Evolutionary development economics: bridging the gap between micro and macro in the theory of economic development

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Short abstract:
This paper focuses on the evolutionary perspective on growth and development and examines its critique to mainstream theorizing and formal modelling in this area. The paper highlights the elements that make this perspective distinctive and assesses its achievements and potential as an alternative perspective on economic development. We examine, firstly, the extent to which this line of enquiry may enhance our understanding of the economics of development. Secondly, we assess the extent to which it has been able to develop a coherent and widely shared approach to the use of analytical tools and modelling techniques in order to push forward the evolutionary theory of economic development. Finally, we consider whether it can contribute to the political economy of underdevelopment by offering cogent and manageable frameworks of thought that can be applied to the analysis of development problems.

Long abstract:
The economics of development and the political economy of underdevelopment have been major battlefields among different traditions of economic thought. As an offspring of keynesianism, development economics enjoyed, during the 50s and 60s, a golden age during which it almost stood as a parallel discipline to conventional economic analysis. With the decline of Keynesianism, development economics also lost momentum and the topics on economic development became part of the theory of economic growth, notably in the North-South models and the convergence literature of the so called “New growth theory”. Postkeynesian, structuralist and marxist critiques of the mainstream have produced their corresponding theories and models of economic development and have also led to their own prognosis of the problems of underdevelopment. Despite the
differences among mainstream and heterodox critiques, the different approaches share some elements in common. They have converged in their tendency of looking at economic development issues mainly from a macro perspective. Increasingly, a shared conviction has been built in the sense that success and failure in economic development has to be studied as an integrated phenomena, as testified by the generalized use of north-south/centre-periphery modelling in formal analysis. History, culture and institutions, factors traditionally emphasized by authors from the evolutionary tradition, have also gained recognition as factors playing a crucial role in the process of development. At a textbook level, for instance, they can be found playing a prominent role as “fundamentals” in the mainstream discourse on economic growth and development.

In spite of the fact that the various traditions of economic thought have converged in some key elements of their view of economic development, there remain fundamental differences among them. In this paper we focus on the evolutionary perspective on growth and development and examine its critique to mainstream theorizing and formal modelling in this area. Our purpose is not only to identify those elements that make this perspective distinctive, but also, and most important, to examine its achievements and potential. First we ask to what extent its line of enquiry may enhance our understanding of the economics of development in comparison with other approaches. Secondly we examine to what degree it has been able to develop a coherent and widely shared approach to the use of analytical tools and other modelling techniques which allow it to push forward the evolutionary theory of economic development. Finally, we consider whether it can contribute to the political economy of underdevelopment by offering cogent and manageable frameworks of thought that are applicable to the analysis of development problems.

Regarding the first point we maintain that the evolutionary approach represents a significant step forward in the study of economic development: its population perspective leads it to build a bridge between micro and macro levels analysis which provides a better understanding of the phenomena of structural change. With respect to the second point, we hold that building a more unified approach to formal modelling constitutes a major challenge for the evolutionary perspective, as it has been to other heterodox schools. This approach has built a solid critique of the equilibrium method and has also challenged the deductivist excesses within mainstream economics. On the positive side, it has put forward interesting proposals for the development of a formal framework appropriate for the study of structural change and coordination. In addition we find in the evolutionary literature both analytical and simulation modelling coexisting and complementing each other. However, much work remains to be done within the community of evolutionary economists in order to build a more unified set of principles on the use of deductive and inductive reasoning and to achieve a broad consensus on the status of the knowledge that emerges from analytical and simulation modelling. Finally, regarding the third point, we argue that the focus on the dynamics of institutions and technology, that characterizes the evolutionary perspective, coupled with its view of development as a complex open ended phenomena contribute to introduce a more creative and open minded attitude in the analysis of the problems of underdevelopment. But, as we also argue, the success of the evolutionary perspective in providing policy guidelines is highly conditional on the progress made in the second point. A coherent and broadly shared view on evolutionary models of economic development is essential in order to build widely accepted and applicable models that can help to better imagine the future under different policies and development strategies.
1. Introduction: Development Economics

Development economics and its different alternative theories find their origins in the acute contrast in economic performance among different countries. Economic research on development is often found as part of a series of interdisciplinary studies that deal with different aspect of underdevelopment. Within the economic analysis of underdevelopment, there are different economic theories, related to different schools of economic thought, that have attempted to deal with specific problems of the economic systems of less developed countries. Development economics has traditionally been policy oriented, being its task to help to lead those countries to similar conditions to those that prevail in more advanced countries and to achieve similar economic performance. From the theoretical point of view, its point of departure is fundamentally macro at both the descriptive and the analytical levels. The theoretical substrate of which the theory of development emanates is the theory of the economic growth.

The Keynesian revolution introduced two contributions that not only were fundamental in the development for economic thinking in the postwar period, but also determined to a great extent the course of the theories on the economic development. The first contribution is the principle of effective demand, which justifies state intervention to promote stability and full employment. This idea became a corner stone in development economics to justify the role of the state in promoting economic development. The second major contribution was Harrod’s (1939) extension of the Keynesian theory to the long term. Harrod proposed a growth model that established the basis of modern growth theory. His original contribution was however more ambitious since he sought to integrate growth and economic fluctuations in his theory. Harrod’s model provides an analytical a simple framework to examine the relationships between some of the main variables that affect the growth. In line with the classics, capital accumulation plays the key role and, following Keynes, to the extent that the capital/output ratio is stable, the flow of domestic and external saving which finances investment determines the rate of growth of the economy.

