to overcome the limitations imposed by classical mathematical analysis, the type used in

[17] Usually infinite speed is not enough, it also needs certain functional forms which revealingly enough are then called ‚well-behaved’.

[18] Of course, this definition only captures the three most outstanding properties of what is called neoclassic economics.

[19] Disequilibrium macrodynamics, a flourishing new research field, is a recent area close to the borderline to an evolutionary economic program (compare [Flaschel et al., 1997].

[20] This more radical use of research on individual decision making clearly could substitute much of the current hype in experimental economics, which only tries to prove wrong what an already vanished neoclassical clique had postulated decades ago.

mechanics[21]. Again there is a lot of material from pattern recognition (emergence!) to simulation language development waiting to be explored and adapted by evolutionary economists[22]. This is the ***simulation research frontier***.

But the language capable to describe the emergence of neg-entropic waves will itself emerge in interaction with its topics: Innovation theory (nowadays sometimes implicit in industrial organization theory) and theories about the emergence of institutions (institutionalism probably is a term much to loaded with historical confusions) are and should provide milestones along which evolutionary theory can develop. A major impact thus can be expected from what I would call the ***meso-economic research frontier***.

As the latter research frontier is already heavily leaning on empirical observations, it is straightforward to take one further step to define an ***evolutionary economic policy research frontier***. To test what is developed theoretically by consulting on all economic policy levels is not only a necessity to get research funded. For ET2, which is not discovering eternal laws but rather is probing new mechanisms of political economy (mechanism design, auction theory), these tests are part of research itself – not just ex-post justification. Unfortunately this area is currently one of the least developed ones.

Finally, and admittedly as a matter of personal taste, three central concepts, namely '***utility***', '***money***' and '***power***', whose evolution escaped the balanced world view almost completely should be emphasized in evolutionary economics. Not limiting research on just these three one could form a ***basic concepts research frontier***.

This list surely is not exhaustive. In particular it omits some overlapping general topics like drawing conclusions from comparisons between ET0, ET1 and ET2 (compare Witt's 'continuity hypothesis [Witt U., 2003]). Comparisons span over wide ranges of disciplines anyway, thus the transdisciplinary character of evolutionary economic programs need not be mentioned explicitly: Anthropologists studying different societies at different stages of development might contribute to theories on the long-run dynamics of primary metabolisms. Physicists studying Parrondo's paradox [Harmer G. et al., 2000] as a symmetry breaking ratchet might contribute to our understanding of symmetry breaking decision making in political economy, or in the emergence of the so-called free will of individuals[23].

As these examples show, evolutionary economic programs are not only challenging, their wide and inspiring new battle fields are fun. They should, and to some extent already do attract many new students as well as several scholars from neighbouring scientific areas – and surely some homeless intellectuals. What is important too, is that research funds find it more

[21] A long time ago already Emannuel Farjoun has shown how backward economic analysis even with respect to the use of mathematics in physics itself is. Even the apparatus of stochastic mechanics is not really digested.

[22] Artificial Life has been a fashion for some time but probably had more appeal for sociologists than for economists. For the latter the major drawback probably stems from the simplistic assumptions about model building capacities of masses of homogenous agents in AL (compare [Langton Ch., 1995]). In this respect game theory seemed to offer more plausible approaches. But future AL is not bound to follow this track.

[23] This idea will be worked out in a forthcoming paper [Hanappi, 2003].

and more interesting to support ET2. One major reason for that trend seems to be the disappointment with mainstream economic theory, in particular general equilibrium theory (in its anti-deluvian form, not as CGE), which proved to be a best practice example of sterile, academic ivory tower activity. Some evolutionary economic programs will have to use state of the art tools to fill this gap and meet some of the challenges formulated by the practioneers outside academia. Other evolutionary economic programs will concentrate on the development of basic concepts and methods to be used by the other programs. ***Evolutionary principles thus should be applied to the development of evolutionary economic programs themselves*** – there are relatively stable elements but they are in permanent interchange and flux.

Conclusion

This paper set out to provide a vision concerning evolutionary economics[24]. As the last section concluded, this vision turned out to be homomorphous to the subject studied by it: The parts, called evolutionary economic programs, process like organs in the evolution of an organism. Special emphasis was given to the development of an evolutionary language, which was suggested to follow the track of simulation environments.

In several respects the argument was vague. Though vagueness never should be considered as an independent virtue - if issues still are not completely clear a vague and stimulating mentioning of the problems has to be preferred to noble silence waiting for secretly worked out final solutions. In the same spirit, hints at large research fields that are not further used in the argument should not be misinterpreted as simple name dropping. The literature behind *is* important and *must be* studied in detail, hints are to be understood as teasers. ‘Deficiencies’ of this sort have been pioneered by Schumpeter, and earned him the title of a footnote economist who never managed to found an economic school. I hope the vision put forward in this paper explains why these are not deficiencies but necessary and advantageous properties of an evolutionary science ET2.

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[24] In several respects this view overlaps with recent work of Kurt Dopfer [Dopfer K., 2003].

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