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TOWARDS A THEORY OF ECONOMIC DEVELOPMENT[*] WITHOUT THE OWL OF MINERVA[**] AN OUTLINE & A SUMMARY[♦]

Abstract

I attempt to outline a strategy for modelling economic development without growth theory[***], thus returning it to its own noble, independent, traditions Formal growth theory -- whatever its origin -- is shackled to an equilibrium benchmark that, in turn, binds its visions for development modelling within narrow, ahistorical, anti-empirical and completely unrealistic paths. The reasons for this unnaturally `eternal braid' between development models and growth theory are partly due to historical accidents and, mainly, due to a particular kind

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[**] Perceptive and knowledgeable readers would infer, first, that I have chosen this title with Hegel's sad indictment of philosophy's penchant for being useful only with hindsight - except that one should read that famous penultimate paragraph in the *Preface* to the **Philosophy of Right**, replacing `philosophy' with `growth theory' (see next page). Second, there is also the obvious influence of Lord Kaldor's *'Okun Memorial Lectures'*, delivered at Yale University in October, 1983: **Economics without Equilibrium**, (Kaldor, 1985). Kaldor was my first thesis supervisor at Cambridge, just about the time he began his systematic critique of `equilibrium economics', going much beyond his `capital theoretic' criticisms of aggregate neoclassical theories of growth and distribution (cf. for example, Kaldor, 1972).

[♦] Dedicated to the memory of Gunnar Myrdal, a reading of whose monumental 3-volume study of the 'Asian Drama', in the exciting, turbulent year of 1968, was instrumental in shunting me from the study of the sciences to economics.

[***] This is what is meant with the allusion to *'The Owl of Minerva'* in the title. The point I wish to emphasise is that formal growth theory, of any variety, has never succeeded in being useful, except with hindsight - ex post, so to speak. Hegel chided philosophy -- read growth theory -- for being so in that famous penultimate paragraph of his Preface to **The Philosophy of Right**: *"One more word about teaching what the world ought to be: Philosophy always arrives too late to do any such teaching. As the thought of the world, philosophy appears only in the period after actuality has been achieved and has completed its formative process. The lesson of the concept, which necessarily is also taught by history, is that only in the ripeness of actuality does the ideal appear over against the real, and that*

of mathematical somnambulance. The proximate causes for these infelicities are stated with some substantiation and reasons given for an alternative modelling approach -- together with an outline of model for development without any reliance on any form of growth theory.

JEL CLASSIFICATION: O1

KEYWORDS: GROWTH; DEVELOPMENT; AGENT

1. Introduction

"You will be speaking of «The Econometric Approach to Development Planning». This is the theme of your study week, a theme which seeks to gather together the latest results of a new branch of science, econometry, and to present them to political economists in order to aid them in formulating those plans for a more stable security and for greater development which can contribute so much to the well-being and peace of nations", Pontificia Academia Scientiarum, 1965, p. xxxvii.

A little under fifty years ago, on October 7–13, 1963, at the *Pontificia Academia Scientiarum*, eighteen outstanding economists presented scientific studies, during a *Study Week* on **The Econometric Approach to Development Planning** (*ibid*). A measure of the significance of the economists and econometricians who presented their visions on The Econometric Approach to Development Planning on that occasion can be gauged from the fact the seven of them went on to become Nobel Laureates.

Development Planning was very much a topical issue, both in practical policy terms and formal analytical terms in economic theory. In

growth theory, the golden age of golden rules of accumulation had just been heralded and optimal control theory and dynamic programming models were unifying the planners and market adherents on both sides of the cold war. Prime Minister Hayato Ikeda had launched the income doubling plan for a resurgent Japanese Economy. Prasanta Chandra Mahalanobis, the father of the Indian Planning experiments, now irreversibly abandoned, spoke at the Study Week in broad, visionary, enlightened terms on the aims for *'The Social Transformation for National Development'* by means of economic development – the subject to which we have now returned, here, in the same city, under the auspices of the identical august body.

Remarkably, one of the contributions at that Study Week in the Vatican, the one by Tjalling Koopmans: On the *Concept of Optimal Economic Growth* (pp. 225-300), provided the mathematical economic foundations for the kind of growth theory that dominates current orthodoxy. Koopmans revived a noble tradition of growth theory, underpinned also by ethical and political considerations of intergenerational issues, initiated by Frank Ramsey in 1928 and reconsidered by Jan Tinbergen (who was present at *The Study Week*) and Richard Goodwin, in the late 1950s.

Sadly, the ethical considerations that had prompted Frank Ramsey to be wary of discounting the future, in mathematical models related to optimal control – at the time Ramsey wrote it was the mathematics of the calculus of variations that was being applied - seems to have got lost in the intervening years. The 'Euler equation' - and its dynamic programming counterparts, the Bellman equation, the Value Function, and so on – are routinely derived by second year undergraduates, without the slightest ethical blot on their conscience about the discounting of intergenerational welfare.

In an unintended sense, then, at least one - but, in fact, more than one - of the famous contributions to *The Study Week* has been 'immortalized' in the orthodox growth literature of economics and, thereby, inadvertently no doubt, shunted the resurgent development economics to be underpinned by the irrelevant formalities of *The Owl of Minerva, blind to ethics*, epistemologies and phenomenological indeterminacies.

My reading and reflections of the contributions to *The Study Week*, and their unintended impact on subsequent research and consolidation of

a vision for growth theory and, eventually, also for a crippled theory of development, can be summarised in the following way. Growth theory became formal and narrowly technical and lost its anchoring in the moral sciences and thereby became devoid of philosophical, epistemological and ontological significance. Hence, to the extent that any theory of development was underpinned by growth theory, it shared these deficiencies. More importantly, from an epistemological point of view - and, perhaps, also methodological - *the uncertain, undecidable, complex, incomplete, unsolvable* dimensions[1] of development theory and policy were short-circuited by a reliance on trivially applicable mathematics, wholly without significance for the monumental issues that have to be tackled in a theory of development. Above all, the element of humility that accompanies uncertain, tentative, undecidable, comples, incomplete, indeterminate dimensions, has been pawned to a formalization that has undressed the Emperor.

The agenda I set for a theory of development is in the spirit of what was attempted in the decade and a half, between 1943–1958, an 'era' our most recent Nobel Laureate has felicitously (and correctly, in my view) termed the period of High Development Theory (see, section 3, below). I aim to reformulate theorising about development in the Polya-Simon framework of Problem Solving, where economic development is formalized as a Combinatorial Decision Problem, thus unshackling it from orthodoxy's senseless adherence to an unrealistic mathematics and a non-applicable, non-empirical, epistemology.

The three pillars on which I try to erect my structures are provided by Polya-Simon, Michael Polanyi and Schumpeter. From Schumpeter, who I consider to be my intellectual grandparent, via Richard Goodwin, I extract a vision and a conceptual underpinning, orthogonal to orthodox economic theory, for theorising about economic development. Michael Polanyi's 'tacit dimension' in knowledge and its epistemologies provide me with the philosophical basis for introducing the purely personal, human, dimension in formalising decision problems in all its rich indeterminacies. Finally, the formalization of economic development as a Combinatorial Decision Problem is inspired by the Polya-Simon methods of human and organisational problem formulations and their algorithmic

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[1] I invoke these concepts in their strict model, proof and recursion theoretic senses.

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underpinnings. This latter line of thought and attack allows me to appeal to the mathematics of constructive and computable analysis – a world of mathematics rich in indeterminacies, undecidabilities, unsolvabilites, uncomputabilities and incompleteness.

These formal worlds allow me to return the tradition of theorising about economic development by the phenomenologists, epistemologists and the philosophers, who have a more humane and humble vision of human and institutional possibilities.

2. An Agenda

"By 'development', ... we shall understand only such changes in economic life as are not forced upon it from without but arise by its own initiative, from within. ... [T]he mere growth of the economy, as shown by the growth of popu-lation and wealth, [will not] be designated here as a process of development. ... Development in our sense is a distinct phenomenon, entirely foreign to what may be observed in the circular flow or in the tendency towards equilibrium. It is spontaneous and discontinuous change in the channels of the flow, distur-bance of equilibrium, which forever alters and displaces the equilibrium state previously existing. Our theory of development is nothing but a treatment of this phenomenon and the processes incident to it", Schumpeter ([1911], 1934), pp. 63-4; italics added.

Theorising in economic dynamics has always been enriched by ima-ginative - albeit misleading - metaphors and analogies. From Wicksell's careful use of the 'Rocking Horse' metaphor, incorrectly attributed and inappropriately invoked by Frisch, and utilised by all and sundry working within the real business cycle and newclassical paradigms, all the way through Swan and his *Meccano sets* and, now, Romer with his appeal to a child's *Chemistry set*, growth theory - with developmental pretensions - in particular has been replete with them. I shall follow this tradition and invoke three such metaphors for suggesting a way to model economic development without any underpinnings in formal growth theory: the *Jigsaw Puzzle, Chess* and the *game of GO*.

2.1 Schumpeterian Precepts for Modelling Development

Very soon after arriving at the European University Institute for a few happy years of a Professorial stint, not least due to - and because of - the presence of Richard Goodwin in neighbouring Siena, I took the chance to invite him to give us a talk on Schumpeter, which he did under the uncharacteristic -- for the austere scholar he was -- title: *Schumpeter - The Man I Knew*[2]. In these very personal reflections on Schumpeter there was an almost throwaway remark on a particular modelling metaphor that has, in recent years, been severely 'bastardized' by endogenous and evolutionary growth theorists[3], the notion of 'creative destruction': *"[I]t came as a great shock to me to find that in the very last paper he ever wrote, before dying in his sleep in his home at Taconic, he said the future of research lay in the study of the records of the great business enterprises – no mention of econometric model building and testing.*

Now after many years, and in view of the poor results of model building, I sympathise much more with his point of view and see it as the logical culmination of his own unique contribution. Like Marx he was a student of the morphogenetic nature of capitalism. The economy is not a given structure like von Neumann's model, or a collection of hydrogen atoms, it is an organism perpetually altering its own structure, generating new forms. Unlike most organisms it does not exhibit durable structural stability: it is perhaps best thought of as [being in] a kind of hyper-Darwinian, perpetual evolution. We are so familiar with it, we normally do not realize how remarkable it is. It is not like morphogenesis in animals and plants, where the species is programmed to generate a particular structure, and exhibits structural stability by creating the same form for thousands of years. Rather it is analogous to the much disputed problem of the generation of new species.

The economy is unsteadily generating new productive structures. In this sense Schumpeter was profoundly right to reject the elegant new mathematical models: they are the analysis of the behaviour of a given structure. He saw that not only was the economy creatively destroying parts of its given structure, but

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[2] For several years it circulated in a proverbial samizdat existence only as an EUI Discussion Paper which, in those early years of the existence of the department of economics, had a very limited circulation.

 With the notable exception of three of the pioneers of evolutionary dynamics in economics: Richard Day, Richard Nelson and Sidney Winter.

also that one could not analyze a given structure, ignoring that this cannibalism was going on", Goodwin, 1989, pp. 107-8; italics added.

Coupling this observation with the guidelines in chapter 2 of *The Theory of Economic Development*, summarised in the extensive opening quote of this section, I infer and suggest that an interesting, rich, meaningful set of criteria for theorising about economic development should be in terms of what I have, in other work, come to call *'undecidable dynamics'*. Within the scope and space constraints of this paper I cannot even begin to outline the formal mathematics of undecidable dynamics and will have to resort to self-referencing, however un-humble such an act must be[4]. The notion and mathematics of undecidable dynamics goes far beyond the ordinary richness of nonlinear dynamics and this is because of the way nonlinear dynamics is coupled - in a formally equivalent, dual, way - to classical recursion theory and, thereby, made amenable to issues of decidability, incompleteness, unsolvability and uncomputabilty (an example of which is given in the penultimate section, below).

2.2 High Development Theory - an Interregnum

"It will become apparent that what I identify as `high development theory' is essentially the nexus among the external economy/balanced growth debate, the concept of linkages, and the surplus labor doctrine. This theory's golden age began with Rosenstein-Rodan (1943) and more or less ended with Hirschman (1958). Obviously this nexus does not cover all of what was happening in the field of development economics even at that time, but it is the core of what I believe needs to be recaptured", Krugman (1993), p.16; italics added.

The architects of High Development Theory (HDT), in the sense in which Krugman has defined the field, were Rosenstein-Rodan, Hans Singer, Raul Prebisch, Harvey Leibenstein, Richard Nelson, Gunnar Myrdal and Albert Hirschman – but the inclusion of Jan Tinbergen, Ragnar Frisch, Ragnar Nurkse and Arthur Lewis to this pantheon will not be incongruous in any sense at all. That Schumpeter is not included in this list, especially since Hans Singer was seriously motivated by his early studies under him (and Spiethoff and Keynes), and also Nurkse took the Schumpeterian vi-

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[4] I refer, with sincere apologies, to my forthcoming text on *Computable Foundations for Economics* (Routledge, 2009), for detailed discussions of the mathematics of undecidable dynamics.

sion seriously, is anomalous. I suspect that this was because Schumpeter's Theory of Economic Development was not interpreted as applying to economies that were still in the early stages of 'capitalistic maturity' (but cf. Laumas, 1962, and the references cited therein, for a dissenting view). Moreover, the appropriation of the Schumpeterian vision by the evolutionary theorists may have also contributed to the lack of attention paid to the applicability – indeed, the richness - of the conceptual framework for the problems of economic underdevelopment.

Be that as it may, summarising the Krugman 'thesis' on HDT in a concise way, we have (all quotations are from Krugman, op.cit, pp. 15-16; italics added):

• *"Once upon a time there was a field called development economics - a branch of economics concerned with explaining why some countries are so much poorer than others and prescribing ways for poor countries to become rich. In the field's glory days in the 1950s, the ideas of development were regarded as revolutionary and important and commanded both great intellectual prestige and substantial realworld influence. Moreover, development economics attracted creative minds and was marked by a great deal of intellectual excitement"*.

• *"That field no longer exists ..."*.

• *"And very few economists would now presume to offer grand hypotheses about why poor countries are poor or what they can do about it. In effect, a counterrevolution has swept development economics away. [T]he counterrevolution went too far. [D]uring the 1950s a central core of ideas emerged regarding external economies, strategic complementarity, and economic development that remains intellectually valid and that may continue to have practical applications. This set of ideas ... I will refer to as 'high development theory'"*.

• *"High development theory anticipated in a number of ways the cutting edge of modern trade and growth theory. But high development theory was virtually buried, essentially because the founders of development **economics** failed to make their points with sufficient analytical clarity to communicate their essence to other economists ... . Recent changes in economics now make it possible to reconsider what the development theorists said and to regain the valuable ideas that have been lost. In other words, [I] call for a counter-counterrevolution in development theory"*.

The essential point that Krugman wants to highlight is quite simple: the economic concepts that were at the core of the theorising exercises

of the HDT theorists - *increasing returns to scale, complementarity, extent of the market, multiple equilibria with low level equilibrium traps in poverty,* all classic Smithian themes by any other name - were not amenable to mathematical modelling with the kind of mathematics that was routinely available to the mathematical economist, or even in mathematics. Hence, the theories of the HDT era were not formulated and formalised in a language intelligible to the increasingly mathematised conventional economist. Therefore, the rich content of the HDT theorist was thrown away with the in the proverbial 'baby & bathwater' mode.

Now, with the increasingly sophisticated availability of nonlinear and combinatorial mathematical tools, even to the graduate student in mathematical economics, and given that fields considered adjacent and complementary to development economics – such as industrial organisation theory, international economics and growth theory – have begun to utilise these tools, a time may have come for a reconsideration of the contents of the HDT era.

The catch, however, is this: *equilibrium* rules and *processes* do not! The cardinal Schumpeterian desiderata are relegated to footnotes or afterthoughts or appendices. Of course, a nonlinear model, for example encapsulating the 'Big Push' idea of Rosenstein-Rodan, does entail multiple equilibria - but the *path*, as a *process*, from, say a low level economic equilibrium, to one that is rich in economic possibilities, is added as an *ad hoc* mechanism, not part of the intrinsic dynamics of the model. It may be useful to recall a pungent 'warning' by Schumpeter, on this particular issue:

"*[W]hat we are about to consider is that kind of change arising from within the system which so displaces its equilibrium point that the new one cannot be reached from the old one by infinitesimal steps. Add successively as many mail coaches as you please, you will never get a railway thereby*", ibid, p. 64; italics in the original.

This is one of the ways in which the conceptual richness of the HDT period has been emasculated - by forcing them into a straitjacket of a mathematics that was not rich enough to encapsulate the nuances that accompanied the subtle non-economic constraints that Myrdal, Nurkse, Singer, Prebisch, in particular, had in their treatises. Above all, not even the ordinary nonlinear mathematics to which Krugman appeals

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can begin to encapsulate the kind of *complex dynamics* envisaged in Schumpeter's vision for a theory of development - in the form of *'hyper-Darwinian evolution*[5].

Finally, the policy prescriptions, in the form of strategies for economic development, on the basis of these multiple equilibrium, non-algorithmic, pseudo-dynamic, optimization models fall into the standard categories - most notably, concentrate on increasing return sectors, industries or regions, and admonish the politician and the applied economist to recommend the establishment of the appropriate organisational structure so that such 'economies' can be exploited.

That old hobby- horse, reigning during the heyday of optimal planning exercises, 'turnpike theorems', is not even mentioned in footnotes, these days! That is the extent to which processes have been removed from the discourse of this kind of attempt at a rejuvenation of HDT, whose *raison d'être* was, in fact, the primacy of (disequilibrium) processes.

2.3 New Growth Theory - an Aberration

"All these pretty, polite techniques, made for a well-panelled Board Room and a nicely regulated market, are liable to collapse. At all times the vague panic fears and equally vague and unreasoned hopes are not really lulled, and lie but a little way below the surface", Keynes (1937), p. 215.

I shall summarise one strand of New Growth Theory, simply to indicate, as concisely as possible, why any such framework is wholly inappropriate for providing foundations - or even act as a handmaiden to – for a theory of economic development in particular, for a Schumpeterian vision of economic development. I shall construct my 'strawman' with the material and framework provided by Romer's approach, although I could equally well and easily have resorted to the Lucasian models. Only the details would differ between the two; the fundamental infelicities are identical.

I shall summarise my critique in a schematic form, to highlight the infelicities – at least from the point of view of one who is interested in the kind of theory of economic development advocated by Schumpeter.

[5] The analogy would be with models of 'hyper computation', but this is a subject that requires much more serious space for even a simple explication within the narrow scope of this paper.

Romer's Methodological Credo: 1

• Growth is a general eq^m process; ∴ , a growth theorist must construct a **dynamic general equilibrium** model underpinned by explicit specifications of preferences, technology and an equilibrium concept.

• The mathematical tool to be used in the characterization of dynamic **competitive** equilibrium models should be the Kuhn-Tucker theorem since it offers a procedure for reducing the problem of **calculating** competitive equilibria to that of **solving** a maximization problem.

• Of all the policy questions concerning growth, the most fundamental is whether there are any policies that an *omniscient, omnipotent, benevolent social planner* could implement to raise the welfare of all individuals in an economy; i.e., in formal terms, the question is *whether or not equilibria are Pareto optimal.*

• To treat this question seriously, economists must generate a set of models with Pareto optimal & Pareto suboptimal equilibria, s.t., policy questions w.r.t growth facts can be reduced to a choice from such a set.

The 'High Point' of Romer's Methodological Credo: 2

• Given the equivalence between saddle points and competitive equilibria, the economic theoretical implication of the Kuhn-Tucker theorem is:

• The sufficient conditions of the theorem embody the *First Fundamental Theorem of Welfare Economics*: i.e., **competitive equilibria are Pareto optimal**.

• The necessary conditions of the theorem imply the Second Fundamental Theorem ofWelfare Economics: i.e., for any Pareto Optimally determined quantities, <u>there exists</u> *a price system that decentralizes these quantitites as a competitive equilibrium.*

A Romer-inspired formalization of a Representative Agent Growth Theory

Consider a generic constrained maxmization problem Þ:

Max f_0 (x), s.t x ∈ Ω; f_1(x) ≥ 0, f_2(x) ≥ 0, ..., f_m(x) ≥ 0

To apply the Kuhn-Tucker theorem to Þ,

$f_0(x)$ must be concave and the constraint set, defined by the inequality constraints, $f_i(x) \geq 0$, $\forall i=1, ..., m$, must be convex.

$\mathcal{L} : \Omega \times R^{\tau} \rightarrow R$ *by the rule*

$$\mathcal{L}(x, \lambda) = f_0(x) + \sum_{i-1}^{m} \lambda_i f_i(x)$$

This function is concave convex:

1. When x is held fixed held fixed, the function $L_\lambda(x)$ that sends x to $\mathcal{L}(x, \lambda)$ is a convex function;

2. When λ is held fixed held fixed, the function $L_x(x)$ that sends λ to $\mathcal{L}(x, \lambda)$ is a concave function;

3. i.e., $\mathcal{L}(x, \lambda)$ is a saddle function;

4. The essential content of the Kuhn-Tucker theorem is: saddle points of $\mathcal{L}$ are equivalent to solutions to Þ;

5. This translates into an equivalence between: saddles points for Lagrangians and equilibria for competitive economies.

The Methodological foundations of New Growth Theory

Given the equivalence between *saddle points* and *competitive equilibria*, the economic theoretical implication of the Kuhn-Tucker theorem is:
The sufficient conditions of the theorem embody the *First Fundamental Theorem of Welfare Economics*: i.e., **competitive equilibria are Pareto optimal** => *The Benevolent Central Planner* in action.
The *necessary conditions* of the theorem imply the **Second Fundamental Theorem of Welfare Economics**: i.e., for any Pareto Optimally determined

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quantities, **there exists** *a price system that decentralizes these quantitites as a competitive equilibrium* => *The Invisible Hand in action.*

Proposition
Theorising for Economic Development with *The Owl of Minerva* is dangerous - whether in daylight or in darkness.