In this way, Keynesian interventionism laid the foundations for a vision of the State as a key agent of development. Harrod’s model, contributed to focus economic policies on capital accumulation. In the post-war period until well entered the seventies, one can find a noticeable emphasis in the active role of the state through its contribution to capital accumulation, calculations in development plants relative to saving requirements are based on Harrod’s relationships.

Building on Keynes and Harrod, successive contributions of economists concerned with underdevelopment gave origin to development economics. To the basic ideas of the role of the state and the emphasis in capital accumulation they added structural and institutional elements. The works of Rosenstein-Rodan (1943), Nourse (1952) and Hirschman (1958) centre the attention on the relationship between industrialization and development. Whereas the formers supported a balanced growth strategy, the latter argued in favour of un-balanced growth. From Hirschman’s perspective the impulse of specific sectors generates bottlenecks that stimulate investment and economic activity through the linkages of the productive structure.

Another landmark in development economics is the work of Rostow (1956) on the stages of development where he presents a progressive vision of the development process. This work has had a great influence in the consolidation of a hopeful vision that justified state activism in the promotion of development.

Another mayor contribution to development economics was the two-gap model of Chenery and Strout (1966) which occupied a prominent place in policy design. Its
underlying view combines confidence in the self-regulatory power of the markets, the optimism of Rostow’s take off, and the ‘classical’ emphasis on capital accumulation. Chenery and Strout identified a series of bottle necks that may prevent growth, such as: skill shortages, technological lags, weak diversification in the productive system and institutional deficiencies, among others. However, they concentrated in two questions: insufficient domestic saving to finance investment and an insufficient foreign currency generation to finance imports. That is, the saving-investment gap and the gap associated to external deficit. Chenery and Strout’s framework was followed years latter by Bacha’s (1990) three gaps model which adds to the other two gaps the fiscal deficit gap, which enters as an additional restriction to growth.

Towards the end of the seventies there was a generalized disenchantment among economists and politicians involved in the promotion of development who considered that development policies and development plans had been unsuccessful. Some argued that the strategies adopted by most of the developing countries where exhausted. This climate contributed to spread a “vicious circles” vision. According to that vision the political, economic and social structures of the less developed countries were responsible of their inability to advance in the development process.

Economic thought on the problems of development has not been as cumulative, linear, and monolithic. Critical visions of development emerged and evolved in parallel with the mainstream developing economics described above. There were radical critiques to conventional development economics which criticized its excessive emphasis in quantitative aspects and charged it of paying insufficient attention to the implications of the asymmetries in the relationships between developed and less developed countries. Dependency theories are the best example of these radical critiques. Within this tradition we find arguments as diverse as Prebish’s non radical argument on the deterioration of the terms of trade and the radical critique based on the notion of a World-Wide System.

Latin American structuralism led by the ECLAC, with Prebish as one of its main champions, identified the pattern international specialization as one of the obstacles to development. Latin American structuralism proposed a strategy of import substitution term combined with regional integration agreements to correct the effects of a disadvantageous insertion in the world economy.

In the late sixties the idea that the insertion of less developed countries in the world economy was one of the obstacles to development combined with the unsatisfactory results of import substitution were the basis of a more radical dependency theory. According to the more radical Latin American dependency theorists the problems of underdevelopment were not only related to a deterioration of the terms of trade, but also to the characteristics of foreign capital penetration. Dependency theories emphasize the dualism and the polarization that characterize the Capitalism of less developed countries. World-wide systems arguments go along the similar lines. According to these thesis, national societies are organized hierarchically within a world-wide division of labour that generates systems dualism in which modern and traditional elements coexisting and giving rise to diverse belts of centre, semi-periphery and periphery. Dependency, with its different ramifications, became a denunciation of the false character of the promises of development of orthodox growth models. According to this vision, development does happens in the peripheral spaces but it is limited, it is not self-sustained and it distributes very unevenly the benefits of growth.

1 Prebish’s (1950).
3 See for instance Furtado (1973) and Sunkel (1969)
These theories have been severely criticised and dismissed, from the mainstream development economics perspective for their lack of theoretical basis and empirical support.\(^4\) The debates of the 60s and 70s illustrate the heated battles among economists and social scientists of different traditions in relation to the problems of underdevelopment. Conventional development economics has evolved and has become increasingly integrated as part of Economics. At the macro level North-South models based on the of theories of the endogenous growth, growth accounting and the hypotheses of absolute and conditional convergence constitutes the new theoretical substrate of Development Economics. By the same token, at the micro level, the Walrasian perspective dominates. Applied general equilibrium model has become a one of the main tools through which the resource allocation problems of the less developed countries are analyzed. From an orthodox perspective, the essence of the solution to the problems of less developed countries consists of eliminating the obstacles to the creation of the markets and establishing the necessary conditions for their correct operation (what is usually referred to as ‘getting the prices right’).