Remark
As a matter of fact, I can state and prove a formal theorem encapsulating the slightly playful-looking 'proposition' stated above. Indeed, a series of theorems – or, in true mathematical style, a series of Lemmas, culminating in a theorem – beginning with formal proofs of the non-effectivity and non-constructivity of the two fundamental theorems of welfare economics and going on to a demonstration of the computational complexity of the algorithms used in the implementation of the Kuhn-Tucker theorems. The formal results would make it clear that Romer's (and Lucas's and Prescott's and all their followers and side-kicks) *omniscient, omnipotent, benevolent social planner* would need to invoke nothing less than divine grace and power to *implement efficient policies raise to the welfare of all individuals in an economy.*

Surely, divinity expects more and better from us, as economists!

Let me, however, end with the sane thoughts of a pioneer visionary growth theorist, who was also an 'insider' to the HDT era: Richard Nelson. In his stimulating new book, he wonders, perceptively:

"To the extent that formalization of important and previously unformalized understandings about technical change and economic growth defines an important part of the agenda for the new growth theorists, it seems useful to ask why certain ideas have been picked up and formalized and others not ... . The answer, I believe, is that another part of the agenda of the new growth theory, or a constraint pm that agenda, is to hold the modelling as close as possible to the canons of general equilibrium theory. Romer ... states this explicitly, and the form of the models that have been developed by others suggests that they too hold this as an objective or constraint. However, it certainly seems relevant to think a little about what is gained and what is lost by operating under this constraint" (Nelson 2005, p. 12).

My attempt at answering just this question, but from the point of view of a theory of economic development, is outlined above.

2.4 Old - Optimal Growth Theory - a Reflection

"A More specific optimality concept is implied in the strictures of Professor Harrod ... and of Frank Ramsey ... against any discounting of future utilities. These authors leave little doubt that they regard only equal weights for the welfare of present and future generations as ethically defensible", Koopmans, op.cit, p. 226; italics added.

I digress slightly, to return to themes taken up in the Preamble, and to make a link with the previous Vatican meeting which discussed similar issues. For this I present a textbook version of the violation of the ethical spirit and the mathematical warnings of Frank Ramsey - just so that readers can wonder, from yet another point of view, whether there is any point in the whole exercise of formal growth theory as a basis for a theory of economic development. After all, a theory of economic development devoid of ethical concern is almost more meaningless than that proverbial allusion to 'Hamlet without the Prince' - especially in these days of intertemporal concerns that have a global reach.

<u>Frank Ramsey's Two Strictures of 1928 & 1926</u>

• "One point should perhaps be emphasized more particularly; it is assumed that we do <u>not</u> discount later enjoyments in comparison with earlier ones, a practice which is *ethically indefensible and arises merely from the weakness of the imagination; ... ."*

• "Nothing has been said about degrees of belief when the number of alternatives is *infinite*. About this I have nothing useful to say, except that *I doubt if the mind is capable of contemplating more than a finite number of alternatives*. It can consider questions to which an infinite number of answers are possible, but in order to consider the answers it must lump them into a finite number of groups. The difficulty becomes need to introduce it. We can discuss whether past experience gives a high probability to the sun's rising tomorrow without bothering about what probability it gives to the sun's rising each morning for evermore",

Frank Ramsey: Foundations – Essays in Philosophy, Logic, Mathematics and Economics, p 261 & p.85.; emphases added.

Violating the Ramsey Strictures in the Ramsey-Koopmans Textbook Growth Model

Society, whether developed, developing or underdeveloped, is represented by one superrational, infinitely-lived, economic agent, whose optimal decisions underpin the trajectory of every kind of economy – optimally. The general framework is as follows (I follow, quite literally, the presentation in the well-known advanced macroeconomic textbook by David Romer):

The Household's Utility Function is:

$$U = \int_{t=0}^{\infty} e^{-\rho t} u\big(C(t)\big) \frac{L(t)}{H} dt \tag{1}$$

where: u is the instantaneous utility function, depending on consumption $C(t)$, at time t; H and $L(t)$ are # s of member in a household and total population, respectively.

Hence, $u\big(C(t)\big)\dfrac{L(t)}{H}$: the representative household's instantaneous utility at t; ρ: (subjective) discount rate;

Assume: $u\big(C(t)\big) = \dfrac{C(t)^{1-\theta}}{1-\theta}$, $\theta > 0$ & $\rho - n - (1-\theta)g > 0$ (2)

A constant relative risk aversion utility because the coefficient of relative risk aversion, $-C u''(C)\big/ u'(C)$, for this u is θ; i.e., independent of C.

The Household's Budget Constraint:

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$$\int_{t=0}^{\infty} e^{-R(t)} C(t) \frac{L(t)}{H} dt \le \frac{K(0)}{H} + \int_{t=0}^{\infty} e^{-R(t)} W(t) \frac{L(t)}{H} \qquad (3)$$

Rewriting =>

$$\frac{K(0)}{H} + \int_{t=0}^{\infty} e^{-R(t)} [W(t) - C(t)] \frac{L(t)}{H} dt \ge 0 \qquad (4)$$

This is equivalent to:

$$\lim_{s \to \infty} \left[\frac{K(0)}{H} + \int_{t=0}^{s} e^{-R(t)} [W(t) - C(t)] \frac{L(t)}{H} dt \right] \ge 0$$

Now, the household's capital holdings - wealth - at time *s* are:

$$\frac{K(s)}{H} = e^{R(s)} \frac{K(0)}{H} + \int_{t=0}^{s} e^{R(s) - R(t)} [W(t) - C(t)] \frac{L(t)}{H} dt \qquad (5)$$

Hence, the budget constraint can simply be written as:

$$\lim_{s \to \infty} e^{-R(s)} \frac{K(0)}{H} \ge 0 \quad \text{(the no Ponzi game condition)} \qquad (6)$$

Defining $c(t) = \dfrac{C(t)}{A(t)}$ and using $L(t) = L(0) e^{nt}$, we get:

$$U = B \int_{t=0}^{\infty} e^{-\beta t} \frac{c(t)^{1-\theta}}{1-\theta} dt \qquad (7)$$

where:

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$$B = A(0)^{1-\theta}\frac{L(0)}{H} \quad \& \quad \beta = \rho - n - (1-\theta)g \quad \& \quad \beta > 0$$

The budget constraint (3) can be rewritten as:

$$\int_{t=0}^{\infty}e^{-R(t)}c(t)e^{(n-g)t}dt \le k(0)+\int_{t=0}^{\infty}e^{-R(t)}w(t)e^{(n+g)t}dt \qquad (8)$$

Where, *w(t)*: wage per unit of effective labor & *k*: capital per unit of effective labor.

Since, $K(s) \propto k(s)^{(n+g)s}$, the no Ponzi game version of the budget constraint becomes:

$$\lim_{s\to\infty}e^{R(s)}e^{(n+g)s}k(s) \ge 0 \qquad (9)$$

Finally, therefore, the household's optimum decision problem is: Choose the path of *C(t)* to maximise lifetime utility e utility (7), subject to the budget constraint (8).

Although I have reproduced, faithfully, an advanced textbook version – ostensibly aimed at graduate students - of the staple diet being fed to the formative minds of economists, this is the kind of violation of explicit *Ramseyan* ethical and mathematical strictures that is also routinely presented to advanced undergraduate students. How, then, can one expect to devise a theory of economic development on such a basis for growth theory?

2.5 A New Development Economics

"Some three decades ago ... S.N. Eisenstadt wrote that 'historically, modernization is the process of change towards those types of social, economic and political systems that have developed in Westrern Europe and North America from the seventeeth century to the nineteenth.' ... [S]uch a view now appears untenable to even its author. And yet where are we to go from here? Clearly, the historians of Japan are at a considerable advantage in the sense that the Japanese are at a considerable advantage in the sense that the Japanese historical

tradition itself has long insisted on the singularity of Japanese 'modernization,' deeply rooted in specific institutions but still 'comparable' in some sense to the received Western model. The bottom line, which makes this vision credible, is the 'Japanese 'bank balance''', Subrahmanyam (1998), p. 99.

What I have come to call *The New Development Economics*[6] is defined and circumscribed by the serendipitously simultaneous appearance of three facts of economic life, at the dawn of the 1980s:

I. The apparent sudden emergence of a new group of inter-related Asian 'Tigers' as fully fledged members of the league of developed nations - Singapore, Hong Kong, Taiwan and Korea (South). This was the first such 'emergence' since the 'miracle' of Japan, many decades earlier, indeed at the dawn of the Showa era.

II. The 'sudden' completion of the UN-ICP program on internationally comparative national income data, in the form of the Penn World Tables.

III. The emergence of New - Endogenous - Growth Theory, going beyond the early Neoclassical models of (optimal) economic growth.

The characteristic feature of the simultaneous - serendipitous - appearance of the above three historical facts, statistical richness and a growth theoretical framework, each reinforcing the validity of the other, was embraced with immense enthusiasm by the economic profession, bent on making the subject truly 'scientific' - i.e., capable of experiments and prediction on a sure footing.

A quarter of a century has elapsed since these serendipitous events dominated and excited the theoretical, applied and policy wings of the economics profession.

I do not find it credible to believe that the three great events listed above have anything to do with each other - either as a matter of fact, history or theory. Let me explain.

Firstly, never in these many years has there ever been the slightest investigation of the methods, sources, consistency and theory of the construction of the data that comes out of the 'Penn World Table' stables. This author took it upon himself to investigate the mathematical

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[6] Not a little influenced by the appearance of New Classical Economics, New Growth Theory, the New Institutional Economics ... . and many other such 'New' prefixed fields of economics.

foundations of the construction of the index numbers that underpin the Penn World Table data and was appalled to find that the generated numbers have nothing to do with the claimed theoretical foundations for the construction of them[7].

Secondly, there is very little evidence that any of the 'Tigers' – and certainly not Japan in its transition from Tokugawa Feudalism to the Meiji Restoration and, then, through the Taisho and Heiwa eras – emerged as powerful economies following the policy precepts of New Growth Theory.

Finally, as I have discussed in the previous sub-sections, nothing in the structure or framework of New Growth Theory can justify it as providing a foundation for a theory of economic development.

2.6 Towards a Combinatorial Formulation of a Theory of Economic Development

"The key step in understanding economic growth is to think carefully about ideas. This requires careful attention to the meaning of the words that we use and to the metaphors that we invoke when we construct models of growth. After addressing these issues, [I describe] … ways in which ideas can contribute to economic development", Romer (1993), p. 63; italics added.

The background

In two recent publications Paul Romer broached new visions for an understanding of the growth and *development* processes in widely differing economic systems (Romer, 1993a, 1993b). Romer points out that the conventional modelling of growth processes are deficient in their incorporation of the role and genesis of *ideas*. To rectify this deficiency he proposes an economic definition of *ideas* based, *inter alia*, on a distinction between their use and their production. These definitions have an evolutionary and algorithmic underpinning to them; moreover, the institutional setting in which ideas are used and produced are also given an evolutionary basis.

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[7] In an envisaged expanded version of this paper I shall endeavour to outline and substantiate this claim in some mathematical detail.

For the formal definition of an idea Romer resorts to the imaginative metaphor of toy chemistry sets[8]. Such sets typically consist of 'a collection of N jars, each containing a different chemical element'. Thus, in a set with N jars there can be at least, say, 2^{K-1} combinations of K elements $(K = 1, ..., N)$. If we move from a child's chemistry set to a typical garment factory of a developing country we might find that, say, sewing a shirt entails 52 distinct, sequenced, activities. There are, thus, $52! = 10^{68}$ distinct ordering of the sequences in the preparation of a shirt. Now, as Romer perceptively notes:

"For any realistic garment assembly operation, almost all the possible sequences for the steps would be wildly impractical, but if even a very small fraction of sequences is useful, there will be many such sequences. It is therefore extremely unlikely that any actual sequence that humans have used for sewing a shirt is the best possible one", ibid, p. 69.

Thus:

"The potential for continued economic growth comes from the vast search space that we can explore. The curse of dimensionality [i.e., $2K-1$; or $52! = 10^{68}$] is, for economic purposes, a remarkable blessing. To appreciate the potential for discovery, one need only consider the possibility that an extremely small fraction of the large number of possible mixtures may be valuable", ibid, pp. 68-9[9]; italics added.

There are some formal problems with these imaginative and interesting observations. First of all, there is the perennial question of the *existence* of a best possible *sequence*. Secondly, even if existence can be proved - in some mathematical sense - it is not clear that it can be discovered and implemented in an operational sense. Thirdly, there *will not* be any feasible way of discovering, *formally*, even the 'extremely small fraction' of sequences that may well be valuable. Finally, even in the unlikely event that all of these issues can satisfactorily be resolved, there is the real question of the *transition* from the currently implemented sequence to a 'more valuable region' of the feasible domain. Unless the currently utilized sequence is in the neighbourhood of the 'extremely small valuable fraction' it is unlikely that a transition makes economic

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[8] Economists of my vintage will recall Trevor Swan's brilliant metaphor of *meccano* sets 'to put up a scarecrow ... to keep off the index-number birds and Joan Robinson herself' (Swan, 1956, p. 343).
[9] This, surely, is a basis for 'learning by doing' emanating from Lundberg's famous 'Horndal effect', made famous by Arrow (1962) and David (1975, ch. 3).

sense in the context of a pure growth model with its given institutional background. **The point at which *development* will have to be distinguished from *pure growth* may well be located in this transition manifold, to be somewhat pseudomathematical about it.**

These problems need not be faced as squarely within the traditional production theoretic framework with its handmaiden, the *book of blueprints*[10]. In the traditional framework, the well defined concepts of the efficient frontier and concomitant best-practice technologies and so on make most, if not all, of the above issues almost irrelevant. But, by the same token, make it impossible to raise the interesting and important issues that Romer is trying to broach. Romer emphasises time-sequenced processes and, hence, must have something more than the *book of blueprints* metaphor for the repository or encapsulation of ideas.

To return to Romer's *ideas* on *ideas*, the casual empiricism of the above two quotes, underpinned by the metaphor of the child's toy chemistry set and its functions suggests, to him, the analogy of ideas as mixtures; or, as each of the potentially feasible $2^{\ }{}^1$ mixtures (i.e., each of the 52! = 10^{68} ways of sequencing the sewing of a shirt):

"Within the metaphor of the chemistry set, it is obvious what one means by an idea. Any mixture can be recorded as a bit string, an ordered sequence of 0s and 1s [of length N] ... [A]n idea is the increment in information that comes from sorting some of the bit strings into two broad categories: useful ones and useless ones ... .

When a useful mixture is discovered ... the discovery makes possible the creation of economic value. It lets us combine raw materials of low intrinsic value into mixtures that are far more valuable. Once we have the idea, the process of mixing will require its own [Production Function] (specialized capital and labour). For example, the bit string representing nylon requires a chemical processing plant and skilled workers. Important as these tangible inputs are, it is still the idea itself that permits the resulting increase in value. In this fundamental sense, ideas make growth and development possible", ibid, p. 68; italics added.

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[10] Obviously, the book must have an 'appendix' instructing the user on the necessity and mode of using the *axiom of choice*. Every indiscriminate reliance on *indexing over a continuum of agents, technologies etc.*, is an implicit appeal to the axiom of choice, or one of its *noneffective* and *nonconstructive* equivalents.

The final metaphoric invocation is to get hints on the way to encapsulate, formally, the role played by ideas, defined as *evolving bit-strings*, when 'used to produce human capital'. Here Romer relies on neurophysiological metaphors: ideas, literally, reconfigurate the architecture of the neural network representation of what Simon would term the Thinking (Wo)Man. 'Ideas ... represented as pure pieces of information, as bit strings' (p. 71) enhance the productivity of physical capital solely by a rearrangement of the possible permutations of the constituent elements that go into its manufacture: be it a process, such as sewing a shirt, or a piece of equipment, say a computer. Similarly, they enhance the value of human capital by reconfiguring the physical architecture underlying, say, thought processes: *"Now consider human capital. In my brain there are different physical connections between my neurons ... . [T]he knowledge that reading a software manual [for a new computer and new word-processing software gives] rearranges connections in my brain and makes my human capital more valuable ... . The increased value is created by new ideas. Whether it takes the form of a hardware design, software code, or an instruction manual, an idea is used to mix or arrange roughly the same physical ingredients in ways that are more valuable. And in each case, these ideas can be represented as pure pieces of information, as bit strings"*, ibid, p. 71-

Once again, therefore, ideas represented as bit strings encapsulating 'pure pieces of information'[11] function as inputs into a physical architecture representing human capital and transform its 'wiring', so to speak, in such a way that 'it' is able to process them more effectively, in some sense. From standard results in automata and computability theory, it is well known that neural network architectures can be given recursion theoretic formalisms as automata of varying degrees of complexity. To be consistent with the standard postulates of rationality in economic theory it is, however, necessary to postulate an architecture that is formally equivalent to a Turing Machine. Such an architecture allows rational decision processes to exhibit a kind of formal untamability of ideas. Let me expand on the heuristics of this last comment a little more (to supplement the previous discursive comments)

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[11] The ideal way to proceed, at this point, would be to interpret and define information also recursion theoretically, for which there is a well developed tool-kit provided by *algorithmic information theory*.

The inadequacy of the traditional *book of blueprints* vision of feasible technologies becomes patently evident if any such interpretation is attempted for ideas held by rational economic agents interpreted as Turing Machines. Even if the neurons in a brain are finite, not even the proponents of *strong* AI would suggest that the world of ideas in any unit can formally be tamed or accessed - unless by magic or the kind of sleight of hand involved in invoking the axiom of choice. Somehow, somewhere, the open-endedness of ideas must assert itself in some kind of indeterminacy in models of growth and development. That is why the past can never hold all the secrets to the future. Trivial though this remark may sound, to formally encapsulate it in an interesting and operational way is not easy.

A recursion theoretic formalism

I can, now, put together a recursion theoretic formalism. Before doing this it is necessary to summarize Romer's production sub-model. Romer considers output, Y, to be an additive function of a standard production function and a term representing the production of ideas, one for each of, say, n sectors as follows:

$$Y = F(K, L, T) + \sum_{j=1}^{n} G_j(K_j, L_j, H_j; A_j) \qquad (1)$$

In addition to the conventional notation we have:
- H_j: human capital used in sector (or activity) *j*;
- A_j: 'idea' characterizing sector (or activity) *j*.

The search for new ideas is formalized as a general dynamical system as follows:

$$A(t+1) = S[H_A(t), (A_1(t), A_2(t), \ldots, A_N(t)), (H_1(t), H_2(t), \ldots, H_n(t))] \qquad (2)$$

This has the following interpretation; the genesis of new ideas is a function of:

H_A (*t*): human capital used exclusively in the search of the 'space' of ideas at time *t*;

A_i(*t*): *i* = 1, ..., *N*(*n* ≤ *N*), the collection of ideas available in a specified economic region at time *t*.

The role of ideas in enhancing human capital and a learning-by-doing specification can together be captured in the following way to complete the output submodel:

$$H\left(t-1\right)=\Omega\left[H(t),A(t)\right] \tag{3}$$

Now, according to the intuitive definitions:

I. A_i(*t*), (∀*i* = 1, ..., *N*), are specified as bit strings;

II. H_j(*t*), (∀j = 1, ..., *n*), when considered as arguments of G_j (∀*j* = 1, ..., *n*), are neural networks; to be consistent with the rationality postulates of economic theory, these neural networks must be capable of *computation universality*.

Then, by the *Church-Turing Thesis*, we can represent each H_j, *j* = 1, ..., *n* and H_A as programs (or algorithms) computationally equivalent to the corresponding Turing Machine. Next, by stacking the bit strings *Ai*, ∀ *i* = 1, ..., *N*, we can consider the prevailing collection of ides as a program (or algorithm)[12]. This means the arguments of the function *S* in (2) are a collection of programs and, thus, search can be said to be conducted in the space of programs. At this point a direct genetic programming interpretation of the (computable) search function *S* makes the dynamical system (2) naturally evolutionary. However, the bitstring representing ideas can be retained as the data structures for the programs, partial recursive functions and Turing Machines in (1)-(3). Then, search will be conducted in the space of programs and data structures.

A similar interpretation for (3) is quite straightforward. However, (1) is an entirely different matter. Standard definitions define the arguments of *F* and K_j and L_j as arguments in G_j on the domain of *real*

[12] Recal' that '|A |n idea is the increment in information that comes from sorting ...'. In this connection see the illuminative discussion in Nelson and Winter (1982, ch. 4, 81) on 'Skills as Programs' and Bronowski's 'Silliman Lectures' (Bronowski, 1978, ch. 3).

numbers. Given the algorithmic definitions of H_j and A_j, it is clear that G_j must be a partial recursive function for the whole system (1)-(3) to make analytic sense.

This means one of two possible resolutions.

(a). Either, K_j and L_j ($\forall$ j = 1, ..., n) must be defined as computable reals; hence, extended re-definitions of the domain of definition of H_j and A_j from the *computable numbers* to the *computable reals*;

(b). Or, K_j and L_j defined over the (countable set of) computable numbers;

Either way standard constrained optimization must be replaced by combinatorial optimization, on the one hand; and, on the other hand, one loses the applicability of separating hyperplane theorems[13] and, hence, welfare and efficiency properties of equilibria cannot, in general, be derived by algorithmic methods.

I shall conclude this section with two formal propositions.

Proposition 1

Given the recursion theoretic interpretation of (2), there is *no effective procedure* (i.e., *algorithm*) to 'locate' an arbitrary Pareto improving configuration of ideas from the given configuration as an initial condition.

Proof

The proof of this proposition is based on a simple application of the Rice or Rice-Shapiro theorems in classical recursion theory. The dynamical system that is (2), given the recursion theoretic interpretation, can be represented by an appropriate *Universal Turing Machine* or, equivalently, by an appropriate *Universal Program*. The given initial condition for the dynamical system (2) corresponds to initial configurations for a Turing Machine computation and its program equivalent. These initial conditions and configurations correspond, economically, to the *status quo* set of ideas. But by Rice's theorem no nontrivial subset of programs can be effectively located by starting from any arbitrary configuration for a Turing Machine.

Remark

In other words there is no *a priori* local search *procedure* that can be used to discover a Pareto-improving set of ideas.

[13] More generally, the Hahn-Banach theorem.

Proposition 2

Given an initial, empirically determined, configuration of ideas represented algorithmically in (2), there is no effective procedure to determine whether S, implemented as a Program – say as a *Genetic Program* - will halt (whether at a Pareto improved configuration or not).

Proof

The proof of this proposition is a trivial consequence of the *unsolvability of the halting problem for a Turing Machine*. The necessary contradiction is obtained by supposing that there is an effective procedure to determine whether any given empirically determined configuration of ideas, used as initial conditions to implement a program for a Turing Machine, will result in a well-defined set of output values.

Remark

In other words, this proposition suggests that it is impossible to find, by algorithmic means, definite answers to questions about the existence of feasible production processes to implement any given set of ideas.

These two propositions cast doubts on the blessings of the 'curse of dimensionality' to which Romer refers (cf. above and ibid, pp. 68-9). There are no effective procedures, discoverable *a priori* and systematically, to determine which 'small fraction of the large number of possible mixtures may be valuable'. This is why economic development, like the evolutionary paradigm itself, is so difficult to encapsulate in simplistic, formal, growth models - endogenous, or not.

3. Towards an o Open-Ended Theory of Economic Development

"[Tacit knowing is when] we can know more than we can tell ... .

[S]uppose that tacit thought forms an indispensable part of all knowledge, then the ideal of eliminating all personal elements of knowledge would, in effect, aim at the destruction of all knowledge. The ideal of exact science would turn out to be fundamentally misleading and possibly a source of devastating fallacies ... .

[A] mathematical theory can be constructed only by relying on prior tacit knowing and can function as a theory only within an act of tacit knowing, which consists in our attending from it to the previously established experience on which it bears. Thus the ideal of a comprehensive mathematical theory of experience which would eliminate all tacit knowing is proved to be self contradictory

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and logically unsound", Polanyi, 1966, pp. 1, 20 1; italics in original.

The question, now, is how to embed Romer's enhanced combinatorial model within an *institutional* framework that is conducive to development. I suggest that Romer's *trained person* adds *The Tacit Dimension* (Polanyi, 1966, especially, ch.1, pp.1-27; but cf. also Polanyi, 1962, especially Part Two), among other things, to his enhanced growth model.

To that extent the model has to be formally open ended; i.e., with some indeterminacy. However, the indeterminacy is not arbitrary - there must be, proverbially, *some method in the madness.* The above two propositions are an attempt to encapsulate formal indeterminacy in a structured way. Some kind of formal border between what can be known, learned and 'told' - i.e., formally so described - and that which cannot be so described defines the dividing line between the neat and determined world of formal growth models and the messy and evolutionary development process. The skeletal recursion theoretic formalism and interpretation of Romer's *ideas* given above, and the ensuing two propositions, makes it possible to indicate the formal nature of this dividing line. In general, processes that are *recursively enumerable but not recursive* allow the kind of indeterminacy I am suggesting. The proofs of the above two propositions would locate the indeterminate range without actually determining them - to put it somewhat paradoxically.

It is interesting to note that Paul David (David, 1993), in a not-un-related contribution, tackles the broader issue of the role, nature and scope of knowledge in technological change and, hence, in the growth processes of economies. He, too, proposes an interesting dichotomy for the definition of knowledge: *codified* and *tacit* (the latter along lines suggested by Michael Polanyi, op cit.[14]). These definitions are also based on an economic setting with an institutional structure that seems to have an algorithmic and evolutionary perspective. Paradoxically, and contrary to received wisdom, it is possible, I believe, to use the notion of oracle (or relative) computation[15] to recursion theoretically formalize tacit knowledge. On the other hand, codified knowledge is straightforward algorithmic knowledge and almost identical, formally, to Romer's concept of idea.

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[14] cf. also Nelson and Winter (1982, ch. 4, §2).
[15] cf. Davis (1982, ch. 1) or Rogers (1967, ch. 9).

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Let me try to explain, in an elementary and heuristic way, the meaning of the above remarks. There is no better way to summarize Polanyi's pioneering attempts to delineate tacit from non-tacit knowledge than his concise but richly evocative statement that *'we can know more than we can tell'*. I have suggested that this statement encapsulates the role of Romer's 'trained person', to whom one must turn to implement production sequences that have somehow been transplanted from one institutional and historical setting to another. The essential point and role of Romer's 'trained person' and David's 'tacit knowledge' is that their expertise *cannot be formalised and transplanted*; but they are necessary for the operational part of production sequences to function 'efficiently'.

Assume, now, that the 'codified' part has been transplanted in the form of production processes, formalised, as suggested above, recursion theoretically. An operative, even as part of the formalised production process, may occasionally have to seek the 'trained person's' advice and help on effecting a particular decision at some point in the sequence. How can this role be 'formalised' in the recursion theoretic formalism I have employed above? I believe there is a simple answer although *the simplicity belies its combinatorially complex content*. The simple answer is to embed the model in its standard recursion theoretic formalism within a framework capable of appealing to an 'oracle' for advice and help, as and when the need arises when nonrecursive problems are encountered.

In other words, as 'codified knowledge' is implemented in the form of transplanted production processes formalised recursion theoretically, the relevant operative will seek the help of the 'trained person' whenever knowledge and skills that are *'known but cannot be told'* will be required. This category of knowledge can - and must - include patented knowledge as well. This is almost exactly analogous to a computation process which, from time to time, halts and requests additional, non-recursive information before it can proceed. Thus, the rational economic agent as a Turing Machine operating or implementing 'codified knowledge' of ideas formalised as 'bit-strings' will, on encountering the need for knowledge that could not or may not be so represented will appeal to the 'oracle' for help before proceeding with the computation, decision process and so on. The only non-formal requirement we will have to

append here is that which is classically attributed to an oracle. Under this interpretation the standard model of *oracle* or relative computation is more than adequate for the purposes I have in mind.

There remains, finally, the thorny question of the role of public policy in fostering the search for ideas and the broadening of the knowledge-base of a country or region. The formalism based on Romer's suggestions must be complemented by at least two kinds of case-historic examples: one, examples of the evolution of ideas in the basic sciences in their interaction with applied sciences.

Secondly, case-histories of the institutional underpinnings, and their evolution, for the development of science and technology in the economic growth process, underpinning economic development. I conjecture that a fertile area of study in this direction is an investigation of the institutional basis for the interaction between science and technology in Tokugawa and early-Meiji Japan - and the transition from one to the other. It is that transition regime, I conjecture, that is most relevant for the more dynamic developing economies, such as India, China and Brazil, for lessons on science and technology policy for development and growth.

Ideas for understanding transition regimes must, surely, be based on *non-algorithmic* processes. I suggest a way to make sense of this is to consider economic development as a combinatorial problem, to which a first step is suggested with the above formalism. The metaphor, going beyond Meccano, Chemistry and Chess Sets, is to use the *Game of GO* - in this difficult task.

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THE STRUCTURE OF WOMEN'S PERSONAL SUPPORT NETWORKS IN A SICILIAN COMMUNITY *

Abstract

The purpose of this paper is to examine how and with whose help women face maternity and the first few years of motherhood. For this reason it is fundamental to identify the social network of each woman in order to individuate all those people on whom she can rely in moments of need. Starting from such a presupposition, the different kinds of help available to women have been examined: both from the family and from outsiders (as for instance the services offered by the local community) and from paid services which are privately provided. Furthermore, from among the people belonging to the network of every woman, the possible types of bond with her have been assessed. In order to adequately investigate this area, a questionnaire was designed and subsequently administered to the women living in Barcellona Pozzo di Gotto (the most densely populated and wealthiest borough in the province of Messina after the main city). The criteria of inclusion in the sample are as follows: mothers have to be from 15 to 49 years old, their last child is aged 6 or younger, and they do not have any children over 18 years of age. At the end of this analysis we can see that the existence of a egocentered network is decidedly more consistent in comparison to a total network (or closed network).

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1. Introduction

The starting point of this study developed from the idea of examining the condition of women in Sicily with particular reference to how, and with the help of whom, women deal with maternity and the first few years of motherhood. It was necessary to examine the *social network* of every individual woman in the study in order to identify those people who, in moments of need, the women could depend on.

Furthermore, in this type of analysis it is possible to ascertain: if women adopt specific strategies to affront the difficult job of motherhood; the existence of a well established *network*; the reliability of individual members of the *network*; women's preferences regarding help from among family members or friends as against outside help; whether professional women maintain or abandon their careers during the first years of motherhood; the validity of help available to women from within the network in the form of advice, information, experience, values and resources.

Hence, we want to see the relationship ties of members involved in the *network* and examine how they interact. To identify the individuals upon whom the women most often depend and determine whether this is because they are older, or more experienced or simply because they are both physically and emotionally closer.

As a concept, *network* is often used to indicate a group of people linked by some kind of relationship which can range from casual acquaintance to that of family bond. It is an abstract notion and assumes different meanings according to the discipline or theoretical model to which it refers. The versatility of the term *network* and its applicability to diverse areas of human experience is the key to its success. It offers a variety of analytical tools which are somewhat articulated and often complex. In general a *network* is a set of ties which are bound together by relationships or connections (Wellman, 1988).

In this research a series of considerations are presented regarding networks paying particular attention to *personal networks* and specifying the divergence between *strong* and *weak connections*. The aims of the analysis, the chosen sample and the methods of data collection are described. Finally the professional status of partners and the edu-

cational level of the mothers are delineated, and the level of assistance requested and received from family members and friends, including the availability of local social services, are examined, paying particular attention to the people who can be relied upon in moments of need and how exactly their support is given.

2. The concept of *Social Network*

Sociologists and anthropologists have been applying the concept of *social networks* to human groups since the thirties and forties. Initially this concept was used to delineate the complex nature of social interaction but in time it has become a mathematical application permitting the representation of models of social structures.

The approach adopted in this analysis of *social networks* has been developed from several different trends which, through time, have interwoven and fused. According to Scott (1998) in current methodological analysis there are three principal lines that flow together:

1. from scholars of the *Gestalt* theory who passing through sociometrics and the analysis of group dynamics developed the grafi-theory;
2. from the *Harvard* researchers in the thirties who by studying informal social interaction demonstrated the existence of cohesive sub-groups (*cliques*)
3. from the *Manchester* anthropologists who further elaborated the previous two lines of study to analyse the structure of social interaction within tribal societies and villages and were the first to use the concept of network systematically.

However towards the end of the sixties, following the work of American sociologists, the analysis of network underwent radical change, both theoretically and methodologically. White started to expand his research on the mathematical base of social structures, drawing upon and developing the key insights made by his American predecessors. The themes developed by White were adopted by other researchers giving rise to a complex but more coherent picture of the analysis of *social networks* (Rivellini, 2005).

The models used to analyse social networks belong to the study of Network analysis. Italian social scientists, particularly in recent times,

appear to have rekindled an interest in this area of research. Perhaps this interest is linked to the ever increasing popularity of the term network both in everyday language and in that of the social sciences. Research in the social sciences is geared towards enquiries into family models, social structures, and so on.

Social networks can be surveyed in several different ways. The *whole network* (*or closed network*) is obtained by interviewing all the members of a given population and asking them to identify all the people they are connected to and specifying what type of relationship they have. A squared matrix representing a complete outline of relationships is used to gather this information. In this type of *network* it is possible to study the so-called *network effects* associated with the intrinsic dependency present between links. Alternatively, it is possible to define a network that starts from one single link. This perspective investigates the entire range of social interaction of one individual, obtaining a *personal* (or *egocentred*) *network*, and it is this type of network that will be examined in this paper. In a personal network the description and analysis of the network starts with key individuals, called *egos*. The aim, therefore, is to study how *networks* are perceived by the individuals who are at the centre.

The starting point of the *network* is considered to be the individual, their perceptions of the people who surround them (family, friends, neighbours) and the strategies they adopt to gain assistance. Each *ego* has, as reference points, a series of *alter egos* and types of connection. This type of network is usually used to study the effects of the differential size and composition of personal relationships with regard to social well-being, health, position in the labour market, career possibilities and so on. In the literature a *personal* or *egocentred network* is defined as the totality of relationships that one individual establishes with other individuals (Van der Poel, 1993): this includes all contacts with the so called *emotional support group* and the *social support group*. In order to measure and analyse a *social network* these relationships must be defined. McCallister and Fisher (1978) propose four approaches: *interaction, role relation, affective and exchange*. The latter, based on the theory of social exchange, is the most utilized and is identified with the more general concept of social support which has three distinct dimensions.

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The first is the emotional sphere where problems are discussed and advice given, the second involves offers and therefore the transfer of material possessions or tangible services and the third is expressed in the sharing of specific social activities. This approach favours a one-way interpretation and the eventual diversity found in size and composition of the *network* should be a faithful representation and not the results of the methodology utilized.

Regarding networks there are two different and tendentially contrasting forms of *connection* both in relation to the individual and in relation to larger social aggregates. In essence, everything depends on the strength of the relationships between individuals. Granovetter (1998) argues that "the stronger the *connection*, the more likely it is to be exclusive and excluding and tending towards a closed *clique*".

Strong connections tend therefore to give rise to forms of social capital *bonding*. Since this requires the investment of high levels of energy it is open only to a few; it tends to be possessive and limited in numbers; in definitive, it is a resource and offers the "privileges of a club". Privileges, however, are counterbalanced by the often heavy conditioning that is evident particularly regarding the possibility of creating a wider and more varied network of relationships.

On the other hand, since *weak connections* are generally more superficial and therefore more economical, they can be more numerous and more varied. This is, in fact, their strength as they allow individuals to establish a wider network where each connection is a bridge towards new opportunities. This type of connection keeps the community open to external influences, it admits outsiders and constitutes a much wider network with and between different groups facilitating access to diversified resources.

Finally then, each individual is part of a network of relationships held together by both *strong* and *weak connections*. Individuals can enjoy the advantages of both types of relationship while enduring the conditioning and negative aspects.

The analysis of *social networks* is also influenced by the type of data; in the social sciences data is represented by meaning, motivation, definition and typing. This means that the production of sociological data involves the process of interpretation. Based on these interpretative processes

sociologists have identified distinct types of data with similarly distinct methods of analysis. The principal types of data are as follows:

- **Attributes** refer to the attitudes, opinions and behaviour of individuals or groups considered as a property, quality, or characteristic belonging to individual agents. The information gathered in surveys and interviews, for example, is often considered as an attribute of single individuals. It is possible, however, to quantify and analyse using the many available statistical techniques. **Variability analyses** are appropriate methods for measuring attributes where attributes are measured as values of specific variabilities.

- **Interaction data** refer to the contacts, ties and connections, memberships and group activities that relate one actor to another and cannot therefore be reduced to properties of the individual agents themselves. The interaction is not a property of the actor, but of a system of actors; couples of actors are connected in wider systems of interaction. **Network analysis,** where relationships are examined as an expression of ties among actors, is an appropriate method of investigation with regard to interaction data.

- **Ideative** data describe meaning, motivation, definition and typing. Suitable methods for the study of ideative data are found in **typological analyses** although further development in this field is necessary.

While three distinct types of data have been identified, each with its own method of analysis, there are no specific guidelines regarding methods of data collection. For example there is no distinction between methods of data collection with regard to attributes compared to those for the collection of interaction data. The three types of data are often collected together as if they were integral aspects of the investigation itself. Meanwhile, data can be obtained from questionnaires, interviews, participant observation or from recorded data sources.

The analysis of *social networks* then has emerged as a collection of methods for analysing social structures. In particular, its methods are directed towards an investigation of the interactive aspects of the structures themselves. The use of these methods is dependent on the availability of interaction data rather than on attributive data (Scott, 1998).

All the data from social research, once gathered, must be inserted

into some kind of matrix (Galtung, 1967), a scheme into which raw or codified data can be organized more or less efficiently.

3. Tools and investigative methodology

The aim of the study is to investigate the network of each individual woman, in particular to discover with whom, and in what kind of relationships, women interact in their *personal network*. Furthermore, an examination of the *strong connections* in the different components of the *network* will also be undertaken.

In order to acquire the information regarding the position of women and the problems they encounter a questionnaire was designed, paying specific attention to the way assistance is offered during maternity and the first years of motherhood,. It contained several sections and was amply tested before being administered to the sample group.

The questionnaire was divided into the following parts:
1. personal details;
2. education;
3. work experience;
4. personal details of partner;
5. partner's education;
6. partner's occupation;
7. conjugal relations;
8. family;
9. availability and interactivity;
10. the child;
11. private family services;
12. the home and life conditions.

The questionnaire was structured in this way to help put the women at ease by beginning the interview with general questions before reaching the more specific ones relating to the survey later on.

In order to establish a general outline of the family conditions of the child, attention was given to those sections of the questionnaire regarding partners' professions and women's education. Another point of interest regards the frequency with which the women interviewed saw their own parents or their partner's parents and the relative physical

distance between the two households. The section referring to support available to women was also revealing, as was the kind of services actually used, whether from private sources or from local authorities. Finally, the availability of support from family and friends was considered, with particular reference to those who help the women with childcare.

In this context the analysis will concentrate specifically on *family variables* and *personal variables*.

The questionnaire contains a good deal of information regarding family context. The information refers to both sets of grandparents (permitting a measurement of the frequency of visits, their physical location, and why they leave their children in the care of grandparents specifically), other family members, and lastly, friends and neighbours (specifying if they can be relied upon to provide support).

Besides *family variables* it is also useful to consider variables involving personal choice such as, for example, the motivation behind decisions not to enrol children in nursery school or decisions not to entrust childcare to outsiders, while also trying to understand the women's frames of mind.

Since this is an exploratory analysis it was not necessary to construct a representative sample so a reasoned and balanced sample was used. The population of interest in the study consisted of 50 women, aged between 15 and 49, whose latest child was aged 6 or under and who did not have children over 18. The women in the sample, differentiated according to number of children, were as follows

- 12 women with only one child;
- 18 women with two children;
- 12 women with three children;
- 8 women with four or more children.

50 women of differing ages were selected from among potentially suitable candidates in order to have a representative sample of the local population.

Data was gathered in May 2007 over a period of 18 working days. From the sample extracted initially only 5 women (10 %) refused to be interviewed so, in order to reach the established quota of the sample, other women with similar characteristics were chosen. The low level

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of refusals may have been influenced by the informative presentation letter sent by the Statistics Office of the Barcellona Pozzo di Gotto municipality to all the potential components of the sample inviting them to participate in the survey.

The average length of the interview varied from person to person as the questionnaire was designed, so that only some sections were administered in their entirety to all the women involved. For instance, the average length of the interview was shorter for those who declared they didn't work and had never previously worked, or for those who declared that they had nobody to rely on in moments of need.

4. Women's support *networks*: results from the explorative analysis

In order to get an overall perspective of each family we started by examining the occupational position of the partners of women in the survey and the educational level of the women themselves. We dedicated particular attention to women with "three or more children" as they are presumed to encounter more difficulties than those with fewer children. A detailed analysis of partner's employment position was undertaken considering above all if he was in employment or otherwise, whether he was employed in the public or private sector and also the type of employment contract. We distinguished two groups according to number of children: those with "one or two children" and those with "three or more children".

Only two cases were observed of partners who had never worked, and in both cases they fell into the category of "three or more children". Taking into consideration the type of work carried out by partners at the time of the survey, it can be inferred that in large families there was a higher frequency of unemployed men.

Furthermore, we found that there was a greater possibility of finding large families among public sector employees than among those in the private sector, in fact it was observed that belonging to a large family was more likely among workers with fixed term contracts.

Summarizing then, we can say, as hypothesized, that large families encountered more difficulties than those with only one child.

If however, we consider the level of education of the women in

the survey, it can be seen that there is a difference in education level between women with "one or two children" and those with "three or more children". It can be deduced that there is a higher likelihood of having a large family

among women who completed only the statutory education programme than amongst those who were graduates.

The following graph, using data from the survey, helps to visualise partners' occupational level next to women's level of education.

Figure 1 - General family conditions
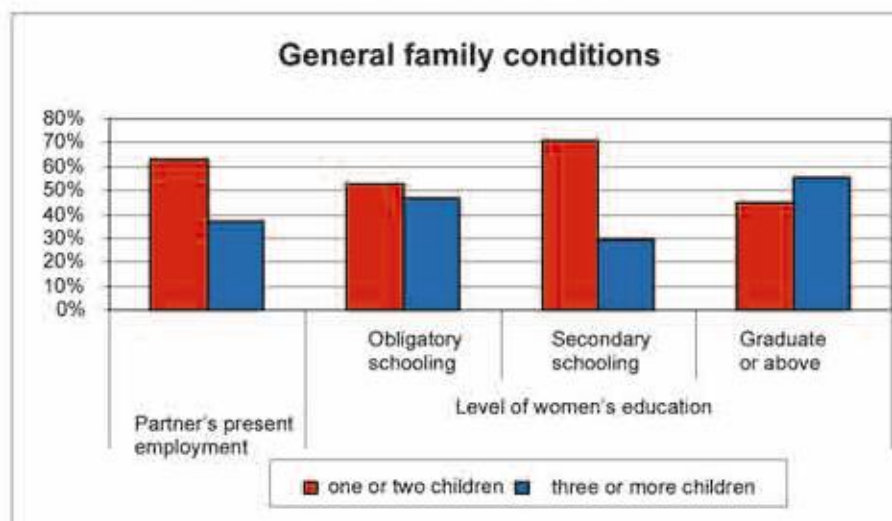
Source: explorative survey on "Motherhood and support networks"

In order to obtain an overall picture of the eventual causes of the difficulties encountered by large families we examined the relationships between couples and their respective families of origin. Place of residency of the women in the survey was examined as was the frequency of visits to and from parents of both the women and the men.