In the last quarter of the last century this vision provided the theoretical basis for a radical shift in development strategies. From the eighties onwards the economic policy of numerous developing countries experienced a noticeable change and followed the liberal policies which are often summarized as the ‘Washington Consensus’. This led to a drastic reduction in the role of the State in the economy and in to massive privatizations. High expectations were created about the effects liberal reforms, which have not completely materialized. This has given origin to criticisms of the ‘Washington Consensus’ from within and from outside the mainstream. In spite of the dominion of the New Classical Macroeconomics and of the walrasian general equilibrium perspective, heterodox thinking in economics has continued evolving, it is alive and well, although dispersed. There are, post-keynesian, ricardian and Marxist analysis of development, which have taken part on the debates about liberalization and economic reform. Each school has produced its own criticisms of the mainstream. Space precludes us from looking at each of them. In this paper we focus in a relatively new perspective, which has however deep roots on old traditions. The recent upsurge of evolutionary thinking in economics has found inspiration in some of the most substantial critiques of major heterodox schools of economic thought. It has also nourished from the insights on economic change of some of the most prominent economists. The paper is organized as follows: in section 2 we present the critique of the evolutionary approach to mainstream orthodoxy. Section 3, outlines the distinctive characteristics of this approach and discusses its relevance for development economics. Section 4 deals with formal modelling within this approach it focuses on its role in the diffusion of evolutionary thinking and comments on the prospects for its application to development economics. Section 5 comments briefly on the current status of evolutionary economics in terms of what it can deliver from a political economy perspective. Section 6 concludes.

\(^4\) See for instance Lall (1975).
2. The evolutionary critique to mainstream economics

The evolutionary approach emerged and has developed as an heterodox critique of mainstream orthodoxy that seeks to build a superior framework for the study of economic change. The orthodoxy towards which most of the evolutionary critique is addressed is the equilibrium perspective of post-marshallian and neo-walrasian neoclassical economics, as it can be found in standard economics textbooks, which constitutes the world view of what is generally regarded as orthodox economics. It is true that mainstream research extends well beyond the narrow perspective that emerges from textbooks, that many mainstream economists hold more sophisticated views and that they may be more eclectic in their approaches and flexible in the exploration of non conventional methods. Our narrow focus on the textbook vision is not intended as a dismissal of the evolutionary critique. Such a textbook vision is not a “straw man”. It contains the core of the perspective and methods subscribed by mainstream orthodox economists (in spite of their eclectic inroads into heterodoxy) which are commonly held to define the discipline. From this perspective, economics is mainly about the application of the equilibrium method to problems of choice involving the allocation of resources in order to derive testable propositions. The evolutionary perspective does not endorse this restrictive conception of economics.

One of the most substantive criticisms of the evolutionary approach to the mainstream has been directed towards the combination of the equilibrium method with a methodological programme that seeks to impose Bourbakian formalism to the discipline. This programme posits mathematical deduction as a requirement that has to be fulfilled by any proposition within an economic discourse in order to be rigorous and scientific. As a consequence, a large part of economic research has produced exercises in mathematical logic rather than attempts to understand economic phenomena, as many authors have pointed out. In addition to the criticism to the excesses in formalism, almost all the fundamental concepts and models of the neoclassical core have been scrutinized and questioned: the conceptualization of individual and collective economic agents (the economic man, the household, the firm and organizations in general); the theory of consumer preferences and the theory of production, and the concept of rationality that underlies decision making: the representation of choice in consumption, production and pricing decisions, among others. Macroeconomic analysis whose microfoundations rely on the aggregation of representative micro agents or in the plain extrapolation of micro concepts, as is the case of the aggregate production function, has also been questioned. As a result of such critiques, alternatives have been proposed and put to work in theoretical and empirical research in an attempt to overcome the limitations exposed in the critique of the mainstream. This has resulted in a diversity of sometime complementary and sometimes rival methodological approaches, concepts,

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5 In addition to the specific contributions that the approach has made to economics, the criticism has also led to a not always acknowledged assimilation of some of its concepts within the mainstream, although conveniently adapted and renamed to be amenable to conventional analysis. The concept of general purpose technologies which is used to capture key ideas that were present in the notion of techno-economic paradigm put forward by Freeman and Perez (1985) comes to mind as a good example.
6 See for instance Krugman’s (96) talk to this association:http://web.mit.edu/krugman/www/evolute.html
7 The fact that mainstream conventional economics is wider and changing and goes beyond its textbook representations has often been put forward to criticize “easy” straw man critiques. See, for instance Colander et al. (2000) and Colander et al. (2004), who, by the way, in their effort to isolate the complexity vision in the 2000 paper, include evolutionary economics in the mainstream conventional group.
8 See for instance Velupillai (2005)
theories and models within the evolutionary broad tent. To a great extent, this is a reflection of the fact that the contemporaneous evolutionary economic thought that has been developing during the last twenty years emerged as a collective attempt to join, in a pluralistic debate, the most substantive heterodox critiques of the mainstream. In particular those fuelled by the interest in providing an alternative for the understanding of economic change. The insights on the analysis of economic change by authors as different as Smith, Marshall, Marx, Veblen, Schumpeter, Keynes and Hayek, among other prominent economist, are often quoted as sources of inspiration. Thus, several evolutionary visions have been incorporated in this pluralistic debate towards a, yet to come?, evolutionary synthesis.

As evolutionary economics has developed and the original contributions have been further elaborated, and attempted to be “tied together”, the criticism of the mainstream has also transformed from outright rejection to a more careful consideration of those parts of mainstream that may be subsumed under the evolutionary approach and those that may be complementary from that part that ought to be rejected as being plainly wrong or misleading.

Being economic change the central theme of the approach, its strongest criticism has been directed to the applications of the Walrasian (and neo-Walrasian Arrow-Debreu) long-run general equilibrium and to those concepts, theoretical devices and methods related to it which are considered inadequate for the study of economic dynamics as a process that takes place in real time. As Potts has forcefully argued, the deepest and most substantial criticism shared by most of economics heterodoxy is directed to ‘the sleight of hand in algebraic logic that conjectures a set of elements in a space to then appear as a set of elements in a field…’ By treating the ‘non-integral’ economic space as a field: 1) the notion of structure has been shunned from the analysis (no room has been left for the specific connections that constitute the structure of the economic system); 2) any consideration of economic interaction has been precluded (only the actions of economic agents are taken into account by restricting the analysis to the “final” state of the system); 3) an enormous analytical and conceptual simplification is made which reduces the analysis of processes to the analysis of states (there is no real time as a device that prevents everything to happen at the same time). Such simplifications, which have proved extremely powerful in the physical sciences, may have severe negative implications when applied to the economic and social domains. Dynamics, under the equilibrium approach, are hypothetical movements around rest points, while transitional dynamics are hypothetical movements across steady states. Walrasian general equilibrium is eminently static, it can not deal properly with economic change and it is, therefore, of no help for the task of discovering the laws that explain it.

The evolutionary critique is more sympathetic towards Marshallian short-run partial equilibrium framework, as the original contribution of Marshall was meant to provide a useful mechanical metaphor for the analysis of the response to shocks in a period of time short enough to prevent any significant adaptive change to take place.

9 The Dosi et. al. (1988) collective volume on economic change, which brought together a large number of contributions from diverse traditions and closely related creation of the EAEPE in the early 90s exemplify this movement.
10 See chapter 2 of Potts, (2001) for an exposition of the implications of assuming that the economic space has the properties of a field, for an argument about the lack of basis of this assumption, and for several examples of how the bottom line of some of the more solid criticisms of several heterodox schools to the mainstream converge to a critique of this assumption.
12 See Foster (2003) on Marshalls perspective on time, irreversibility and economic change.
Thus, in spite of the emphasis placed by the evolutionary approach on non-ergodicity, path dependency, positive feedbacks and the irreversibility of evolutionary change, it is also acknowledged that there may be instances in which the assumptions required for reversibility and ergodic-behaviour may be valid, equilibrium analysis may be applicable and the predictions of short-run linear models reasonably accurate. As pointed out by David, (2005), there may even be aspects of economic life in which the influence of initial conditions may be transient, where there are no positive feedbacks and which are sufficiently stable to be thoroughly explored. Such instances, are compatible with ergodic behaviour and long-run equilibrium analysis may be useful. In this cases the problem would only be to determine the time span for which the theoretical long run applies.

The main reason for the reserve of the evolutionary approach with equilibrium notions stems from the view that in evolutionary processes the historically stationary states attained at different phases of economic development are unstable. They lack the equilibrating tendencies that are presumed in long-run equilibrium models. Economic evolution is a non-equilibrium process driven by the endogenously generated change associated with the growth of knowledge. Along this process the system self-organises: patterns of structuring and restructuring take place to temporarily solve the systems coordination problems, which can be identified through the emergence of macro order. But this order is continuously disrupted by the generation of novelty. Capitalism is restless and its development is a non-equilibrium evolutionary process whose course can not be deduced by means of an equilibrium framework. Equilibrium may be used, and is used, as an organizing principle in evolutionary modelling of economic change to represent a state of coordination. However, its transient nature is made clear and the emphasis is placed in the forces responsible for its ephemeral existence.

Explanations of economic development have to pass through an understanding of the generation of novelty, its diffusion within the economic system and its role in the competitive process, since it is the key force of economic change. For this reason, supply side long-run equilibrium macro theories of economic growth cannot provide a deep understanding of economic development. Macro analysis is useful to describe growth and development but, on its own, it can not explain them. By introducing micro models of human capital accumulation, learning and innovation, new endogenous growth theory has attempted to provide such an explanation. Imperfect competition micro models of innovation represent a progress within mainstream analysis. But what much of endogenous growth theory has in fact done is to introduce dubious aggregates (such as a stock of ideas) and to impose convenient restrictions on parameter and functional forms to obtain the desired steady growth path. It has done so regardless of the distance between its assumptions and empirical facts of the microeconomics of innovation and technological change. As an alternative, evolutionary economics focuses the attention on a meso level which provides a bridge between micro and macro phenomena related to growth and development and, through it, a door for their deeper understanding.

The mainstream orthodox view of development economics relies heavily on growth theory and general equilibrium models, which are two of its main work horses. The view of development economics that this perspective conveys equates development and growth: Underdevelopment is basically understood as low per capita income arising from low growth rates in the past. Aggregate growth models point to some combination of low human and physical capital accumulation, high population growth, low education.

On this see for instance Metcalfe (2001) and Steedman (2001)
and low productivity growth (technical progress) as its cause. General equilibrium points towards the presence of market rigidities and market imperfections, although its main role has been as applied models used to predict the effects of shocks and policy intervention on sectors’ outputs and on relative prices. When dealing with less developed countries, applied general equilibrium openly makes use of required ad-hoc modifications of the perfect competition model since applied general equilibrium economists recognize that theoretical purity often comes at the cost of empirical relevance.