The majority of the families lived in the same borough as the woman's mother, even if over a kilometre away. This condition made little difference between the groups with at least two children and those with more than two.

Women who were part of large families were more likely to live in the same neighbourhood as their mothers, even if not in the same building, and, more frequently than others, lived in other boroughs. There were slightly fewer women from large families whose mother had died with respect to women with at least two children. In the majority of families women frequently spent time with their mothers and there was little difference between those with two children and those with more.

Regarding the relationship existing between the women and their mothers-in-law, most of the families lived in the same borough as the mother-in-law, with a more consistent percentage regarding large families who live in the same building as the mother-in-law, and also in this case there was little difference between those with at least two children and those with more than two. Whereas women from large families whose mother had died, were more numerous with respect to women with at least two children, and this may depend on the fact that, as part of large families, on average they are older (third children, in fact, are often born when women are older). Lastly, women from large families, since they more frequently live in the same building as the mother-in-law, saw her more often than women with "one or two children".

From the data gathered it is possible to affirm that most of the women interviewed lived in the same borough as their parents or in-laws. In 30% of the cases they live within one kilometre, or nearer, of the mother's home; in the case of the mother-in-law, the percentage increases to 50%. Close proximity means that contact is more frequent.

The same is found in the figure below, from which we can note that percentages of women who rarely see their mother or mother-in-law are low.

Figure 2 - Frequency with which women meet their mothers and mothers-in-law
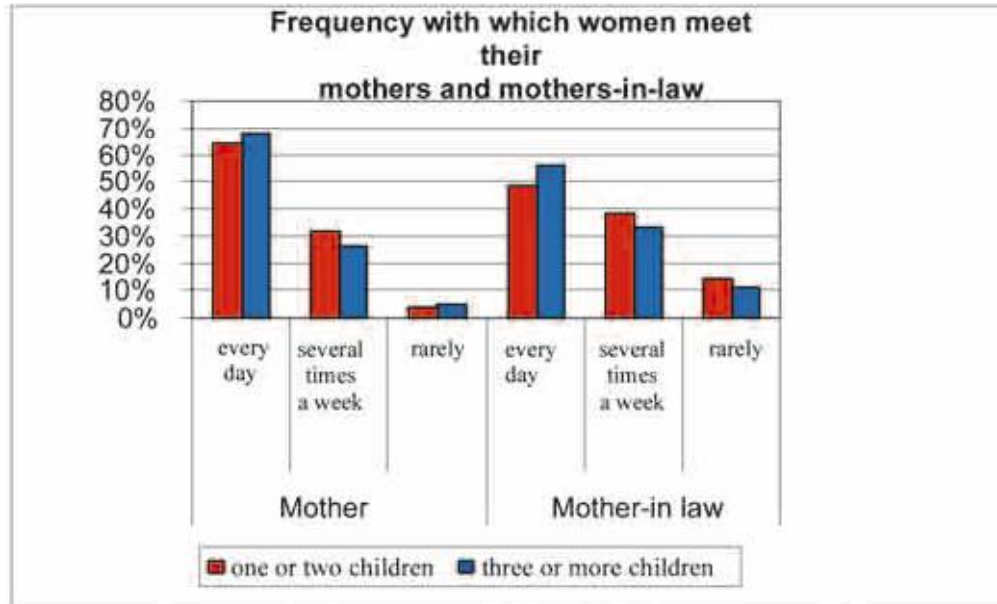
Source: explorative survey on "Motherhood and support networks"

As this study is concerned with how, and with whose help, women deal with the first few years of motherhood, we made a distinction between free assistance provided by relatives and friends, privately available services, and local social and community services.

It emerged that from among the families in the study, families with at least two children, compared to the others, received more free help from relatives and friends, in particular with regard to moral support, small tasks, childcare and also financial help.

While instead it is the large families who tend to use more those services which are privately available, such as home-help, babysitter and care for the elderly or disabled. Similarly they are more likely to make use of local social and community services, in particular, nursery schools, playschools and services offered by religious institutes. Families with "three or more children" in this instance were the ones who made most use of nursery schools with respect to other local services.

A single graphic representation shows which services are most used by the women.

Figure 3 - Services used by women
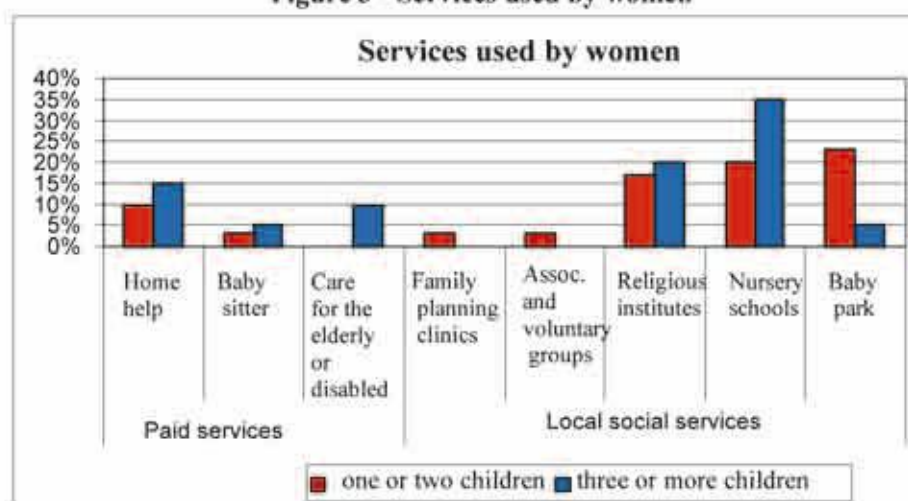
Source: explorative survey on "Motherhood and support networks"

Considering singularly each type of free help received by women from friends and family, it can be seen that partners and mothers make the greatest financial contribution towards the women's welfare, with some differences to the detriment of families with "three or more children".

High percentages were also found for help provided by mothers and mothers-in-law. Women with "one or two children" received notably more help from their mothers, while women with "three or more children" from their mothers-in-law, in coherence with the data gathered regarding residential proximity. However, in large families, the help women received from the mother-in-law, which occurred in 55% of the cases, didn't equal that received from the mother (60% of the cases), therefore they are obliged to ask for help from sisters-in-law, aunts, female friends, neighbours and so on.

Concerning home-help, the women interviewed received this type of support mostly from their mothers, mothers-in-law and from partners.

Percentages differed between large families and families with at least two children and in this case the former received a greater amount of help than other families. Women from large families have more people to ask for help, they have an extended family circle who are willing to help and carry out tasks. Women with "one or two children" were helped more by husbands, brothers and sisters.

Now we will try to individuate who intervenes most to offer help to young mothers, taking account of all available help and distinguishing between number of children. Figure 4, below, illustrates what type of help is available from the circle of family and friends.

Figure 4 - Types of free support from relatives and friends

Types of free support from relatives and friends
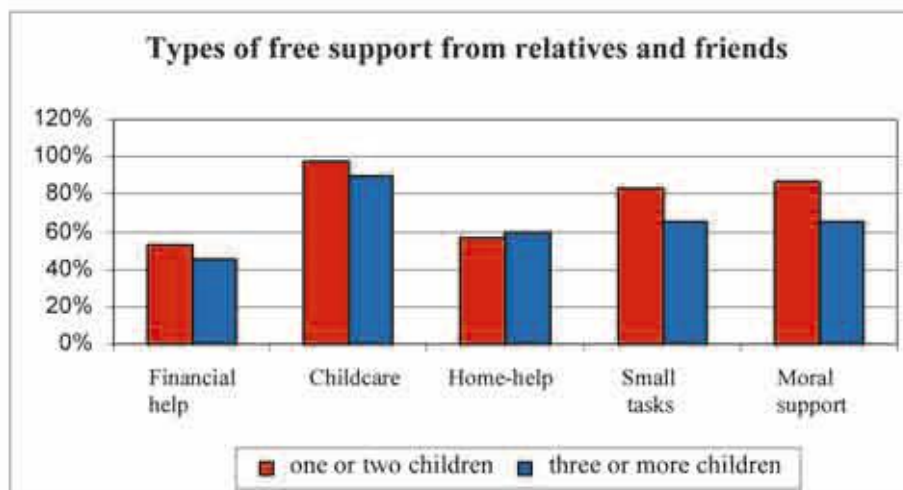
Source: explorative survey on "Motherhood and support networks"

The majority of the women interviewed relied on mothers, mothers-in-law, partners and sisters. In large families there is also a certain frequency to rely on sisters-in-law, aunts, female friends and neighbours to a greater extent than women with at least two children, although it seems, however, that large families receive less help from close relatives than do families with fewer children.

Summarising then, it can be said that among the different types of

assistance available and considered here, help with childcare is the most prevalent. We will now examine how help is provided and who, in the first few years of childcare, provides it.

From the data we can see that a greater measure of assistance is received from mothers than from mothers-in-law, but it must be said that there is a lower propensity of help available from mothers towards large families while, on the other hand, they tend to receive more help from mothers-in-law.

Help with childcare is much lower on the part of fathers and fathers-in-law compared to mothers and mothers-in-law, however, it should be noted that help from fathers was more evident among large families. This could be due to the fact that more fathers than mothers could drive and were able therefore, to reach daughters with large families who, as we saw earlier, lived further away.

Comparing the help received from sisters and sisters-in-law, we observed a net preponderance to offer help to large families on the part of sisters-in-law, which could be influenced by the closer proximity to the family of origin of the partner.

In childcare there was a substantial difference between the help women received from their husbands and help from brothers. The former, in fact, are the most available, due probably to a higher awareness of sharing the responsibilities of running the house. At the same time a tangible difference was observed between contributions from partners with at least two children and those instead from large families.

The graph shows clearly which relatives provided the most help to women.

Figure 5 - Help with childcare
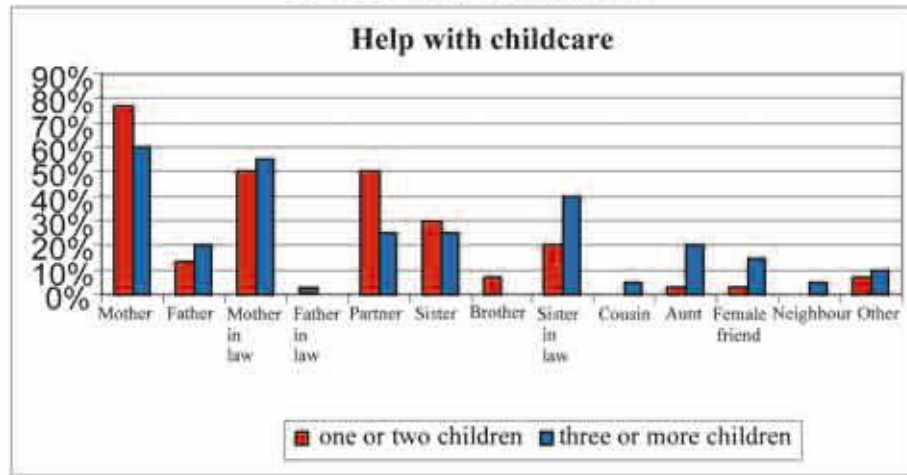
Source: explorative survey on "Motherhood and support networks"

Now we will examine in detail how the people considered so far contributed to helping with childcare.

Mothers of the women surveyed "always" and "often" offered help: in playing with children (86%), in feeding (42%), in washing and dressing (33%). We also observed the extent to which partners' mothers helped with childcare: they were mostly involved in playing with children (62%), and then in feeding (31%). However, it should be noted that mothers made more relevant contributions than mothers-in-law.

Partners offered more help to women regarding help with childcare, in fact, high percentages are found in playing with children (95%), putting children to bed (55%), watching television (50%), taking children to the park (40%), feeding (35%) and medical visits (30%). There is a modest figure for fathers helping with washing and dressing children (15%).

The major contribution from sisters regarded playing with children, watching television together, but also with feeding and washing and dressing. Finally, sisters-in-law who, besides playing with children, in a few cases helped with feeding, in taking children to the park or in accompanying them to nursery school.

5. Conclusions

This investigation into the *network* of social interaction of *women-mothers* in a Sicilian community, taking into consideration the professional status of partners and the education level of the women themselves, has given us a general outline of the difficulties encountered by families, particularly large families. It emerged that 75% of partners from families with "three or more children" were unemployed at the time of the survey, compared to 25% of families with "one or two children", which obviously creates more difficulties within large families. Women's education level was examined from which it was possible to evince that 53% of those with "one or two children" had only completed statutory education programmes, while 45% had graduated. The situation is reversed for women with "three or more children", 47% had only completed statutory education programmes, while 55% had graduated.

Regarding the residential proximity of both sets of the couple's parents and the frequency of contact, it was ascertained that a closer residential proximity favoured more frequent contact. In particular, in 82% of the cases couples lived in the same borough as the woman's parents, and in 90% of the cases they lived in the same borough as the parents of the man. If we distinguish between families with "one or two children" and large families, it emerged that in families with at least one child, 86% lived in the same borough as the mother and 92% lived in the same borough as the mother-in-law; while in large families it was found that 75% lived near the mother and 85% near the mother-in-law.

An examination of the different types of support needed by the women in the survey showed that it was large families who more frequently requested support from outside the family circle, such as for example, home-help, babysitter, care for the elderly or disabled, in the order of 30%; while only 13% of the families with "one or two children" requested this type of support. This element highlights the fact that very few women are willing to trust people from outside the family circle in moments of need. This is probably generated by the fact that the women lived further away from their families of origin and nearer to mothers-in-law, who perhaps, don't seem to fully compensate for the physical distance from the maternal grandmother.

Regarding locally available services it was noted that large families made the most use of them, with particular reference to nursery schools with 35% of the cases compared to families with "one or two children" who only reached 20%.

Data concerning the free help available from family and friends showed that it was the families with "one or two children" who benefitted most from this type of support in comparison with large families.

During interviews an attempt was made to understand how, and what type of support was given by the family members indicated by the women in the survey. In the financial sphere it was the mother, mother-in-law and partner who supported the women from families with "one or two children", while in larger families women received help from the mothers, fathers, mothers-in-law, partners and sisters, even if to a lower extent than in families with "one or two children".

Both types of the families surveyed received the most support in terms of home-help from mothers, mothers-in-law and partners.

With regard to carrying out small tasks, women from large families relied mostly on mothers, fathers, mothers-in-law and partners, but also on sisters-in-law, aunts, and female friends, while women from families with "one or two children" requested this type of support from mothers, mothers-in-law and partners, sisters and brothers.

Concerning moral support, however, women request this type of help from mothers, fathers, mothers-in-law, partners, sisters and sisters-in-law, particularly those from families with "one or two children". Similarly women with "three or more children" who, however, also turn to female friends, aunts and neighbours for moral support.

The main area of support identified was regarding childcare. Women for the main part asked for this support from mothers, mothers-in-law and partners but also from sisters or sister-in-laws with a higher ratio for families with "one or two children". Similarly in large families who also turn to cousins, aunts, female friends and neighbours.

Using this type of analysis it is possible to have a clear example of *personal network*. Starting from the women interviewed, the central landmarks, it is possible to examine how *networks* are perceived by the individuals at their centre and how they actuate their support strategies.

From the data gathered it is possible to affirm that in mothers'

networks the existence of *strong connections* is without doubt more frequent than the presence of *weak connections*. In fact, Granovetter defines "the strength of *connections* as a combination of, the frequency of visits to, time dedicated to, emotional involvement with, level of reciprocal familiarity and services exchanged" (Granovetter, 1998), which is what was offered by the families of the women interviewed.

Another aspect which should not be overlooked is residential proximity. It is possible to evince from this explorative survey that it is the family of origin who, by living closest, provides the most support. Moreover, it was noted, in cases of couples with "three or more children", there was a greater probability of them living closer to the in-laws although this never fully compensated for the distance from the maternal grandmother.

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Fabio Di Dio* - Luca Correani**

CORE INFLATION MEASURES AND THE EFFECTIVENESS OF MONETARY POLICY. AN INTERPRETATIVE MODEL

Abstract

Monetary authorities speculate that by using core inflation measures it is possible to subdivide observed price variations into two components: a persistent component extended over a long time horizon and a short-term component representing transient shocks. The first type of variation is that which interests policy authorities, since it is controllable and goes by the name of core inflation (or underlying inflation). The second type of shock is outside of their control and goes by the name of the non-core component. Through a simple aggregate supply and demand model, we demonstrate that the success and effectiveness of a monetary policy in terms of price level stability depends on the extent to which inflation measures reflect long-term movements or include temporary shocks. In fact, if the inflation measure includes short-term effects, the task of controlling inflationary pressures becomes considerably more complicated. Indicators purified from transitory components identify core inflation but a common methodology for its calculation does not yet exist. There are, however, different approaches to identify core inflation which can be synthetically classified into two large groups: methods linked to the statistical approach that focus attention directly on the issue of how to measure core inflation from existing data; in methods linked to the modeling approach the estimates of inflation are instead conditioned by economic theory and are the result of an identification schema in which persistent elements are distinguished from temporary elements. Each method has its advantages and disadvantages and in practice, there is an inclination to base decisions on a battery of indicators, comparing the differences and evaluating them case by case.

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KEYWORDS: CORE INFLATION; MONETARY POLICY; INFLATION INDICATORS

1. Introduction

Monetary authorities constantly face the problem of identifying which price changes are to be considered as transient and which instead as permanent. This identification is of fundamental importance to implement appropriate and timely monetary policy prescriptions. An incorrect evaluation of the nature of inflation, together with the delays with which a monetary policy makes its effects explicit, can lead to extremely harmful consequences for the economy. For example, an untimely evaluation of the onset of persistent inflationary pressure can lead to sustained price increases requiring a more prolonged period of restrictions. To the contrary, an excessively restrictive policy in response to a temporary increase in inflation may produce immediate depressive effects on employment. To overcome these difficulties and avoid choices that have negative repercussions on economic activity, many central banks have long since constructed core inflation measures, or rather, purified from transitory components.

The Central bank of Canada, for example, has repeatedly made public that it '*focus on the consumer price index excluding the volatile food and energy components*', to then declare explicitly that its monetary policy is not '*try to offset short-run movements in the CPI caused by these fluctuations in prices of food and energy*' (Bank of Canada, 1991). This behavior in the practical management of monetary policy reflects the now widely consolidated belief that the success and efficiency of monetary policy, in terms of controlling inflation, depends on whether inflation measures contain long-term movements or include temporary shocks. This 'decomposition' of the inflation index into its permanent and transitory components does not only have an important role as a practical guide to monetary policy, but is of crucial relevance to its effectiveness.

Nonetheless, while there is broad agreement on the important informative contribution that core inflation indicators provide in monetary policy decisions, there is no agreement on the most effective measure in

determining core inflation. The most elementary approach, and probably the most used, consists in simply excluding certain price categories from the consumer price index. The noted CPI approach *'excluding food and energy'*, reflects the origin of the concept of core inflation and the experiences gained during the 1970s, when fluctuations in food and oil prices, caused by OPEC's influence and independent of monetary policy choices, had a short-term impact on inflation. However, the idea of separating the constituent components of inflation is not only a practice motivated by practical or contingent reasons but finds its precise theoretical justification in consolidated literature on core inflation. Roger (1995), in linking the importance of core inflation to the role that the central bank of New Zealand played in maintaining the stability of prices, states: *'A measure of underlying inflation has an important role to play both as a guideline for monetary policy and as a benchmark against which to assess the Bank's performance in maintaining price stability. The appropriate measure of underlying inflation for policy purposes, therefore, is one which is able to distinguish between one-off shocks to price arising from supply-side developments as opposed to shocks to the ongoing inflation rate arising from demand-side development'*. This proposition seems to echo Eckstein's (1981), considered the inventor of the term core inflation, who explains that the role played by demand shocks and the evolution of production costs on inflation: *'The aggregate inflation rate has proved volatile and dominated by "surprises". Variations in aggregate demand have long been known to affect the price level, yet other factors have frequently obscured this relationship. Such shocks as energy and food price explosions or government micro policies of regulation and taxation have been seen as alternative theories of inflation...'*.

Eckstein, therefore, distinguishes an element of inflation resulting from a supply shock and an element that emanates from changes in aggregate demand. As concerns monetary policy Laidler (1990) clarifies that *'the core inflation rate...can be controlled by policy and, more specifically, by monetary policy, even though the vast majority of the literally thousands of individual pricing decisions whose outcomes it summarizes are taken without conscious reference to stance of policy'*. However, some assumptions are made in stating that monetary policy is able to monitor the effects on demand, which Quah and Vahey (1995) take upon themselves to explain:

'The assumption that the concept of core inflation is meaningful at all is an assumption that there is a unique core inflationary process in a macroeconomy – across all sectors and all regions. While this might, at first, seem improbable, that a common monetary base exists, provides some basis for such an assumption. That the various other shocks to the economy can be represented by one type of disturbances is, probably, a greater leap of faith. The hope is that this other type of shock represents an average of the dynamic effects of the (potential many) underlying shocks'. In their structural approach, Quah and Vahey (1995) link core inflation to the real economic product, or rather, to the component of inflation *'that has no medium to long term impact on real output'*. The theoretical framework at the base of this approach is that long-term inflation reflects the state of demand in an economy and does not to influence the product. In order for this component to be neutral in the medium to long-term, it must contain or reflect expected inflation. This definition seems to exclude that supply shocks can have a permanent effect on inflation but includes cyclical movements associated to changes in demand (see section 4.2). In other approaches, such as those based on Bryan and Cecchetti's (1993, 1994) statistical techniques, core inflation is defined as *'the component of price changes which is expected to persist over the medium-run horizon of several years'* stressing, however, that a clear, precise and unanimous definition of core inflation has not yet come to light: *'While the term core inflation enjoys widespread common use, it appears to have no clear definition. In general, when people use the term they seem to have in mind the long-run, or persistent component of the measured price index, which is tied in some way to money growth. But a clear definition of core inflation necessarily requires a model of how prices and money are determined in the economy'*.