As macroeconomics, development economics is to a great extent a policy oriented branch of economics. Mainstream development economics usually places the analysis of development at a country level. The transit from underdevelopment to development depends on the achievements on three fundamental areas: 1) Increasing the rates of capital accumulation and technological progress. 2) Creating those markets which are lacking, eliminating restrictions to the operation of markets and improving the functioning of existing ones by fighting their imperfections. 3) Transforming and adapting indigenous institutions and cultural specificities to be in accordance with the basic institutions of capitalist market economies. “Old” development economics placed particular emphasis on government intervention in promoting development through (1) and (2), while (3) (modernization) was to a great extent seen as a by-product which came as a result of economic progress. “New” development economics has stressed (2), from which (1) would result. The route for development would be based on the opening of national economies to trade and investment, and on the adoption of economic reforms that give impulse to the market through the elimination of restrictions and the withdrawal of the state from economic activities. The predicted outcome of these changes is a faster convergence towards a developed country economic performance. Initially, in the new perspective, (3) was still seen as a natural by-product. However, attention has gradually shifted towards the role of (3) in economic development in response to the wide disparity observed in the performance of different countries after liberalization and economic reform experiments. Local institutional and cultural characteristics have been charged as responsible of poor performance and observed failures. While in “Old” development economics there was an implicit developed country prototype, in “New” development economics such a developed country prototype is made more explicit: it can accommodate a diversity of indigenous institutional cultural features as realizations of the fundamental institutions of a market based economy.14 Research on the institutional roots of development and underdevelopment is a major area of recent research within the mainstream, and the way of the institutional transformation required for development remains as the mayor policy puzzle. Finally, there is increasing awareness within mainstream about the fact that it is only possible to make sense of the growth performance of individual countries from a global perspective.15 This takes up a point insistently put forward by radical critiques of

14 We would dare to say that in the limit, from an orthodox point of view, the ultimate test of whether an economy has achieved a developed country status would be to able to build an applied general equilibrium model of it with no or only marginal need to introduce structural rigidities and other ad-hoc elements in the specification. Amongst perfectly developed countries, cultural and institutional specificities would be irrelevant for the functioning of the economy. A common general model would be applicable to all of them and all the relevant differences would be reduced to differences in the values of parameters and variables in their respective models.

15 Grossman and Helpman (1991) provides an example of the stream of N-S models of late 80s and 90s which holds this global view. A more emphatic recent vindication of this same idea is found in Ventura (2005).
“Old” mainstream development economics, although from a radically different point of view.

The evolutionary perspective of the economic system, to which we now turn, differs from the conventional one and, as it is argued in sections 3 to 5, leads to a different view of economic development, suggests alternative routes for theorizing and modelling, and looks therefore at policy issues related to development under a different light. We end this section by pointing out that this approach sees the economy as an evolving adapting complex system and holds that, to understand its dynamics, it is necessary to replace the mechanical representation that ascribes to the economic space the attributes of the mathematical concept of field with an alternative representation which:\(^1\) can capture the existence and absence of connections which define the structure of the system at each point in time; 2) can account explicitly for the introduction of novelty and for the competitive and cooperative interactions that take place amongst the system elements and subsystems which are in the basis of its growth and structural change; 3) can incorporate time as a device that not only relates the state of a system with its previous and imagined future states but also prevents everything to happen at the same time. A major advantage of this alternative framework is to make it possible to fully incorporate the role of diversity, selection, retention and the generation of new diversity within an evolutionary explanation of economic development.

3. The evolutionary perspective of economic development

As mentioned above, the evolutionary perspective of the economy is that of an adapting evolving complex system. The economy is an open system in which energy and new knowledge are continuously incorporated to create goods and services to fulfil human needs and aspirations, and to solve the coordination problems and conflicts that arise in this process. The development of the economy responds to mainly endogenously generated but also exogenous disruptive changes through a process of structuring that involves growth and increasing complexity. New connections are established, while others fade away, and new layers of interconnection appear transforming the multilayered hierarchical structure of the system. The development of the economic system is an ongoing process of self-organizations and the role of economics is to identify its emergent properties, explain them and make conjectures (attempts to predict) of how and when they are likely to change. Despite the heterogeneity found within the evolutionary camp there are five common shared views that broadly define an evolutionary perspective.

A first characteristic of the evolutionary perspective is its commitment to understand historical processes of economic change and thus to give up, whenever it is necessary, the powerful theoretical shortcut that reduces economics to the analysis of steady states. This implies a greater role for historical accounts, structural description and taxonomical exercise in economics than there is in current mainstream. It also gives room for the exploration of a greater diversity of heuristics and methodologies, and leads to a more careful and wider exploration of the mathematics and mathematical objects that are used to represent economic phenomena. In line with its criticism of the use and abuse of mathematics, the evolutionary approach emphasizes that the nature of the phenomena being studied shall dictate the choice of the formal objects used to represent them and also the use to which they can be devoted. By doing so, it will be possible to more confidently attribute the general properties of such objects to real

\(^1\) See Potts (2001).

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economic phenomena and, perhaps more important given the present state of the discipline, it will also be possible to identify situations whose specificity defy general solutions and sweeping generalizations. In evolutionary economics mathematical tools and formal models are also used for heuristic purposes as exploratory devices and not necessarily and always to derive and test propositions (more on these in section 4).

As it was mentioned at the end of section 2, a second distinctive characteristic of evolutionary theories of economic change is the view of diversity, retention and selection as playing an important role in the explanation of economic dynamics. Technological, institutional and structural change figure at the top of its research agenda and in fact, it was around such themes that an evolutionary broad tent of heterodox thinking emerged. Although the evolutionary perspective has nourished from a variety of heterodox intellectual traditions, an attempt of synthesis remains as an ongoing project. Therefore, there is ontological debate on the explanatory status of the evolutionary triad (the mechanisms of variation, selection and retention within the economic and social domains), as there is debate about the broad paradigm and founding principles of the evolutionary approach and on the role that mathematical and formal models may play within the approach. Some authors, for instance, pose self-organization and the complex system nature of the economic system as its basic general description, and set the evolutionary approach within a broad new synthesis that has emerged in science in general within which this evolutionary triad may be subsumed. Others emphasize the universal explanatory power of highly abstract Darwinian concepts that extend to the natural and social domains and commit to a Darwinian ontology as standing point for evolutionary causal explanations. Where as others take distance of such ontological commitment and uphold that evolutionary mechanisms and regularities in the natural and in the social domain differ and that, although they are related, do not share a common ontology. In particular, the differences between biological evolution and cultural evolution are stressed, and it is upheld that the Darwinian scheme is not an ontological fact of cultural evolution. The above mentioned debate is one among many taking place under the evolutionary tent. These differences in perspective are highly relevant since they lead to different lines of theoretical and empirical research and to the application of different concepts and methods to the analysis of the same phenomena. Broad paradigmatic and ontological disputes aside, evolutionary economists share the view that the theoretical scheme which combines diversity, selective retention and the generation of new variety plays a prominent role in the explanation of economic and institutional change. They also recognize that there are close connections between evolution, complex system dynamics and self-organizing processes, and that these notions and the concepts and theories related to them are bound to be at the centre of the evolutionary synthesis.

18 See references to these notions in relation to the evolutionary approach (in the chapters by Allen and Silverberg in Dosi et. al 2008). See also Foster (1993, 2005), and Raine Foster and Potts (2006) for series of arguments in support of this view.
21 We hold the optimistic view that these ongoing debates are healthy signs of the pluralistic way in which the approach has developed since the various heterodoxies converged in the effort to build a theory of economic change. Adopting a broad evolutionary view of this and other debates, we can say that their proposals will find their place and their weight within the approach as a result of an evolutionary process in which their continuity and hopefully their fertility in generating relevant insights will rank high as selection criteria. In any case the possibility of synthesis will remain to the extent that the dialog keeps open and debate does not lead to a splitting in separate and isolated camps.
A third characteristic of evolutionary economics is that, while mainstream orthodoxy finds its core at the micro level, the core of the evolutionary approach is to be found at the mesoeconomic level. To a great extent this focus on the meso level determines the insights that it can deliver on the dynamics of the economic system. A population perspective with diversity and interaction of heterogenous agents within the economic system is thus central to the approach. Without neglecting the micro and macro levels of analysis, through its population perspective evolutionary analysis helps to build a bridge between these two levels of analysis. This bridge helps to understand the emergence of macro structure and the dynamics of aggregates. At the micro level, it uncovers the relationship of the macro structure and its dynamics with the behaviour and the development of micro units.22

A fourth characteristic of the evolutionary approach closely related to the former is that it is involved in multi-layer analysis. Abstraction proceeds by cutting reality at different levels and identifying links and interactions at such levels. As mentioned above, the links and position of agents in this complex network is one of the sources of their heterogeneity. Collective entities like organizations emerge and change as a result of systemic self organization, and the structure of this complex networks may confer properties which are relevant for their stability and flexibility. The tasks consist in building concepts, analytical tools, theories and models that enable to describe the economic system at such levels, explain their dynamics and establish the relationship between the different layers. This is a formidable collective task. However, it is through the progress of building theoretical and empirical studies (which, as small pieces of a puzzle, contribute to create an image of the whole) that a cogent evolutionary perspective economic change can be built.

A final characteristic of the evolutionary approach, closely related to its heterodox and pluralistic origin and to its perception of the economy as an open system embedded in wider social and ecological systems, is its open dialog with adjacent disciplines. Thus, while keeping the demarcation of what is the subject matter of economic enquiry, evolutionary economics has established a comfortable dialog with natural and social sciences with which the borderline is often a blurry one. The stereotype of mainstream orthodoxy is one of isolationism; however, mainstream economics has been quite open to advances in other areas of scientific enquiry, in particular those related to the use of mathematical methods.23 Evolutionary economics, on the other hand, has been more permeable in the assimilation of concepts and theories. Thus while mainstream economics has been charged of imperialism in its relation with other social sciences, evolutionary economics has been more open to cross fertilization and interdisciplinary work.

The above description of evolutionary economics simplifies the job of clarifying where it stands in relation to development economics. Evolutionary economics is about the qualitative and quantitative changes that occur in the economic system and is concerned with the co-evolution of technology and institutions. Thus the major themes that traditionally have occupied Development Economics are at the centre of the evolutionary research agenda. In this approach, the heterogeneity of micro and macro

22 In contrast with the often criticized ‘homo economicus’, which is defined as an isolated entity, in the alternative homos that have been put forward by evolutionary economists an integral part of what defines the individual economic agent and its development are its connections with its context (physical, mental and emotional) which influences his decisions.