This paper is organized as follows. In the second section, using a simple aggregate supply and demand model, we demonstrate how when a central bank is suffering from imperfect information on the nature of inflation (whether they are transient or permanent shocks does not matter), the monetary policy results ineffective. In Section 3 the same model is generalized with the introduction of rational expectations. In section 4 we describe the various approaches in the calculation of core inflation and the implications for monetary policy management. In Section 5 we explore the criteria of choice with regard to these indica-

tors and analyze the implications for monetary policy. Conclusions are drawn in section 6.

2. A standard model to determine core inflation

The ability to achieve proposed monetary policy objectives is highly dependent on the model with which a central bank interprets the functioning of the economy. One of the key relations, relevant for almost all formal models, is the representation of the aggregate supply curve. The estimation of this curve may be further complicated by the possibility of distinguishing between output and inflation movements as a result of the shift in the aggregate demand with respect to transferences of the aggregate supply curve. An example could render this idea clearer. Let us suppose that the economic system can be represented by a simple aggregate supply and demand schema (logarithmic model) whose trend is reproduced in figure 1 (AD-AS lines).

Fig. 1. Supply and demand model with core and non-core shocks
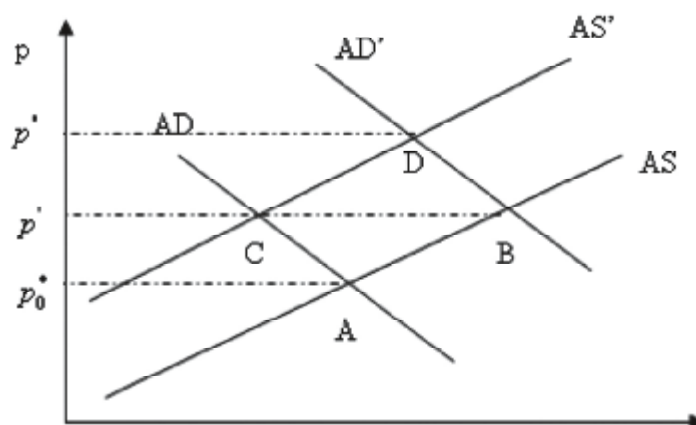
Source: our representation

Initially the economic system is in equilibrium in correspondence with point A; successively the system and therefore the price-output equilibrium is disturbed by two different idiosyncratic shocks. The first type of shock is that which shifts the demand curve from AD to AD′ and can be interpreted as a permanent shock (on consumer tastes, firm propensity to invest etc.); the second shock instead shifts the supply curve from AS to AS′ and is of a transitory type (a short-term oil price increase, for example). At the end of the period, when the shocks have made their effects fully explicit, the system finds itself in D. This price increase originated however from the combination of a transitory effect and a permanent effect: the latter shifted the balance of the system from A to B, while the transitory effect from B to D (with $p = p''$). The path that leads to point D can also follow another course (but is equivalent to the first): The transitory shock shifts the supply curve from AS to AS′ and the system is located in C, the permanent shock then takes the system to D. It is the final point, however, that interests us: in the wake of the shock, the economy will register an overall inflation equal to $I_{TOT} = p'' - p_0^*$. But how much of inflation is determined by transient factors (those that have determined supply movements and determine non-core inflation) and how much, instead, by permanent factors (that identify core inflation)?

Meanwhile, we note that a part of inflation, that generated by transient (non-core) factors, will disappear in a short space of time. In the period subsequent to that in which the shocks struck prices and in the absence of monetary policy interventions, the system will find itself in B with $p = p'$ and $I_{CORE} = p' - p_0^*$, i.e., with only core inflation. The task of the central bank, interested in intervening to isolate only the permanent effects, is to build an identifier schema to isolate the various components of the overall inflation . On the basis of this estimate it will proceed to formulate an 'optimal' monetary policy, or rather, effective in neutralizing only the permanent shock.

It is clear that if the identifying schema were to consent perfect identification and p_0^* was the only target, then the central bank would have an life easy: it would react in such a way so as to neutralize only the permanent type shocks (or rather, core inflation).

But if, as happens in reality, the price movements are not perfectly

distinguishable, the possibility of maintaining the declared target is compromised. In fact, it is possible to demonstrate that a central bank that does not base its monetary policy decisions on core inflation 'amplifies' the potential shocks of the system, with a consequent risk of increasing the output and overshooting variability with respect to the inflation objectives.

An example is useful here to understand the consequences of an incorrect evaluation of the nature of inflation. Let us suppose that the central bank has as its monetary policy objective the maintenance of a level of prices equal to p_0^*, and that this, in the initial period $t = 0$ represents the level of equilibrium of the system. The economy is represented by the following equations (AD-AS model):

$$p_t = m_t - y_t \qquad \text{AD}$$
$$y_t = y^* + (p_t - p_0^*) \qquad \text{AS} \qquad\qquad (2.1)$$

where p_t is the price level at time t and p_0^* the equilibrium price level at time $t = 0$; y_t is the product level at time $t = 0$.

Let us suppose, moreover, that in $t = 1$ the central bank observes a shock (positive) on the price level that shifts in this way from p_0^* to p_1^* but is not able to distinguish between permanent and transitory shocks. If the shock is purely transitory, the central bank does not intervene ($m_1 = m_0$) because it knows that in $t = 2$ the shock will disappear and the prices will return to $p_2^* = p_0^*$.

If, to the contrary, the shock is permanent (ε_p), the central bank will intervene with $\Delta m = m_1 - m_0 = - \varepsilon_p$, neutralizing its effects in this way.

At this point, it is possible to imagine two likely situations*. In the first case, the central bank interprets the price rise as permanent while, conversely, in the economy the inflationary pressures are determined by transient factors.

For the central bank the price level in $t = 1$ is determined by the following system of equations:

---

* It is clear that these are two extreme cases. In reality, inflationary pressures may be both permanent and transitory and can strike both aggregate demand and supply indifferently. It is possible to represent this situation more realistically with a more complex model, but the same conclusions would be reached. Our example particularly highlights the consequences of a wrong evaluation of the two types of effects.

$$p_1 = m_1 - y_1 + \varepsilon_p \quad (\varepsilon_p > 0) \quad \text{AD}$$
$$y_1 = y^* + (p_1 - p_0^*) \qquad \text{AS} \tag{2.2}$$

while the 'true' inflation model is:

$$p_1 = m_1 - y_1 \qquad\qquad\qquad \text{AD}$$
$$y_1 = y^* + (p_1 - p_0^*) + \varepsilon_T \quad (\varepsilon_T < 0) \quad \text{AS} \tag{2.3}$$

Since in this case, the central bank considers it has to activate itself to lead the system to p_0^* it is easy to verify that with $\wedge m = - \varepsilon_p > \varepsilon_T$ the central bank will implement a monetary policy that is 'too' restrictive obtaining in $t = 2$ a price level below its target ($p_2^* = p_0^*$). Vice-Versa in the case of $|\varepsilon_p| > |\varepsilon_T|$ This effect is graphically shown in Figure 2.

Figure 2. Model with non-core shocks and central bank intervention
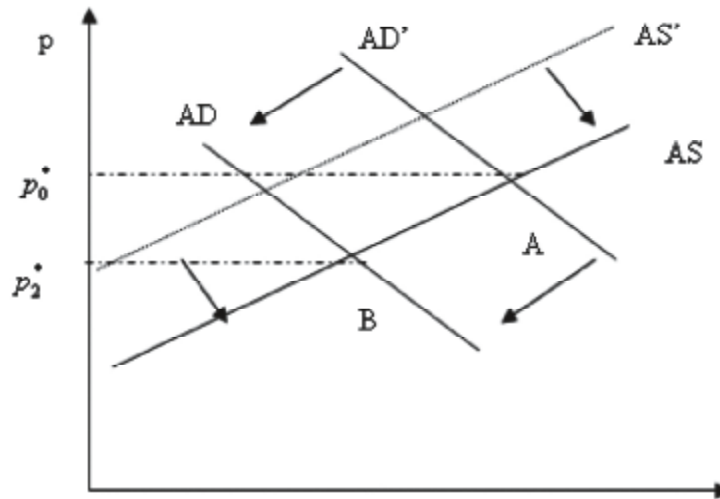
Source: our representation

Since in the system it is the supply curve that initially shifts to then return to its initial position, in $t = 2$ the restrictive monetary policy, due

to the effects of an erroneous interpretation of the nature of the inflation, will take the system to a lower price level than the equilibrium level that is the declared target in our example (from point A to point B or rather from p_0^* to p_2^*) with a negative impact on economic activity as well.

As an alternative to this case, we can suppose that the central bank interprets the price rise as a non-core shock, and therefore does not require intervention, while in reality the effect is permanent and requires restrictive intervention.

In this case the central bank's model for the determination of prices is:

$$
\begin{aligned}
p_1 &= m_1 - y_1 && \text{AD} \\
y_1 &= y^* + (p_1 - p_0^*) - \varepsilon_T && \text{AS}
\end{aligned}
\tag{2.4}
$$

whilst the 'true' model is:

$$
\begin{aligned}
p_1 &= m_1 - y_1 + \varepsilon_p && \text{AD} \\
y_1 &= y^* + (p_1 - p_0^*) && \text{AS}
\end{aligned}
\tag{2.5}
$$

Figure 3. Case with core shocks and non-intervention by the central bank

Source: our representation
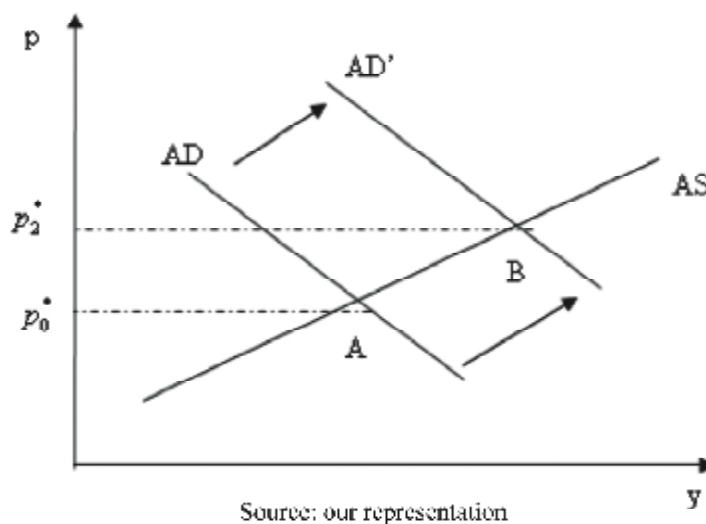
Since $\Delta m = \mathrm{m}_1 - \mathrm{m}_0 = 0$ it is easy to verify that in $t = 0$ the price level is above the target set by the central bank $(p_2^* > p_0^*)$.

The situation is graphically analyzed in figure 3. Setting off from point A, which represents the equilibrium of the system, the bank identifies the observed inflation as non-core and therefore deeming it unnecessary to intervene. Since the price shock is instead permanent, it determines a shift towards the top of the demand curve with a final impact of core inflation equal to $I_{CORE} = p_2^* - p_0^*$ (point B in the graph).

These examples, although highly simplified, highlight the key points of our discourse: the effectiveness of the monetary policy, in terms of controlling price stability, depends on the authority's capability to distinguish between monetary demand shocks (permanent) and supply shocks (transient in nature).

At this point, it is appropriate to make two brief clarifications. First, it must be borne in mind that monetary policy does not generally only pursue the stability of prices but also that of the product. When monetary policy rules are more complex in order to take account of effects on output, then the reference model must be modified thus obtaining conclusions that are generally different from those in this and the subsequent sections (Hogan et alii, 2001). Secondly, the role of the expectations in the economic system must be considered. These could 'amplify' the distorted effects produced from a monetary policy that does not distinguish between permanent and transitory effects. The following section aims to clarify this point further.

3. A model to determine inflation with rational expectations

In the example in the previous section is has been more or less implicitly assumed that agents' expectations are static. In this section, we change this hypothesis and assume that agents are equipped with forward-looking expectations, generalizing the model in the preceding section and assessing the efficacy of monetary policy when the monetary policy authority is unable to distinguish between transient and permanent shocks. In this new context, the system will be thus be represented by the following equations (in which, for analytical convenience, AS is made explicit in prices).

$$p_t = m_t - y_t + \varepsilon_p \qquad \text{AD}$$
$$p_t = p_t^e + (y_t - y^*) + \varepsilon_t \quad \text{AS} \qquad (3.1)$$

As in the case in the preceding section, we assume the central bank pursues only the objective of stable inflation, or rather, a price level equal to p_0^*, which also represents the system's state of equilibrium at the time our story begins. The monetary policy instrument is m_t, the amount of currency in the economy at time t, and we suppose that it is perfectly controllable (instantly). This instrument may be used by the central bank to neutralize any shocks on the equilibrium price level, taking the system towards the assumed target price level.

More specifically, let us suppose that at $t = 1$ a shock intervenes on prices which therefore rise from p_0 (initial level) to p_1 (new level following the shock). The central bank, having as its objective to stabilize prices at the level p_0, will follow the following monetary policy strategy. If it considers that the shock is permanent, it will intervene by varying the amount of currency in order to neutralize it. Therefore, if the shock is equal to ε_p, the amount of currency will increase from m_0 to m_1, such that $\Delta m = m_1 - m_0 = -\varepsilon_p$.

If, to the contrary, it considers that the shock is of a transitory type, then it must do nothing other than wait for the effect to exhaust itself (at time $t = 2$) and, therefore, leave the amount of currency unchanged.

As we demonstrate below, in both cases the monetary policy will be effective.

First, let us suppose that we are in $t = 1$ (a time in which the permanent shock manifests its effects $\varepsilon_T = 0$) and we apply the expectation operator (rational) to both equations (3.1). In this case, the equation system (3.1) will be:

$$y_1^e = m_1^e - p_1^e + \varepsilon_p^e \quad \text{AD}$$
$$y_1^e = y^* \qquad \qquad \text{AS} \qquad (3.2)$$

Equalizing the two equations and making the expected price level explicit, we have:

$$p_1^e = m_1^e - y^* + \varepsilon_p^e \tag{3.3}$$

which, substituted in the supply equation and made explicit in prices, determines:

$$p_1 = m_1^e - y^* + \varepsilon_p^e + (y_1 - y^*) \tag{3.4}$$

Again substituting (3.4) in (3.1) and following several algebraic passages, we have an equilibrium income level in $t = 1$:

$$y_1 = y^* + (m_1 - m^e) + (\varepsilon_p - \varepsilon_p^e) \tag{3.5}$$

With substitution in the demand function, we obtain the equilibrium price level in $t = 1$:

$$p_1 = m_1 - y^* - (m_1 - m_1^e) - (\varepsilon_p - \varepsilon_p^e) - \varepsilon_p \tag{3.6}$$

Except for random disorders (which for simplicity we assume are nil), the agents' expectations will anticipate the monetary authority's choices neutralizing the effects ($m_1 = m_1^e$) and will formulate better expectations on the disturbances of the system consistent with the information available to them ($\varepsilon_p = \varepsilon_p^e$). In the final analysis in $t = 1$ the system (3.6) becomes:

$$p_1 = m_1 - y^* + \varepsilon_p \tag{3.7}$$

Since in $t = 0$: $p_0 = m_0 - y_0$, the inflation in the system will be attained by the difference between prices in $t = 1$ and $t = 0$ (for simplicity let us assume that $y^* = y_0$):

$$p_1 - p_0 = (m_1 - m_0) + \varepsilon_p \tag{3.8}$$

However, should the central bank identify the precise nature of the shock, it will vary the amount of currency to the level m_1 and obtain $m_1 - m_0 = -\varepsilon_p$. In this case, the monetary policy was effective because it maintained the price level to $p_1 = p_0$, or rather, it defended the declared target.

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The problem is that the central bank is unable to identify this shock or obtain correct information on the nature of the shock, whether temporary or permanent. In this case, the monetary policy will be totally ineffective with respect to the objective of price stabilization at the level of p_0. This proposition is not difficult to prove.

If, in fact, the central bank had a distorted idea of the origin of the shock, it would interpret the transitory shock as permanent. Since in this case it should intervene with an active monetary policy, it 'will produce' inflation[†], unable to maintain the declared target. In fact, if prices have increased as a result of a transitory type of shock on the supply side then the model of the economy (in $t = 1$) will be:

$$y_1 = m_1 - p_1$$
$$y_1 = y^* + (p_1 - p_1^e) - \varepsilon_T \quad (\varepsilon_T > 0) \tag{3.9}$$

or rather, made explicit in prices:

$$p_1 = m_1 - y_1$$
$$p_1 = p_1^e + (y_1 - y^*) - \varepsilon_T \tag{3.10}$$

Resolving as in the previous case, we arrive at the following expression of the output equilibrium:

$$y_1 = y^* + (m_1 - m_1^e) + (\varepsilon_T - \varepsilon_T^e) \tag{3.11}$$

which, substituted in the demand equation, will give us the equilibrium price:

$$p_1 = m_1 - y^* - (m_1 - m_1^e) - (\varepsilon_T - \varepsilon_T^e) \tag{3.12}$$

If the expectations are rational, the last two terms will be annulled and will it remain as:

$$p_- = m_1 - y^* \tag{3.13}$$

[†] More generally the central bank "will produce" further price instability.

Since the central bank has made a mistaken evaluation of the origin of the shock and interprets the shock ε_T as if it were ε_p, it will adopt, as declared, an active monetary policy, changing the amount of currency, which will shift from m_1 to m_0 with $\Delta m = -\varepsilon_p$. Therefore, in $t = 1$ the change in prices will be equal to:

$$p_1 - p_0 = (m_1 - m_0) = -\varepsilon_p \qquad (3.14)$$

(3.14) admirably conveys the idea of the proposition we want to demonstrate and provides a clear implication for economic policy. The information imperfections that the central bank is subject to in making its decisions can have rather serious consequences on maintaining price stability.

If $\varepsilon_p < 0$, an active monetary policy designed to neutralize a permanent type shock (transitory) and it is instead of the transitory type (permanent) then it will 'produce' inflation. The declared target will not be respected and this will affect the expectations of economic operators, which in turn, will have repercussions on the overall economic activity (and vice versa in the case in which $\varepsilon_p < 0$).

In this example, which could however be further enriched, it is easy to understand the importance of the indicators or schemas that can signal the true nature of the shock to the central bank, whether they concern core inflation or not. Some of these indicators and identification schemas (at least those most frequently used by central banks) are described in the following section.

4. Alternative approaches to the measurement of core inflation

Even though the term core inflation is often identified with inflation net of 'food and energy' components, alternative measures of core inflation have been proposed. The existence of various definitions and measures reflect the absence of a widely accepted definition of core inflation. Simplifying to the maximum, it is possible to classify these alternative measures according to two macro-approaches. According to Mankikar and Paisley's (2002) terminology, there is a *statistical approach* and a *model-based approach* or *modelling* approach.

The statistical approach focuses attention on a practical problem linked to the identification of a measure of core inflation. It derives core inflation measures through the construction of an aggregate price index. This construction comes about through both the exclusion of certain goods of the price index and through a very precise weighting of the price index components, but also through the use of "smoothing" techniques of the historical series included in the index.

Instead, the model-based approach derives measures of core inflation through imposing identification restrictions on models based on economic theory, in a context of multivariate econometric analyses. In this approach, attention is focused on the conceptual problem of how to define core inflation. It leads to estimates that may be associated to models with dynamic factors or as components of measured inflation with particular effects from the interaction with other variables (Velde, 2006; Quah and Vahey, 1995).

Further examination of the statistical approach and that based on models is the subject of the two next subsections.

4.1 *The statistical approach*

The historical reference of this approach can be found in the work of Bryan and Cecchetti (1993). There have been subsequent improvements and additions by the authors themselves (Bryan and Cecchetti, 1994; Cecchetti, 1996; Bryan, Cecchetti and Wiggins, 1997).

Researchers using this approach focus attention on the problem of how to measure core inflation directly from existing data. They typically use price indices or rates of inflation as their starting point, then ask how the available data can be manipulated to provide an accurate estimation of core inflation. Operationally this approach is applied to disaggregated CPI data, using cross-section or historical series methodologies.

The cross-section methodology 'constructs' core inflation using information relating to components of the CPI and follows the original Bryan and Cecchetti (1993) definition according to which core inflation is '...' (Bryan and Cecchetti, 1993, 1994; Bryan, Cecchetti and Wiggins, 1997; Cecchetti, 1996; Wozniak, 1999).

The historical series methodology measures core inflation based on the statistical properties of the historical series of the CPI (Blinder, 1997; Culter, 2001; Smith, 2004a; 2005b). This methodology selects measures of core inflation with a high predictive power via three stages: (1) the selection of historical series that produce the best forecast; (2) the identification of optimal weights to be associated to components of the CPI; (3) the re-weighting of CPI components so that the historical series sub (1) chosen has a larger weight.

A characteristic of this approach is that none of the measures are 'supported' by a specific model, or rather, none of the measures represent a theoretical model. We can generally state however, that the choice of methods used to identify the components of core and non-core inflation can be explained through simple and rudimentary models of price determination similar to those presented in the preceding sections. The statistical methods of analyses, for example, applied to cross-sectional price changes, distinguish two basic categories of the problem: *noise* and *bias* components. *Noise* components refer to all the temporary shocks that do not impact on prices in the long term and whose effects decrease in time. These shocks have a strong influence on prices in the short or very short term (monthly or quarterly frequencies). *Bias* components refer to shocks that strike the weights of the CPI, permanently modifying the weighting system.

From the vast literature on this approach (Roger, 1995; Cecchetti, 1996; Bryan, Cecchetti and Wiggins, 1997; Wozniak, 1999) we can identify six alternative methods for the calculation of the indices:

(a) the specific adjustment method;
(b) the exclusion method;
(c) the trimmed means method;
(d) the average weighted method;
(e) the standard deviation trimmed means method;
(f) the percentile method.

(a) The specific adjustment method's objective is to eliminate shocks that are not directly connectable to inflationary pressures on the demand side. Such elimination is normally carried out case by case, according

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to specific ad hoc hypotheses. According to Roger (1995), the objective of the specific adjustment method is to *'purge the headline series of the estimated effects of specific types or sources of disturbance when they occur'*. This method is particularly powerful when information relevant to the effects of price shocks is immediately available. In this way, the task of eliminating the 'undesired' components can be punctually affronted and the effect of a shock on a subcomponent of the CPI may be removed without impacting on the price movement of the remaining components. There is, however, a clear arbitrary element in identifying the shock, and, furthermore, *'... is probably better suited to dealing with generalized price level shock than with shocks to particular prices... . The more indirectly that shocks feed into the price level, the more difficult it is to make specific adjustments'* (Roger, 1997).

(b) The exclusion method consists in omitting from the CPI those categories of goods and services that are traditionally very sensitive to shocks on the supply side and normally self-transient. These categories are, for example, agricultural products, electricity and natural gas, and various types of fuel and tobacco. Agricultural products (cereals, fresh fruit, vegetables and plants) are the most volatile components of the CPI due to their high sensitivity to seasonal factors and natural supply shocks according to the conviction of a large number of researchers: *'During periods of poor weather, for example, food prices may rise to reflect decreased supply, thereby producing transitory increases in the aggregate index. Because these changes do not constitute underlying monetary inflation, the monetary authorities should avoid basing their decisions on them'* (Bryan and Cecchetti, 1993). A unanimous agreement to exclude oil from core indices followed the 1970s oil shocks (Clark, 2001), even though it was known that price excursions were not as frequent or as large as those of agricultural product prices. The exclusion of all these goods should produce an inflation measure close to the central trend and reflect the state of demand in the economy (Roger, 1995; Wozniak, 1999). The exclusion method resets the weights of goods excluded from the basket when the weighted price index is calculated. Although used in practice by many central banks, it has several drawbacks: exclusion of too many components of the CPI can determine the neutralization not only of the noise effects, but also of important information on the real inflationary pressure.

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(c) The trimmed means method is the systematic exclusion of goods with large price excursions, regardless of the group of goods they belong to. Setting the weights to zero, all prices of goods that manifest strong upward or downward trends are automatically excluded. This method allows 'smoothing' the series of price indices and, at the same time, to eliminate distortions related to the calculation of the sample mean. According to Wozniak (1999), intuition of this method consists in taking account of the fact that the sample mean gives a distorted estimate of true inflation (core) because of exogenous shocks on the prices of certain goods. In this sense, the approach excludes, or rather, rejects data that manifests extreme price variability. If the distribution of prices is symmetrical to the average price, the exclusion of extreme values does not change the sample mean. However, if the distribution is asymmetrical, exclusion shifts the sample mean downwards (in the case of positive asymmetry) or upwards (in the case of negative asymmetry). The economic justification behind this method is mainly due to the dynamics of relative prices that temporarily affect aggregate price levels, causing a short-term shock. Some models, moreover, demonstrate that large fluctuations in relative prices cause higher inflation (Ball and Mankiw, 1994, 1995), others instead demonstrate that a growth in inflation causes a fluctuation in relative prices (Shlelishinki and Weiss, 1977).

(d) The weighted median method was first proposed by Bryan and Pike (1991). It is methodologically similar to the trimmed means method and consists in the calculation of the median prices of all the components of the CPI. The main difference with respect to the previous methodology is that the median weighted method uses all components of the CPI rather than eliminating some, lowering the risk of losing information relevant to evaluating inflation.

(e) The standard deviation trimmed means method consists in excluding from the CPI all those prices that have expressed large excursions in a certain month compared with the same month of a base year. The principal defect of this method is that prices are excluded without real knowledge of the origin of the shock. Consequently, in using this method it can happen that useful information on prices is discarded such as, for example, the variation of state-controlled prices that play an important role in the formation of the expectations of individuals. For further de-

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tails see Bryan, Cecchetti and Wiggins (1997) and Wozniak (1999).

(f) The basis of the percentile method is the consideration that, since the sample mean is an estimator that is not distorted by the real average, the percentile of price distribution that corresponds to the sample mean should also be an undistorted estimator of the average empirical distribution (Roger, 1997; Wozniak 1999). The mechanism by which this method operates is to compare all price distributions of the CPI components and find the percentile that corresponds to the sample mean. The key idea is that the distribution of price variations in the CPI in a certain period presents an individual sample of the population. This sample is interpreted as a set of core price variations.

4.2 *The model-based approach*

In this approach, core inflation measures are estimates of a theoretical model. In substance, core inflation estimates are conditioned by information contained in other variables, in line with economic theory. In this case, core inflation is the result of an identification schema in which the persistent elements are distinguished from the temporary.

A structural approach for such identification was originally described in the work of Quah and Vahey (1995). The theoretical framework behind this approach is that in the long term, inflation reflects the state of demand in the economy and does not to influence the product. It is clear that unexpected price shocks can lead to significant changes in the economic structure, with effects on the product both in the short and long term. According to Quah and Vahey (1995) the inflation measure based on the CPI can be erroneous due to the high sensitivity of various non-monetary factors. In this respect, the authors suggest breaking down the inflation measure into core (obtained by identification) and non-core (obtained as a residue) components. In this context, core inflation is the component that does not influence the real product in the long term and reflects the state of demand in the economy. In other words, aggregate inflation is decomposed into a measure of core inflation that is not associated with medium and long-term movements of the product and a residual element that is associated with persistent effects on output. This decomposition is based on a structural VAR model that includes

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the inflation rate (changes in the CPI) and a measure of the aggregate product, together with the restrictions on the properties of the nuisance parameter of the system. In Quah and Vahey's (1995) model, two types of disorders particularly disturb the balance of the economy: a permanent disorder (core inflation shock), which has an effect on product and on inflation in the short term, requiring that output be neutral in the long term; a temporary type of disorder (non-core inflation shock) that has permanent repercussions on the product, but is constrained to not having any impact on the core inflation measure. In short, the decomposition of the historical series of inflation is effectuated according to information on the persistence of the effects on the product.

The theoretical model that is the basis of Quah and Vahey's approach presupposes that the Phillips curve is vertical in the long term. This hypothesis at first sight may seem harmless and not overly simplistic. In fact, if we accept that the Phillips curve is vertical in the long term then we are assuming that inflation is neutral in its effects on the real economy. This issue is not that obvious for at least two reasons. First, even fully anticipated inflation can have real effects, as many studies have documented (Fisher and Modigliani, 1978). More generally, to the extent that inflation is a tax on the detention of currency, variations of this tax can have implications on the decisions of agents on the amount of balances to detain, which in turn will produce further real effects.

Secondly, if price stability is the only objective of monetary policy and if we accept not only that the core inflation identified by Quah and Vahey corresponds to the component of inflation that is under the control of the monetary authority but also that it is neutral with respect to output in the long term, then the question of why a central bank should maintain price stability arises. In fact, if it controls price levels in the long term and if the rate at which these grow does not have effects on the level of the real economy, then one rate of inflation is worth another. There is no reason to prefer a 2% inflation rather than 20%. Price stability should not play any role as concerns monetary policy objectives.

A more realistic assumption could be that the Phillips curve is not vertical in the long term, but negatively inclined in the short term as in Friedman's (1977) formalization. Such an assumption encapsulates the concept that inflation in the long-term is costly to society, but less easy to identify.

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Beyond these conceptual difficulties, this technique presents other problems related mainly to the transposition phase of the model in a practical measure. The same authors advise caution in using this methodology. In particular, they note that it may not be appropriate to synthesize all non-core disorders into a single type of shock. As Fase and Folkertsma (1996) noted:

'The assumption that all other changes in measured inflation and output may be explained by a single type of shock which invariably influences the endogenous variables in the same way may be seen as no more than an approximation'. The Claus model (1997) in this respect includes other variables in the VAR, representing different price dynamics in relation to the nature of the shocks. Fase and Folkertsma (1996) also point out that, when VAR is estimated in the primary differences (as in the original Quah and Vahey (1995) and Claus (1997) articles)), the models do not identify the level of core inflation, but only variations in the level. Clearly, for a central bank with a target level of inflation this is not a negligible problem: if the objective is to control inflation, the indeterminateness of the level of the rate of inflation is clearly an issue. This point is even more important if the central bank pursues inflation targeting, since its explicit task is to make the rate of inflation stationary.

But beyond technical issues, the implicit methodology in the approach does not satisfy the principal properties desirable in a measure of core inflation for various reasons. First, the choice and the number of variables to include in the VAR are at the discretion of the researcher. By way of an example, Quah and Vahey (1995) choose the CPI as a price variable, while Fase and Folkertsma (1996) construct a weighted average of the various prices. Likewise for the choice of the output measure: Quah and Vahey (1995) use industrial production, Gartner and Wehinger (1998) use the GDP in real terms. Clearly, the choice of one variable over another alters (sometimes considerably) the results and, therefore, the measure of core inflation. In addition, while the variable choices may be on a par, the results of the VAR will vary in relation to the sample period used. In fact, once the VAR has been updated, the estimates change and the model may not prove robust.

Finally, there is a problem linked to the interpretation of results. The difference between measured and estimated inflation cannot be easily

explained in terms of identifiable shocks. The authors generally identify periods in which movements in the exchange rate can explain the divergences between the core and official measure of inflation, but there is no evidence that corroborates this explanation and neither is there an explanation for the other differences. In these cases, the difficulty is that the VAR approach must be very simple in order to be manageable; but this simplicity is at the expense of a full understanding of the causes of shocks on inflation.

5. Choosing the optimal measure for monetary policy

The choice of which indicator of core inflation is considered 'optimal' for monetary policy is not easy. This choice will be affected by both the criterion with which it is chosen and the objectives of the monetary policy.

There is currently no uniformity in the choice of a formal criterion with which to assess the accuracy of a core inflation indicator. Generally, central banks select the criterion on the basis of its adaptability with respect to monetary policy objectives. Literature has however considered some important attributes or criteria desirable to measure core inflation. According to Wynne (1999) the evaluation of such measures should be made according to the following criteria:

1) Transparency in the construction. A core measure of inflation should be constructed in a relatively transparent and easy way such that it facilitates communication of the concept to the public.
2) Similarity in the average. A core measure should have an average comparable with that of the historical series of inflation chosen as a reference to monetary policy in the long term.
3) Identification of the inflation trend. A core measure should show consistency in the inflation trend compared to that of the historical series chosen as a reference to monetary policy.
4) Explanatory content. A core measure should be able to explain the movements in the historical series of inflation choices as a reference to monetary policy, as well as provide information on future developments.

Many studies assessing the performance of core measures are con-

centrated only on some of these criteria. Cogley (2002), for example, prefers measures that show a good capacity of adaptation in the within-sample regression (as partly foreseen in criterion 4). Bryan and Cecchetti (1994) examine the predictive within-sample capacity of the indicators but also the out-of-sample's. Wynne (1999), and Bryan and Cecchetti (1994), note that the rationale for the construction of a core index must be to identify the common component of price variations attributable to monetary policy. If this is the objective of a core price index, then it is not clear why the measure of price indices should be reduced to price index elements such as the CPI. The difficulty is that monetary policy has complex effects on the demand of the different types of product. The effects on demand are not necessarily similar in the prices of all subjects (different types of families and businesses); nor is there a good reason to assume that the distribution of the effects of monetary policy on prices of subjects remains stable over time. Clarke (2001) considers the measures of core inflation in view of their complexity, similarity in the average, identification of the inflation trend and within-sample explanatory capacity. Silver (2006) discusses a wide range of comparison criteria to judge the relative merits of core measures proposed.

Given the lack of a common performance criterion for core inflation measures, it is difficult to select a criterion for an 'optimal' monetary policy. In substance, it is a problem of adaptability of the criterion to the objectives of monetary policy that the central bank is proposing. The risk is to select 'good' indicators under a performance profile but little 'adaptable' to the objectives of monetary policy; conversely, a not particularly reliable criterion could be 'aligned' to the objectives of the monetary authority.

There are, therefore, two aspects which are closely interconnected but conceptually distinct in the selection of core measures: one aspect concerns optimality of the indicator with reference to the objectives of monetary policy and comparing the effects of inflation with the declared target; the second aspect concerns the procedures to define and measure the core indicator in an attempt to differentiate between temporary and persistent causes or to decide on which price index variation to focus monetary policy.

If the measurement method is effective in distinguishing between

short and long-term price movements and if this method is not in contrast with the objectives of monetary policy, then the measure of core inflation becomes a genuine instrument of monetary policy. Ideally a core measure should be:

(a) a good indicator of current and future inflation trends;

(b) a reliable reference for monetary policy

In relation to point a), we would do well to remember that monetary authorities often monitor a large quantity of data on the current state of the economy and on the rate of inflation. This ensures that the most recent information is incorporated in current decisions. However, because the monetary policy has a bearing on inflation with often long and variable delays, central banks must have a tool to assess the future evolution of inflation. The core measure supports the analysis of the new scenarios, providing a means by which the monetary authorities can separate short-term fluctuations from the most persistent. From this point of view, the most useful measures of core inflation manage to minimize the deceptive signals on current trends and future inflation. As an indicator, core inflation is a guide to policy-makers to make decisions that must be oriented to the objective chosen. Those responsible for monetary policy can respond to the indicator at their discretion or may take a less discretionary approach and incorporate the indicator in the policy rules. For example, the so-called *Taylor rules* use the current inflation deviation of the target as a guide for policies[*].

If the policy-maker is also able to distinguish between temporary and persistent fluctuations then core inflation may be a useful instrument for monetary policy. In many cases, this measure is also made public, aiding in the communication or transparency of the policy, since it clarifies in which way policy-makers react or not to fluctuations in the official inflation rate. Its use in the communication of the policy may also improve public understanding of the concept that the policy is tied to persistent movements in inflation.

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[*] In the case of the *Taylor rules*, the central bank adopts a rule for the variation in the interest rate. It is possible, however, to demonstrate the equivalence of the rule with the case in which the central bank controls the money supply, as in our example (Romer, 2000).

Furthermore, certain core inflation measures could be considered more controllable by the monetary authorities than the official inflation rate. Due to the fact that the use of an instrument implies that the monetary authority will accept the responsibility for inflation ex post, it makes sense to define the instrument in terms of inflation measures that are controllable ex ante. This could be an important element for high-quality inflation 'accounting', in the sense that the measures indicated in the preceding sections may be appropriate indicator-instruments, both direct and intermediate.

6. Conclusions

The success and effectiveness of a monetary policy in terms of stability of the price level depends on how much the measures of inflation reflect long-term movements or include temporary shocks. Although the consumer price index (CPI) is used as an inflation target, the central banks must draw up other indices to detect inflationary pressures. Inflation measures purified from transient price shocks are particularly significant. The high impact of non-monetary factors on a measure of inflation can, in fact, lead to significant price volatility, begetting the question of how much inflation is the result of a persistent (or long term) effect and how much reflects only short-term effects. If, in fact, the inflation measure contains short-term effects, the task of controlling inflationary pressures is considerably more complicated. Indicators purified from transitory components identify core inflation, but as yet no common methodology for its calculation exists. There are however various methods to identify it that can be classified into two large groups: statistical methods linked to the approach focusing attention directly on the issue of how to measure core inflation from existing data; and methods linked to the modeling approach in which estimates of core inflation are conditioned by economic theory and are the result of identification schemas where the persistent elements are separated from the temporary. Each method has its advantages and disadvantages and in practice, there is an inclination to base decisions on a battery of indicators, comparing the differences and evaluating them case by case.

Finally, the choice of which indicator of core inflation is considered

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'optimal' for monetary policy will depend on both the guideline criteria on which it is selected and the objectives of monetary policy though several of the evaluation criteria (transparency in construction, similarity in the average, identification of inflation trends, explanatory content) or parts thereof, are adopted by almost all central banks.

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FROM NASH EQUILIBRIUM TO DARWINIAN EQUILIBRIUM IN THE EVOLUTIONARY GAME THEORY

Abstract

The main purpose of this paper is to delineate the contemporary development of Game Theory as regards to the evolutionary approach, whose scientific value is due to its interpretative capability of real phenomena both in biologic-genetic and in economic field. In the paper it is shown that these studies, which are based on the idea of "evolutionar(il)y stable strategy" and on "replicator" dynamics, implied the overcoming of the deadlock situation in which Game Theory had come because of the multiplicity of Nash equilibria, in spite of the numerous attempts to analyze a selection process of this type of equilib-rium by studying its refinements. In the paper there are also some references to the main mathematical aspects of evolutionary games and to interesting applications of this approach to economic contexts.

1. Introduction

From a non superficial analysis of the games that in literature are qualified as "dynamic", it emerges that their dynamic connotation resides only in the variability of the players actions in the different subsequent states. Such actions nevertheless are a consequence of combined strategies pre-existing the same dynamics. In order to understand such observation it is enough to think about a game represented in the exten-

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sive form, that can be seen as a dynamic game if time is considered in order to identify the passages through the various "knots" of the "tree" representation, according to a sequence deriving by a "first move" and also bound to a pre-defined scheme of possible consequent actions even in a multi-alternative way. We could also say that in the dynamic games the elements in comparison, that is to say, in conflict, are perfectly rational individuals, while in the evolutionary games the conflict takes place among strategies, that acquire the role of "players."

The complexity and the elevated variability of the economic contexts to which often and in more and more intense way the Theory of Games is applied, have induced the researchers of "intelligent"[1] choice methods, to widen the elementary dynamic structure of the aforesaid games.

Before the interesting developments of the evolutionistic approach, the literature on the Theory of Games had reached a deadlock situation, due to the problems of analysis correlated to the multiplicity of Nash equilibria and to the numerousness of its refinements finalized to the individualization of a method for "choosing" an equilibrium in the inside of that multiplicity. The problem of the choice of Nash equilibria has only apparently been resolved by the research of its refinements, in fact, once seen the elevated number of the latter, every Nash equilibrium in a context with multiple equilibria ended up finding a reason to exist.

The individualization of the equilibrium toward which the system places itself dynamically and spontaneously is the result of an analysis that keeps in mind how the gen-erations of rational and intelligent subjects modify their own beliefs and rules: the equilibrium to which we come to, allows to observe (as to say, ex post) the validity or the non-validity, as well as the consistence, of the strategies that the subjects themselves have formulated according to their beliefs as well as their objectives. All this can be studied in a rigorous way if we use a model based on an evolutionistic approach, in which the "evolution" takes the

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[1] Keep in mind this interesting definition: the Theory of Games is an area of Mathematics that studies models of con-flict and cooperation among rational and intelligent agents. With the term "rational" it is intended to characterize every agent that maximizes his objective function (expected utility, profit). With the term "intelligent" it is intended to attribute to the agent the ability to become aware to inte-ract with other subjects that are rational and intelligent and, therefore, it is intended to give him the propensity to take decisions according to the suggestions deriving not only by a pure individualism, but also from the interaction with the others ("strategic interaction").

form of "cultural evolution."

In Game Theory, by the adjective "evolutionary" it is intended to characterize the approach that has had origin from a stream of research in biological field, primarily fed by geneticists, whose studies were finalized to the justification of some specific equilibria within biological and natural phenomena. Also in regarding to the classical Game Theory it can be said that it has broadly been applied to biology, even though it had been conceived by Von Neumann and Morgenstern (Von Neumann, Morgenstern, 1944) for the study about the economic behaviours.

One of the fathers of the Evolutionary Game Theory is John Maynard-Smith, who, in 1972, published an article entitled "Game Theory and the evolution of fighting" (Maynard-Smith, 1972), which it is deemed to contain the roots of the modern approach of the theory of games. His contribution was subsequently improved in cooperation with George Price (1973). To say the truth it must be said that these articles had been preceded by the work of the geneticist Fisher (1930) who had already been dealing with the theme of the natural selection, with characteristics tightly similar to the one treated by Maynard-Smith.

Another meaningful contribution, previous to the development of the evolutionistic literature of games, has been furnished in 1969 by the researcher David Lewis, who correlated the classical Theory of Games to implicitly cooperative behaviours of people speaking the same language, creating more than one interesting and fascinating hint for the analysis of linguistic processes to be considered as evolutionary games.