23 Evolutionary game theory, the application of computer based methods by complex systems theory and agent based modelling for instance have been or are in the way of being assimilated by the mainstream. However in the application of these and other formal tools employed by evolutionary economists, significant differences in concepts and theoretical perspective remain.
entities is not only a natural thing but an integral part of its explanatory framework, and this applies to the uneven development that can be observed in comparative analysis of national economists. As “New” mainstream development economics and its radical critiques acknowledge, the development of the capitalist market economy is a world-wide phenomenon and as such it has to be studied. Within the multilayer analysis that characterizes the evolutionary perspective, a country-world perspective is one, highly relevant layer to be distinguished within which single countries’ developmental processes may be analyzed. Other relevant layers can be defined on the basis of any set of meaningful populations that can be identified (firms and corporations, sectors and technologies). Clearly, no developed country prototype can be put forward since all countries are developing countries. We know from history that civilizations flourish and decay, that nations are relatively recent formations that may split and merge. Thus, not only unidirectional trajectories can not be taken for granted but units of analysis and relevant analytical layers may change.

Much of what the evolutionary approach has to offer is in terms of an alternative conceptual framework for the historical and statistical description of the process of development. This framework, as we have argued above, is better suited for the study of change than mainstream orthodox economics, and integrates itself better within the broader area of anthropological and social research that falls under what is called “development studies”. All the major themes of conventional development economics have been approached from an evolutionary perspective: the relationship between different measures of economic growth and economic performance with the numerous aspects that may be related to it: specialization, trade, income distribution, national and international linkages, spillovers, international economics flows, the characteristics of labour and financial markets and so on. As mentioned above, one of the distinctive contributions of this approach is that it provides a framework in which diversity is not a nuisance for the analysis but instead is incorporated to provide an explanation of economic change (together with the mechanisms that create it and the selection mechanisms that operate on it). This and the other characteristics listed above impinge a distinctive seal to evolutionary analysis, and it is by incorporating such dimensions in the analysis that it is able to look at all traditional themes under a different light. To the extent that evolutionary economics makes progress in uncovering laws of economic change and in sharpening its methods to increase its explanatory and predictive power of real world phenomena (which depends on what is knowable and predicable and the extent to which it is so within this paradigm), it will be increasingly able to make relevant statements and proposals which contribute to the political economy of economic development. This progress could also be the basis of substantial contributions to the area of development studies. Empirical quantitative analysis and mathematical modelling are two key elements in this endeavour, and it is to the latter that we turn in the next section.
4. The role of formal modelling

During the last 20 years, scholars working from an evolutionary perspective have elaborated a substantial body of concepts, theories, empirical research and formal models on a wide range of topics related the core concerns of the approach (economic change and the co-evolution of technology and institutions).\(^{24}\) methodology, economic behaviour and learning, consumption and demand, production, networks, firms and organizations, market and market related institutions, innovation and diffusion of innovation, industrial organization and industrial dynamics, growth and development, economic history and history of economic thought are the more prominent areas. It is beyond our reach to attempt a survey of the theories and models in this vast literature. We will limit ourselves to assess the role of modelling within this approach and its perspectives for practical application to development problems. We will do so by examining a key question for evolutionary economics, namely, whether it may be able to establish itself as a mainstream perspective in the study of economic development and in this way be able to trickle down to every day common sense thinking on economic development. We hold that formal modelling is bound to play an important role in the attempt to make progress in that direction, no less than theory and quantitative methods.\(^{25}\) As it is well known by those who study technological change, it is through their diffusion that new technologies acquire economic significance and the same is true of economic ideas. The importance of formal models for the diffusion of evolutionary thinking is due not simply to the fact that this has become a requisite to be taken seriously and be able to communicate almost any idea within mainstream academia. Simple stylized mathematical models together with the graphs and plots that can be obtained from them, as the ones found in economics textbooks, are powerful vehicles in the transmission of fundamental ideas. They are very useful complements of equally important verbal theoretical arguments and verbal accounts of real world situations. A good indicator of the strength of an approach can be found in what it can deliver in terms of theories, models and empirical results at a textbook level. This depends, in turn, on what the approach has been able to achieve at the research level and at the level of professional application in terms of concepts, theories and methods which can be usefully applied to think about economic problems.\(^{26}\) It is also the present situation of the approach in this respect, and in particular in relation to formal models, what determines the role that it may play today in development economics and the role that it may be expected to play in the near future.

\(^{24}\) See Figure 2 in Silva and Teixeira (2006) bibliometric analysis of evolutionary journal articles, which illustrates the fact that the evolutionary papers publication “boom” has taken place during the last 20 years or so. The authors also argue, but do not show, that the path of this research has been divergent. We wonder whether the work of the larger group working under the evolutionary broad tent today is more heterogeneous than the one of the smaller group of the mid 80’s, or what we have in fact is growth and deepening in concepts, theories and methods as a natural result of the growth of research within this approach. In our opinion, as we stated above, dialog is a key element of the unity that is needed to advance in the construction of an evolutionary synthesis. Participation in collective volumes and cross referencing may provide gross indicators of it. It is worth mentioning in passing, that although heterogeneity in research is fine we share the concern of the above mentioned authors regarding the need to seek convergence in a selected set of key issues. The argument in this section points in this direction.

\(^{25}\) This is so even if the use of mathematics and formal models is bound to be different than under current orthodoxy.