In this synthesis of the scientific background that precedes the contemporary developments of the Theory of Games, it is not possible not to make reference to the thought of Charles Darwin (1859). In fact it is sure that the Darwin's ideas about the natural selection and on the biological evolution have influenced the economic theory, and it cannot be said if it has been done in a direct or indirect way, in at least two great fields of study: the neoclassic theory and the evolutionary game theory. Within the neoclassic theory the processes of natural selection are those that allow the optimizing agents, being perfectly rational, to survive to the risks of exclusion from the market, whose vic-tims are the least rational subjects or those who are not able to operate efficient choices both in a technical sense and in an economic sense. In this kind

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of studies, evolutionistic type reasoning have been, therefore, used for defending the hypothesis, rather unrealistic, of the existence of perfectly rational subjects that would apply the principle of individual rationality (cost-benefit analysis) with instrumental mathematical ability. There is to say that the evolutionary approach has also been used for explaining, contrarily, irrational behaviours like those that produce the speculative bubbles in the financial markets, on the base of analysis of the "flock" behaviour, that is, of the behaviour produced by the adjustment to the choices of the majority. The influence of Darwinian ideas on the Evolutionary Game Theory is more evident and profitable, and it can be interpreted as the contribution that Darwin would have had "to pay" to the economic science in order to cure one debt of his, considering that he himself affirms to have thought for the first time about the natural selection following the reflections induced by the reading of the *Essay on the Principle of Population* published by Malthus in 1798.

2. The Theory of Evolutionary Games

The Theory of Evolutionary Games has developed beginning from the Eighties after the publication, in 1982, of the book *Evolution and the Theory of Games* by J. Maynard-Smith and it has the great merit to have given value and significance to the concept of Nash equilibrium, especially in contexts in which a multiplicity of such equilibria are present.

In fact Nash himself has observed how the notion of equilibrium defined by him becomes more reasonable if it is seen as the result of a dynamic process based on the learning deriving from a succession of phases not perfectly rational: a Darwinian dy-namics of a cultural type could be a model of such process. It can be said more precisely that, according to the cooperative or non-cooperative results of the interaction of rational subjects, a cultural type selection process is determined owing to the fact that, in each following stadium, the behaviours or strategies that have produced more advantageous results are adopted by a greater number of subjects creating, in this way, a modified cultural configuration in comparison to the initial one. When there are more possi-ble equilibria, the one characterized by the so-called "evolutionary stability", will be able to affirm itself, revealing to be resistant to following mutations.

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In other words, among the strategies of a population of players, some will be des-tined to disappear, while others will spread, and this will happen according to their "reproductive success", to their *payoff*. The strategies therefore undergo an evolutionary process that conducts, through the "winning" strategies, to the selection of an equilibrium.

The Theory of Evolutionary Games studies this type of selection hypothesizing a context in which limitedly rational players are present and they are casually extracted from a wide population. The hypothesis of limited rationality is to be intended as hypothesis of "adaptive behaviour", which is not based on rigorous reasoning, but on the learning deriving from the repetition of the game and on the consequent adaptation to the strategies that have implicated the greatest relative success.

The strategies adopted by the players are not conceived as the result of the rigorous application of the principle of individual rationality, but as schemes of behaviour acquired through the genetic and cultural transmission. In other words the concept of hu-man rationality is replaced by the evolutionary stability. The advantage inherent in the evolutionistic approach to the Theory of Games, which can guarantee a sure success, is in the fact, as John Maynard-Smith says, that in the reality, there are many reasons to expect that the population of the players evolves toward stable states and there are, instead, many doubts about the rationality of human behaviour.

In the models finalized to the analysis of evolutionary contexts the dynamic connotation, predominantly not linear, becomes richer compared to the classical formulation within which, even if it could be referred to dynamics, anyway this was based on predetermined schemes. In the Theory of Evolutionary Games the change becomes protagonist and it involves the number of the individuals, the individual and group strategies, the number of the competitions that must be faced, always producing new configurations, from which taking, again, the moves for following games.

Exactly for all these aspects it is affirmed that paradoxically the Theory of the Evolutionary Games could better apply to the economic behaviour than to the animal behaviour to which had initially been designated, as paradoxically, according to Maynard-Smith, the classical theory of games is better applied to biology and to the animal behaviour rather than to the economy for which it had been thought by von Neumann and Morgenstern.

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3. A fundamental element of the Theory of Evolutionary Games: the concept of evolutionarily stable strategy

In the development of Evolutionary Game Theory a fundamental stage is marked by the rigorous definition of a new type of strategy, characteristic of competitive contexts in evolution: the evolutionary stable strategy or the evolutionarily stable strategy (ESS). These strategies are such that their results cannot be improved by the realization of any other alternative strategy. The definition of ESS implicitly contains the punitive component of the strategy itself, implicating the loss of part of the *payoff* for every possible deviation. Insofar, if the population of the players chooses an ESS, the latter is destined to be the winning strategy, firmly dominant. The idea of the ESS was originally systematized by Maynard-Smith and Price in their essay (1973), within the presentation of a famous evolutionary game, the one undertaken between hawks and doves for the appropriation of an unique resource.

From the model of the aforesaid game it is possible to enucleate a definition of ESS and a theorem that expresses the sufficient conditions for such type of strategy, obviously suitable to the context of the game of conflict between hawks (aggressive) and doves (cooperative and not aggressive). To understand the content of this definition and of this proposition, both fundamental for the analysis of the evolutionary games, it is opportune to identify the players that operate according to a strategy with the strategy itself.

Definition of ESS. A strategy "*a*" is defined evolutionarily stable if, given a context in which almost the totality of players is composed by individuals "*a*", no mutant strategy "*b*" has the possibility to invade the population of players, by increasing the number the "*b*" players and by reducing the number of the "*a*" players.

Theorem (sufficient conditions for an ESS). A strategy "*a*" is ESS if one of the following conditions is verified:

- a player "*a*" obtains, meeting with another "*a*" a greater *payoff* in comparison to the one obtained by the meeting of a "*b*" player with an "*a*" player;
- an "*a*" player and a "*b*" player get equal *payoffs* from a meeting with an "*a*" player, while, meeting with a "*b*" player, an "*a*" player gets a

greater payoff than a *"b"* player.

The notion of equilibrium that is correlated to the determination of an ESS is an extension of the original concept of Nash equilibrium to evolutionary contexts. Particularly, referring to a game with two players belonging to the same population, the following proposition can be proved.

Proposition. An ESS is an action a^* belonging to the whole strategies of the two players, such that

- (a^*, a^*) is a Nash equilibrium;
- for every mutant strategy $a \neq a^*$, that is a best replay to a^*, the deriving *payoff* from the couple of strategies (a, a) is inferior to that deriving from the couple of strategies (a^*, a).

The criterion of evolutionary stability, that originates from the definition of ESS, with the purpose to select the "best" equilibrium is surely more restrictive and, therefore, it is more effective than the various *refinements* of Nash equilibrium. It introduces, however, some application limits and some lacks: the first ones can be found in the case of non-symmetrical games in which the players belong to two different populations (the preceding definition supposes that the two players belong to the same population); the lacks refer to the fact that the criterion is not inferred from an analytical model that formalizes the process through which we come to the stable equilibrium and therefore it doesn't furnish a method of investigation for the study of the evolutionary process that characterize the dynamics of the game.

The dynamic analysis based on the concept of "replicators", formulated in mathematical terms by Taylor and Jonkers (1978), as well as by Zeeman (1980), tries to give answer to this type of demand which is not satisfied by the concept of ESS alone, without being in antithesis with it, but including it as particular case: in fact the stable steady states of the dynamic models with "replicators" (*replicator dynamics*) coincide with the equilibria induced by the choice of ESS in the case in which at most two pure[*] strategies exist, while they differ whenever pure strategies are more than two.

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[*] It is said that a player adopts a pure strategy when he directly chooses one of the moves available, it is said, instead, that he adopts a mixed strategy when his choice concerns a combination of the available strategies after having attrib-uted to each one of them the probability of it to be carried out.

The dynamic analysis of the "replicators" appears to be very interesting, being, in the actual state of the mathematical literature on the evolutionary games, the most complete method to investigate, in a rigorous way, the evolutionary processes that lead to stable equilibria in situations of strategic interaction among populations of "intelligent" sub-jects. Such mathematical approach identifies the concept of "replicators" with that of *pure strategy*, whose diffusion within the population depends on the "reproductive advantage" (Darwinian fitness) gotten from it. The latter is positively correlated to the dif-ference between the current *payoff* of the pure strategy and the average *payoff* of the population. The higher becomes the advantage of the considered pure strategy, the more numerous copies of the same will be created.

4. The mathematics of the evolutionary games

The theoretical elements delineated in the preceding section underline that, in the actual state of the literature, the attempts to mathematically formalize the evolutionary games are essentially two: the one based on the concept of "evolutionarily stable equilibrium" and the one that analyzes the dynamics of the "replicators." In this section the essential lines of both types of mathematical approaches are traced and commented.

The analyses that stimulate the concept of ESS often have descriptive characteristics, even if sustained by a strong logical-deductive rigor and by hypotheses and definitions formulated coherently to the mathematics of the traditional Theory of Games. In other words, the concept of "evolutionarily stable equilibrium", once defined, is used in the same way of Nash's concept of equilibrium, in comparison to which it is more restrictive, seen the addition of a further condition.

The definition of evolutionary game in strategic form, for instance, is not very far from that of a non-repeated or repeated classical game type. In fact, to define an evolutionary game it is enough to furnish the list, with the relative definitions, of the number of populations of players involved; the list of the strategies of the players (belonging to the same population or different populations); the list of the *payoff* functions of each player, depending by its own strategy and by the rivals' strategies in presence of a note distribution of probability of these latter.

The differences from the traditional theory are due to the interpretation of the role of these constitutive elements of the evolutionary game: in fact the concept of "player" of the classical theory of the games identifies itself with that of "pure strategy" that is a characteristic of the population which the player himself belongs to, as it happens in the game between hawks and doves, where the hawk player, belonging to the population of the hawks, identifies itself with the "hawk" strategy and it is the same also for the dove player: the conflict is seen as the conflict among strategies. Likewise the *payoff* functions, expressing for each strategy (player) the relation between the combinations of it-self with others and the consequent advantage, acquire an evolutionary meaning, in the sense that they will have to give measure, even indirectly, of the probability with which the strategy (player) will result "winning": it will survive the conflict, subsequently re-plying itself. For their nature such functions are included in the definition of ESS, as it can be inferred from what is exposed in a simple way in the preceding section, where the conditions to be verified so that a strategy is evolutionarily stable, are expressed as conditions on the *payoffs*.

Also the formal analysis of these payoff functions is not far from the traditional one and often they are objective functions in problems of constrained optimization.

In literature different criteria of evolutionary stability are present but the one based on the concept of ESS, originally formulated by Maynard-Smith and Price (1973), is the most effective one, even if more restrictive (Dufwenberg, 1997).

As in regards to the replicator dynamics, already mentioned in the two preceding sections, the mathematical analysis is based on the resolution of differential equations (or finite difference equations) whose number is equal to the number of the replicators (pure strategies) and whose unknown variables are the "reproduction differentials", that is the differentials, calculated in dependence on time, of the ratio of the number of players of a strategy and the number of players of other strategies. This ratio depends, in every instant, on the value of the ratio itself in the preceding instant and on the relative variation of the *payoff* level. The variations of the ratio are positively correlated to the relative variation that measures the "reproductive advantage", since the number

of players that adopt the strategy in examination grows, in comparison to the number of those who don't adopt it, when the "reproductive advantage" grows.

The mathematical analysis of such differential equations goes toward the determination of stable steady states, that, as it has been verified, not always coincide with the equilibria induced by ESS. The replicator dynamics, in fact, allows to individualize evolutions of other nature, like those that can lead, for instance, to stable cycles and not necessarily to univocally determined stable equilibria.

Even if this approach based on the differential equation analysis includes a greater number of study cases, it is evident that none of the two mathematical methods described in this section has an aetiological value, since, it is not able to explain the causes of the evolutionary phenomena that lead to stable equilibria.

This consideration takes us to the conclusion that the Evolutionary Game Theory needs a reformulation that systematizes in a rigorous way all the elements, including in itself the aetiology of the events that it describes.

5. Applications of the Evolutionary Game Theory to Economics

The effectiveness of the evolutionistic approach to the analysis of complex and global contexts as those that are object of study of the contemporary Economics, has implicated a great success of the Theory of Games among the economists, superior to that, not universally shared, that the same Theory, in its traditional version, had already had in the Eighties, when many economists granted to it the role of instrument of a great utility for Economic Sciences (Mattoscio, Pagliari 1990, pp. 10-12). This success sustains the forecast of many researchers, among which Gintis (2000), who deem that the Theory of Games could assume the role of universal language for the Behavioural Sciences. In this role the classical approach could be considered a normative version of the theory, pointing out the choices that rational people should make, while the evolutionistic approach could be the descriptive version, for studying the decisional processes that individuals really undertake.

The interest aroused by the evolutionistic theory of games has

stimulated many applications in different disciplines. Here after it is intended to mention the applications in the economic field and in analogous fields.

In Knowledge Economics the *learning evolving* is studied on the base of evolutionary processes in contexts in which the learning is analyzed through genetic algorithms.

The Moral Philosophy and the Political and Social Sciences use evolutionistic models for the study of such important themes as the distributive equity, the social justice, the altruistic behaviour in the human kind, the necessity of private ownership, the international politics. Equally interesting are the applications that study the strategic behaviour of the tax-payers, finalized to analyze how the social disapproval towards the tax-evader might implement a correct behaviour in relation to the fiscal duties on behalf of the collectivity.

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A MULTIDIMENSIONAL FRAMEWORK
OF CULTURAL ECONOMICS

Abstract

In the last few years, cultural economics has played a central role in the economic discourse. Nevertheless, since the relevant literature shows a thematic and methodological eclecticism, the consolidation of a theoretical framework is still questioned nowadays. A general theory is not likely to be developed, simply because this discipline is grounded in a rather comprehensive theoretical body. Culture is a semantic field too evanescent for economics. In this way we think there is no sense in assuming that general function laws may explain easily changing phenomena. It could be more useful to let the multidimensional feature of the issue come out and then suggest a new interpretation of the discipline.

1. Introduction

Cultural Economics is a branch of studies that grow up within economic theory, nevertheless when a new field of studies becomes object of reflection it shows an incoherent categorical setting, that is an indeterminate system with a consequent not clear empirical application. In fact, culture as a concept shows a high rate of semantic difficulty, being a sort of evanescent parameter for the economics.

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Nevertheless, even if the sector literature shows a thematic and methodological eclecticism, the consolidation of a theoretical framework is discussed about still nowadays. For this reason a discipline interpretation seems to be necessary, that step represents a task that influenced our research topics. This interest springs up from the aim to combine economics with culture matters, so to let them both less closed. In this way the topic of the paper lies in elaborating a more robust perspective interpreting the complex phenomenology emerging from the binomial economics and culture within the concept of multidimensionality. Exploring the several dimension that culture as a parameter manifests it is possible to think the discipline in terms of different fields cross fertilizations results.

The reader could ask: is not economics a discipline complex enough? As a matter of fact our aim is not to make the issue analytical side more complex, but to let the reader understand that is possible to make it more structured within its basical categories. In this way, it could be more useful to let the issue multidimensional feature come out and then suggest a new interpretation of the discipline.

Aiming at elaborating a new discipline perspective so to help approach a complex phenomenology, we chose to start with early economic literature contributions (par. 2), in order to reflect about the different issue dimensions that are: the economic dimension (par. 3), the social dimension (par. 4), the spatial dimension (par. 5) and the political dimension (par. 6). This work follows a selective path, considering the most representative contributions for each dimension. In the paper final remarks we delineate a starting point so to enlarge the discipline border with a syncretic approach (par. 7). This approach represents a sort of operating convergence among different types of knowledge, that look like being apparently different. A convergence in this research field extremely required but rarely achieved.

2. First signs in economic literature

Cultural Economics is a specific research field, born from an economics branch; a discipline involved in many economic features of cultural goods creation, production, distribution and consuming. Along the

economic thought history, it is possible to trace the signs that show the early discussions about the culture's economic dimension.

This signs appear in a series of studies that have always shown the interest of the economists for the arts and the culture. In this way there are many reflection about the sector peculiarity, sometimes intuitively, sometime as a personal interest, sometime as a pure divertissmant (Mattoscio, 2006, p. 268), sometimes with reflections setting the economic research within the moral science.[†]

"A noi non è più dato chiuderci in uno schema cristallizzato di cognizioni avute da altre scienze, mentre queste ogni giorno annunziano nuove conoscenze e presentano nuovi svolgimenti; a noi non è più dato, se vogliamo aver diritto a vivere scientificamente, di chiuderci in una formula o trincerarci dietro un sillogismo, davanti all'imperversare di urgenti problemi sociali; ma abbiamo il dovere di penetrare nell'intima struttura di ogni fenomeno della società…" (Mazzola, 1990).

This is the way professor Ugo Mazzola argues in 1897, when taking a chair in economics at the Pavia university, while reading his paper *"Il momento economico dell'arte"*. After few years, in march 1918, some paintings by Manet, Corot, Ingres e Delacroix were sold at an auction at the Paris Roland Petit Gallery. They are part of the Edgar Degas private collection and were purchased by the Chancellor of Exchequer after the suggestion of the economist and art supporter John Maynard Keynes.

In 1936 within a noted paper *"Art and the State"* Keynes argues that Art represents one of the principles that make up a civilized society and, for this reason, it must be encouraged and supported by the State. Adam Smith in the *"An Inquiry into the Nature and Causes of the Wealth of Nations"* introduces, even though in an incidental way, the concept of the artistic production positive externalities. According to Smith live performing arts are able to erase melancholy from the majority of people (quot. trans. in Euromeridiana, p. 3).

In his works Alfred Marshal comments on a peculiarity, most noted in cultural economics: while consuming industrial goods, beyond a certain level, individual satisfaction is decreasing, in consuming music the principle is opposite: the more you consume the more you appreciate.

[†] For a literature review check Throsby (1994) e Towse (1992, 2003), while for a specific Italian review check Santagata, Segre e Trimarchi (2007).

(quot. trans. in Euromeridiana, p. 7). According to this, for the music and for the cultural goods in general the principle of decreasing marginal utility becomes valid. So the English economist paved the way to Gary Becker's and George Stigler's work (1977).

They wrote about the peculiarity of a capital accumulation in cultural consumptions, that accumulation influences the consumer behaviour according to the addiction dynamics. That is to say that when the stock of consumes grows up, so does the ability to make critical judgements about the nature of cultural goods. That can improve his selection criteria and, supposedly, his consume levels. In any case Becker's and Stigler's work confirm the complex nature of cultural consumptions by arguing about the existence of a consumer specialization process over the years. This fact shows a clear convergence in literature: the present cultural goods consuming depends on the past one. The individual satisfaction of cultural consumption depends by tastes acquired, that are linked to the past consuming levels (Gorman, 1967, trans. quot. in Candela e Scorcu 2004, p. 36).

The two authors assign to this phenomena an analytical property of a decreasing marginal utility function. In fact they talk about "rational addiction" and about an exogenous preferences model, assuming a stable preferences structure. In fact they maintain that tastes are fixed inside the DNA of the consumer, who becomes more and more expert in the process (Candela e Scorcu, 2004). In this case the utility function is constant, while what changes is the entire price supported by the consumer, that increases on the basis of past consumes. This price is the sum of the standard purchase price and the cost sustained to gain the information before buying the cultural goods. Galbraith (1963), instead, assumes new hypothesis about a change in the preferences structure, placing the cultural goods consuming theory inside an endogenous preferences model, in which the marginal utility is increasing, due to both the past experience and the social habits.

Others contributes, all coming out from a personal interest of economists' works, are based on the State's financial aid in favour of the cultural sector; an issue discussed, for example, by Robbins (1963) and by Peacock (1969). Lionel Robbins analyses the English State's economic role in supporting the arts through the financing of public museums

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and galleries, Alan T. Peacock interprets art subsidies with the welfare economics framework. During the same years John Kenneth Galbraith (1960) studies the artists economic conditions and the design capability to increase the American manufactures exportations in a paper edited in *The Liberal Hour*.

Cultural economics birth conventionally date back to the publication of the Baumol's e Bowen's research (1966), inside which a theory regarding the sector financial weakness, especially for the live performing arts sector, can be found. However, in these years, the mainstream does not consider the sector as a specific one, but as a common one whose functioning is quite similar to other consumer goods. The predominant approach is the classic one, according to which the only difference between cultural sector and traditional sector is the unproductively of the former.

In spite of this general indifference, in the recent years, this research field has been generating several and more relevant contributes. These contributes, today, place culture from being a marginal phenomena to getting a knowledge economy strategic dimension, and so the cultural goods come to be at the basis of development processes, generating multidimensional analytical models (Mattoscio e Furia, 2006).

3. The economic dimension of culture

In the volume *"Economics and Culture"* David Throsby (2001, ed. it. p. 25) suggest three defining criteria: (i) cultural goods need a form of creativity in the production process; (ii) they concern the symbolic meaning creation and communication; (iii) they could be, potentially, object of intellectual property right.

In general terms, the economists' work about the economic dimension of culture may be reduced to the aiming at describing the cultural goods economic statute. These contributes have been highlighting many characteristic referred to cultural goods peculiarity. Not able to define the concept of culture, the economic analysis pointed out cultural goods different characteristic, assigning them some economic effective implication and elaborating specific models.

The theoretical justification of cultural sector public financing was,

in fact, motivated, including the cultural goods within the semantic filed of the merit goods, defined by Musgrave (1959). In this way these goods satisfied socially important needs (such as health and education) so to justify a moral paternalism, creating an interference with the consumer preferences and so on with the consumer sovereignty principle. According to Scitovsky (1972) the only valid argument about arts public financing relies in the arts ability to educate individual behaviours.

The collective goods status is another fundamental characteristic according to which it is possible to point out for the cultural goods; (i) the production cost is user independent; (ii) the consuming is potentially equal for everyone and is not rival; (iii) the consuming is characterised by the free riding aspects (it is possible to consume these goods without paying a corresponding price).

Economists, in this case talk about cultural goods as public or semi-public goods and, in that sense, they justify the non-profit organizations presence as a consequence of the Market Failure (Hansmann, 1980, 1996). and of the State Failure (Weisbrod, 1980, 1988) . According to this point of view the production levels of cultural goods show the similar disequilibrium of the public good ones. For this reason a third agent, that Arrighetti e Serrvalli (1999) call "intermediate institution" is able to satisfy the heterogeneous demand needs (in the Wiesbrod model) and to send a trust signal in the market tanks to the *"non distribution constraint"* (in the Hansmann model). For example the public policies that follow this line find their fundament in the cultural goods redistribution, i.e. the enlargement of the civil society access to consume.

About the cultural market exchange peculiarity , Trimarchi (1993) highlights a sort of "impossible information" (as he defines it) that prevents the consumer from a correct preventive evaluation mechanism. In that way he compares the cultural goods to the trust goods as Scandizzo does (1999). This category influences directly these goods consuming decision, that becomes enforced by the "reputation" that these goods blend, and by some experts' certification (the critics).

Also Throsby (1994), analysing the exchange dynamics, interprets the tastes cultivation as a three step driven process: (i) a present needs satisfaction; (ii) a knowledge accumulation; (iii) a future consuming experience constructing. Upon this perspective, the formative facet is

the one that characterizes the cultural consumptions. That means that the consuming process depends on the amount of information gathered by the individuals.

The accumulation of perceptive and cognitive data give rise to, formally, a sort of progressive learning that allows appreciating more ad more the cultural goods nature and quality. This process, substantially, reduces the risk perception in consuming an immaterial good, a good that cannot be tested before consuming it, as Trimarchi (1993) writes, there is a positive influence on the consumers willingness to pay. In fact the difficulty and the impossibility to evaluate a cultural good before its effective consuming (for example in the live performing arts) give rise to the so called asymmetric information. In this case the economist compares such cultural market to the lemons market treated by Akerlof (1970) helping interpreting the sector performances in terms of information distribution.

In this case postulating a consumer perfect rationale choice seems to be unsatisfactory, because the cultural goods consumer is not always able to express his preference respect such a consume complexity form (due to the risk perception and to incomplete information). So the preferences seem to be born in an imperfect information circumstance because of the different alternatives immeasurability. According to this approach, the preference, referring to this category of goods, in not monodimensional (calculated only on the basi of the utility) but is multidimensional, that is to say ordered on a scale in which there is no complete substitution among the different goods.

Starting from these first categorizations some thinkers are trying to synthesize the different fields inside the cultural economics (Ginsburgh and Throsby, 2006; Santagata, Segre and Trimarchi, 2007; Throsby, 1994; Towse, 1997 and 2003). In short, following Throsby (1994) in the Journal of Economic Literature publication, the discipline's research lines are the following:
- *the cultural good market performance,* through the variables definition that influence the cultural products and services demand, and through the main aspects that regard the sector supply;
- *the labour market,* analysing the artists' decisions as to labour supply, the elements that determine their cachet and the weight that human

resources have in the production function, in a few words all the aspect regarding cultural labour demand and supply;

- *the public and private support for the culture*, that is based on the market imperfection analysis, on the fiscal system and on the incentives to develop the support.

To all that, is also possible to add:

- *the impact economic evaluation of a cultural production*, that is, moreover, a debated field about the methodologies applied (from cost benefit analysis to contingent evaluation and multicriterio analysis).

All over the current literature there is a common agreement: even if the analysis results are useful to decision makers and sector agents, the discipline still copes with open theoretical and empirical matters. A scientific read still uncertain and penalized by data reliability and robustness. The consciousness of cultural economics as discipline represents, more and more, a heat for the traditional economics analysis and, moreover for the methodology on which it is based: *"Indeed, economists in this area have recently been grappling with ideas from cognitive psycology (Frey, 1991), aesletics (Mosseito, 1992) and other fileds, work that is illustrative of the scope for a broad methodological foundation in this field"* (Throsby, 1994 p. 26).

Since these early pages we can argue that our research field seems to be characterized by evolutionary dynamics that make it complex defining a methodological statute. A dual recent perspective (Lavanga, 2003), even functional in the pattern of urban economic development (Russo e van der Borg, 2005), reduces the semantic complexity of culture category (substantially overcoming a definition of the word). The two analysis fields used in this perspective are: (i) "culture as a product", that rises a question about cultural goods production and consumption, about their economic value and about culture as a tool for place marketing; (ii) "culture as a process", that regards the creative thinking processes that guide the social organization process and the economic development patterns. The former category is related to material elements (tangible aspects) the latter to the immaterial ones (intangible aspects) (Lavanga 2003).

What's the discipline state of art? Mark Blaug (2001) tries to give an answer in the *Journal of Economic Survey*, starting back from the themes

treated by Ruth Towse's anthology (1997): tastes and tastes formation process, demand and supply, the media industries, the art market, the economic history of arts, the labour market for the artists, the Boumol's cost disease, the non-profit organizations cultural sector, the public arts financing. Blaug applied two main methodological criteria to evaluate the discipline progress: the analytical progress, that is to say the conceptual and theoretical basis elaboration and refining, and the empirical process, that is to say thorough estimates of causal empirical relations. The author's conclusion is that even though many goals are achieved in the empirical field, not so many are in the analytical one. Even if many models starting from the methodological individualism to the evolutionary economics have been made, it is now necessary to annex the meta-economics factors within the sector analysis, including social and institutional variables.[*]

4. The social dimension of culture

The necessity of opening the cultural economics to contaminations with other social sciences is confirmed by the fact that other categories are numbered among the statute of the cultural property (functional, it's clear, to the economic science). Great part of the cultural assets, in fact, is by some people led back to the category of experience goods (Pine and Gilmore, 2000), even if it's not proved that the consumption necessarily produces the sedimentation of an experience. Only in some cases (when the choice motivation is dictated by a cultural widening of the consumer) we assist to an experience able to accumulate information for a future consumption, in case of pure entertainment that does not happen or, if it happens, is of little importance.

Connected to the experimental category there is the consideration that the consumption of a cultural property can be sustained by its characteristics as relational and well positioned good (or status good), that allows distinguishing who is ready to carry out this action (Bordieau,

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[*] *"Cultural economics falls somewhere in between the two, more innovative than the economic of education but less fertile in exploiting its potential than health economics, perhaps a little insular und unwilling to learn from developments in the other areas of economics, not to mention psychology, sociology, and policy analysis, but nevertheless continuing to find fresh application of economics on topics of cultural interest"* (Blaug, 2001, p.133).

1979), an attitude that finds a reply in those that Veblen calls "showy consumptions" in the theory of the wealthy class (Veblen, 1899). The sociological approach to this speech derives from the concept of social shortage (Hirsh, 1976), that is from the emergency of new needs linked to the expressive dimension of the well-being (Zamagni, 2005), in a society no more dominated by heavy shortage of material order.

In such social context, the consumption of cultural goods is interpreted like expression of two different motivational guidelines in comparison to the others (Sacco and Zarri, 2005). "The first one corresponds to the desire to approach to the other in order to define a relation, to which it is associated a positive value because it is so - value of tie, exactly. The positional guideline, instead corresponds to the desire to earn one better position than the other on some scale" (Zamagni, 2005, p. 136). This particular configuration, for which the usefulness of the individual in consuming is reported to the amount consumed by the other individuals, raises a criticism to the reduction of the behaviour of the agents to the dimension of the instrumental rationality that is to the model of the rational choice.

Through the well positional concept, the economy introduces between its categories the good symbolic aspect, that incorporates a meaning. Santagata (1998) develops the concept of good semioforo introduced by Panofsky (1939 well), extending its main constituent, that is being bearer of a sign, applied to all the visual art. "In these terms the art object has a double nature, it is at the same time "sign and object", "symbol and goods"" (Santagata, 1998, p. 23). The cultural property is therefore a complex good with a double value, because measurable as goods as meaning.

In general terms, the process of "cultural economy", as defined by Dragone and Sacco (2006), increases the theoretical frontier of the discipline, considering the concept of culture in a wider and flexible way, and also introducing the characters of the anthropology and the social psychology in a perspective of cognitive type. Through this approach, the topic of the plasticity of the preferences induced by the experience and the cultural consumption is led back to the resource of a mental model (Johnson-Laird, 1993), that is to one cognitive efficient representation of the main features of such experience.

According to the cognitive paradigm, therefore, the preferences are formed according to a cognitive process that has a cultural specificity, that means that "the individuals that grow within various cultures will learn different rules in order to elaborate information of the world that encircles them" (Lloyd, 1972 p. 16). The cultural experience then demands an adaptation of the mental model that appears to be expensive not only from the cognitive point of view, but also from the motivational point of view, because in order to develop a more articulated mental model and in keeping with the cultural experience under discussion, the consumer must employ time and energies that could more usefully turn elsewhere (cost opportunity). It is then possible to define, in a theoretical way, the concept of cost of activation of cultural experience (Sacco and Viviani 2003; Sacco and Zarri 2004) like monetary equivalent of the cognitive and motivational cost associated to the elaboration of a mental model adapted to such experience, that is so to allow the individual a satisfying use.

This perspective finds application in the context marked by the transition to) post-industrial economy (and a society, where the primary needs are substantially satisfied and the individual is searching of identity needs. "In such context people begin more and more to ask assets with a cultural value, that is assets that help structure and confirm the mental categories through which reading the truth and defining their role inside it" (Dragone and Sacco 2006, p. 19). The problem of the shortage of the assets and the resources, that make up the economic problem, changes its nature, and in the post-industrial society the identity models are not enough. The culture in this perspective is a resource that activates the mental processes for the construction of the identity models, this consideration associated to the increase of the symbolic and immaterial constituent of the new production processes, sees in the assets with cultural value a resource in order to face the process of de-industrialization and an economy knowledge based.

5. The spatial dimension of the culture

Culture (as also the creativeness) has two deep roots: the time and the space, or rather it is, essentialy, indissolubly tied up to a place or,

in a more social sense, to a community and to its history. (Santagata 2004). If the culture, categorised both in terms of product and in terms of process (Lavanga, 2003; Russian and van der Borg 2005), is intrinsically linked to the spatial context, the result is that the cultural assets are idiosyncratic (that is highly specific) regarding the consumption or production places which they are connected to (Santagata, 2004; Scott, 2000; Storper, 1997).

The special dimension of culture brings two basical phenomena into play: the idiosyncrasy and the local proximity. In such sense, the space and the time have an analytical meaning still deeper in case of cultural assets. If the "locality" is stated as description level, the concept of local collective learning becomes part of the analysis, formulated from a cognitive perspective. The cultural assets, in fact, are the product of idiosyncratic factors because, besides their explicit acquaintance, they need the "tacit knowledge" (the tacit acquaintance) for being produced and distributed and because "personal knowledge relies on past personal idiosyncratic experience" (Polany 1953, p. 21 and seg.). In this perspective the cultural assets are the fruit of a patrimony of information and defined communitarian acquaintance that, at the same time, are not being excluded and are circumscribed in a geographic space and from the personal experience of the individuals that form them. The collective learning, in the knowledge economy, emphasizes the importance of the knowledge localized as territorial competitiveness factor. Such importance becomes fundamental if we accept the fact that some definite cultural systems (of exchange, production and consumption) have a territorial role, that means that they distinguish a geographic space different from others, in competitive terms too.

Saying that a cultural system has a spatial dimension (that is relative to the specific interdependence among economy, culture and place) means to secure the phenomenal aspects of the system to an "areal" character, and that the relations, that spring up from the circumscribed, privileged and selective relationships, have their own territorial aspect. This means that this given system can be defined as a contained matrix of relations between individuals meaningfully in terms of space. In such sense, also the learning of the agents, therefore, is defined in the space (both in geographic and social terms). From this perspective, every action of

the agents is characterized for a specific interlacing of relations in space among the places of exchange, production and consumption of cultural assets. The spatial dimension of the culture represents a point of privileged access in order to interpret the recent developments of cultural economics and the models of local development based on the culture.

For a long time, in fact, not only the social and cultural relationships but also the economic relationships have become strongly sensitive to proximity effects (element involves the spatial dimension), such relationships coagulate in the space in a selective way around local environments that develop cumulatively (Camagni, 1997). Pratt (2004) draws the attention on the spatial perspective of the cultural production arguing that the causal nexus between production and consumption of cultural assets, creativity and innovation cannot be described only in an atomistic way, through the models that see the creativity and the innovation localized in the individuals, confirming that also the creativity and the innovation demand a context in which to be born, in order to develop themselves and to be overspread (Lundvall, 1992).

Idiosyncrasy and the proximity that represent the roots of a culture, its connection with the local society, the history of its managing ranks and the institutions, with the local natural resources, are not only the sign that the production of a good (cultural) has not accidental origins. These two categories have given origin to new devices in order to interpret territorial development dynamics, inducing the economists to recognize that the phenomenal truth, that comes true historically in a defined space, is not completely interpretable if not resorting to meta-economic aspects. This perspective has given origin to local development new paradigms (Crociata, 2008; Mommaas, 2004; Cook, 2007; Lazzaretti, 2001; Russo and van der Borg, 2005; Sacco et al, 2003-2008; Santagata, 2003; Scott, 2000; Valentino, 2001), that reflect on the economic process of the cultural field spatial organization, and that integrate the analysis resorting to sociological, institutional and cultural aspects.

6. The political dimension of culture

As to all what we wrote before leads us to introduce, the role of the institutions within our discipline interpretation. A role we conceptua-

lize here with the regulation mechanisms of cultural policies. In this sense, the cultural political dimension appears to be relevant for the interpretation of the role that the cultural sector get within the economic development trajectories.

This issue can be traced back along a segment composed by three pertinent moments, relevant to understand that cultural goods production and consumption took part in the economic and political discourse with different approaches. As this perspective is possible to define three viewpoints directly related to three configurations assumed in the cultural sector (Crociata, 2008).

This conceptual path reveals two complementary observation filters: (i) the relationship between economic thought and cultural sector; (ii) political guidance and rationality for the sector development public policies.

According to the first viewpoint, the cultural sector shows a "formative configuration", that is to say that culture is seen like a source of spiritual education and individual social identification. Cultural production is considered as an activity completely distant from economics, as we wrote before cultural goods got the status of merit goods and public goods. Economics still relies in a traditional phase, characterized by a society in which the satisfaction of material and primary needs prevail. The principal economic issue is the allocation of resources in a material scarcity.

In this scenario public policies show a paternalist rationality based on the population education through the highbrow culture promotion. Public expenditure is oriented to the traditional cultural infrastructures conservation programs, such as theatres, libraries and museums basically located in the city centre. Meanwhile the same program supports these infrastructures supply, with some grants finalized to enlarge the citizens' access.

Within a democratization process of culture, the decision makers legitimize the cultural sector inclusion in a welfare state system because it' is considered as a social emancipation engine and a community builder identity**.

** *The two main strategies for the implementation of emancipatory urban cultural policy objectives were interventions to create a common civic space and place identity, and to empower disadvantaged individuals and groups to express their voice, constitute themselves as self-conscious communities and make their presence felt in a revitalised public sphere" (Bianchini, 2006, p. 4).*

On a second point of view, the cultural sector shows an "economic configuration". The cultural goods production and consumption become a part of the economic system. In this sense studies (microeconomics) on consumer behaviour, and studies (macroeconomics) on employment levels, on economic value added, and on the interaction with other sectors as tourism have been growing.

This approach is based on a progressive satisfaction of material needs characterized by a demand for primary goods. The increase of a series of factors such as welfare, free time allocation, jointly with an education levels increase, make the rise of cultural goods demand possible. People show a willingness to pay and the public bodies propel the cultural goods consumption in reason of the economic positive externalities (ex to the formative ones).

Public policies aim at combining economic value with cultural value, promoting the cultural sector by supporting increasingly the activities inside the sector. The cultural sector configuration is wider than the formative one, including other sector before not in, such as the audiovisual one. Anyway a still border prevails in the public policies rationality, that seems more focused on a past excellence exploitation. Within a very extended promotion, oriented to increasing the consuming levels, these policies follow a strategy based on a situation rent (due to the cultural capital ad heritage inherited from the past). Even if the cultural sector economic and productive potential rises, the public policies incentive the exploitation of a time cumulated stock of cultural capital. In this case an exogenous growth model is followed, which does not use the present factors but is centred to attract above all tourist for increasing the consuming levels.

On the third viewpoint the cultural sector shows a "renewal configuration". It becomes more and more relevant within the de-industrialization process that hits the whole local economy. The traditional heavy industry decline generates a series of disequilibriums, as well as economic, social ad environmental. That situation contributes the tertiary sector development to cope with the necessity to replace the labour force unemployed ad to fill up the "urban empty spaces" left inoperative by the many production centres closure.

This configuration is strictly related to the previous one, but it shows

the cultural goods and services production within a beginning clusterization process. In this period economics studies concern the cultural industries often spatial organized in urban clusters. The cultural atmosphere generated by the cultural sector spatiality pattern is studied as a segment of urban economy culture driven. It focuses on the potentiality of economic and physical regeneration led by the cultural sector, in a specific moment in which the economic development also means the increasing quality of life and the environmental sustainability.

Even considering the urban social fabric and the productive potential of the firm cluster, cultural policies are oriented to the urban infrastructure renewal, giving them a new use destination (i.e. cultural destination) Meanwhile these policies incentive external firms, capital and people attraction, thanks to extensive city marketing activities, aimed at improving the urbane image.

This is the public policies most evident attribute, even if in many cases these policies show a clear identitary rhetoric. Urban regeneration is based, too many times, on civic identity development, but is still really polarized on an external attraction model too much focused on exogenous resources.

All we argued since now lets us underpin the cultural sector protean character, a peculiarity that impacts even on public policies role within the local development strategies. That situation motivates the strategic planning theoreticians to apply on the cultural sector methodologies picked up by other contexts applications. So from the traditional locality planning, based on a socio-economic impact and projected on a medium period perspective, the public policies rationale pass, in this cases, to the cultural planning. This passage enlarges the vision of those that work in the urban planning processes, inciting the cooperation between the classic architectonic and urban planning, mainly focused on physical aspects, and the economic strategic planning, focused on the value of "space and exchanges within" identification. A sort of cross fertilization that enriches both the planning sides including contributions from the cultural, anthropological, sociological and historical aspects (Bianchini, 1999; Landry, 2000; Mercer, 2006).

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7. Moving from a multidimensional to a syncretic approach

Moving from the first economic literature contributions, the reader can understand that today cultural economics represent a quite variegated set of theoretical and methodological approaches. That characteristic is definable with the term multidimensional, and what we have done is an exercise in order to delineate and show the different dimension and the consequent interpretations. What we argue is that in reason of this different dimensions and of the characteristic of the discipline it is impossible to reduce cultural economics to a general and dominant paradigm. We agree with Valentino (2007): production and consumption processes regarding cultural goods, in a specific sense and the binomials economy-culture in a wider sense show features that are too much different to be aggregated in a unique research field. Even though it is possible to discuss about a discipline new design along a fragmentation according to the different typologies of cultural goods production.

This specific approach, actually common in literature, risks to be static and partial even if it has the strength to go deep inside the different branches (such as cultural heritage economics). The binomial economy and culture generates new reflection topics, that need new exploration fields and, a new formulation in order to interpret the new complex phenomenology.

As Dasgupta argues (1987) the economic sciences progress cannot be considered continuous and cumulative as the physical sciences[††]. So, it is incorrect to state that a new system represents a general improvement respect the previous one: simply it is different, as in the same way different are the phenomena basis conditions that economics has increasingly to understand ad analyse.

Just to make an example, as we argued within the political dimension of culture (as in all dimensions considered) there are different economic approaches to the cultural sector relevance. According to which there are different configurations and different economical ad political tendencies

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[††] *"Gli economisti si occupano di un universo in cui i dati sono mutevoli e non validi in assoluto, ed in cui emergono fenomeni che non solo non erano prima conosciuti, ma che prima non esistevano" (Dasgupta, 1997, trans. it. p 12). "Un sistema di teoria economica si sviluppa in risposta a problemi che vengono determinati da un insieme di circostanze all'interno di un'economia" (Dasgupta, 1997, trans. it. p 14).*

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within the cultural economics discipline. Inside each configuration some new phenomena emerge which, therefore, change the different paradigm elaborated by economic theory. Admitting the multidimensionality of a phenomena leads us to assume its relativity ad so, hermeneutically, to face with a knowledge problem. We have to understand the different framework that are usually applied, how we use them and what kind of interpretative power we give them.

The complex scenario that cultural economics have to cope with, leads us to doubt the thrifty and all-embracing theoretical models and analytical methodologies, according to Hirshmann (1988), but we have to face the discipline with a syncretic approach (Crociata, 2008). This approach is able to analyse our topic within the multidimensionality ad lets the different dimension (above seen) interconnections emerge.

That means to letting apparently distant theoretical elements converge in order to get a new result aiming to representing the multidimensional and such complex scenario described above. This approach practically represents a sort of cross fertilization among different kinds of knowledge, in many cases evoked but rarely caught in this research field. On the analytical viewpoint this syncretic approach succeed in a meta-theoretical framework based upon a new categorical system able to catch a sort of regularity as to the tools applied that is a coherent evaluation of the economic, social, spatial and political dimension of culture.

Although we are not here to discuss about this framework, we contract a moral debt with the Meldolesi metaphor (1988). Introducing Hirshmann's works, the Italian author write about the necessity to "violate the social sciences static boarders": *"E' possibile riutilizzare liberamente, alla maniera del primo Rinascimento, capitelli e colone antiche insieme ed altri materiali per scopi specifici, limitati ma utili. E, nel farlo, trovare la via di nuove prospettive architettoniche."* (Hirschman, 1988, trans. it. p. 13). Cultural economics deserves , so, to be interpreted with more theoretical freedom.

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