\(^{26}\) Beyond the didactic purposes, there are well-known strengths of mathematical models which justify them a place in evolutionary economics: as tools that help to make explicit assumptions and to check and derive further implications of statements in verbal arguments; as basis to conduct quantitative research, and as heuristic devices.
Thus, a key issue for the development of the evolutionary approach, on which we will only sketch a few ideas, are its achievements and potential from the perspective of what could be transformed into prototype models for teaching purposes. Needless to say, the acceptability of those models would have to be endorsed by the fact that they help to transmit fundamental concepts, theories and methods that with or without further elaboration can and have been usefully applied. Let us start by taking some paradigmatic models that could become such prototypes as examples.

Nelson and Winter’s (1982) collection, and the expansion of their earlier individual and joint works on economic change is widely acknowledge as a corner stone of the recent upsurge of evolutionary economics. Besides putting together in a cogent conceptual framework the insight of various of the strands of thought that inspire current evolutionary economics, the authors used both analytical and simulation models to express and develop their theory of economic change. They also used their models to relate their theory to historical data. We doubt that this work would have had the impact it had as a seminal contribution to the evolutionary approach if any of the above mentioned characteristics had been missing.27

These models have set the path for two branches of analytical and simulation evolutionary modelling.28 The analytical model of chapter 10 of their book has been subsequently developed to address issues related to trade, growth and industrial dynamics. Metcalfe’s work on this area provides the best representation of this line of research.29 The simulation models of chapters 12 to 14, in turn, have been the basis of a series of models which have further elaborated on the relationship between growth and technological change.30

For their simplicity and the versatility of their structure, prototypes based on the analytical and simulation models proposed by Nelson and Winter would be candidates to figure in a textbook on evolutionary economics. They provide a clear picture of how the evolutionary mechanisms drive economic change and of what it means to look at economic processes from a population-based perspective. The original analytical model is already quite simple and straightforward, and Anderson, who has made a substantial contribution to make the original simulation models, has produced materials to use them as teaching oriented prototypes.31

As mentioned above, the foregoing argument of Nelson and Winter’s model in relation to an hypothetical textbook of evolutionary economics is intended just as an illustration of what would be required to convey the evolutionary vision of the basic mechanisms that drive economic change at that level. Analogous arguments would have to be made in relation to other key concepts that arise in the evolutionary discourse such as self-organization, emergence, path dependency, lock in and so on. For some of this concepts the original paradigmatic models and examples, which come from outside of economics, are also useful for didactical purposes. Thus, for instance, simple computer implementation of Schelling’s (1969) segregation model and of the Sand Pile model of Bak (1996) can provide a first approximation to the phenomena of emergence and self-

27 However it also has to be mentioned that, for the self-imposed scientific standards of mainstream economics, the relation between models and real world growth data was tenuous since it just appeared as another possible way to fit the data that standard growth models claim to fit.
29 See for instance the various models surveyed in Silverberg and Verspagen (2004), which include these authors’ own work.
30 See Andersen’s (1994), Andersen and Valente (2002), and the materials on Nelson and Winter in Andersen’s webpage: http://www.business.aau.dk/evolution/esa/
organization. However, to get into economics, they would have to be followed by simple models such as the decentralized markets exercises developed by Tesfatsion for teaching purposes in order to see what properties emerge in those artificial markets. This would provide, in addition, an introduction to agent based modelling, another simulation modelling approach related to the evolutionary complex systems perspective.

A major problem that gets in the way of the evolutionary textbook vision project is the same one faced by standard economics: how to relate its theories and models with reality and show that they are useful and, thus, be considered to be worthy of the effort required to study them. By definition, all the mechanisms that operate in the theories and their corresponding models are not readily observable. A solid link with reality has to come in the form of statements that have been repeatedly not refuted by empirical evidence. However, such solid results endorsed by empirical testing are hard to come, and the literature devoted to attempt them is usually quite sophisticated. The standard textbook trick is to introduce suitable narratives of real world phenomena which illustrate that the predictions of the theories and their models have a sound basis and are useful tools to think about these phenomena. This is accompanied with references to advanced research results and by the implicit promise that as models get more sophisticated understanding and predictive power increases. At the discourse level, evolutionary economics is a better sell to a newcomer to economics. Narrative from its processes perspective fits better with the image of the world based in every day experience. The same can be said about its models (and in particular simulation models) which seem more realistic and appealing to common sense thinking of how the economy works. There are also good examples with more appealing narratives taken from empirical research on technology, markets and institutions which can play the same role that their conventional counterparts.

However, paradoxically, the task for evolutionary economics, regarding the connection of theory and models with reality, seems more difficult. This is not only due to the fact that being younger and with much less people working on it that in mainstream it has many open questions and comparatively less amount of empirical research to back it, but also because due to its own perspective, it may fall victim of its own arguments. The evolutionary critique has argued convincingly against the sweeping generalizations of conventional economics and has warned about the misleading results of equilibrium models when they are applied to situations for which they are ill-suited. Path dependency and open system indeterminacy prevent us from knowing in advance the trajectory that economic variables will follow in the long run. An additional problem that affects particularly the prototype simulation evolutionary models to which I have referred above, is that they are very specific. They do not share, in fact, the pretension of generality of their conventional economics counterparts. In addition, they face the problem that the robustness of the results is difficult to establish, since it is not only required to run them many times in order to be interpreted, but they are often sensible to parameter and “small” specification changes. Furthermore, in these models it is also hard to disentangle causal explanations as a result of the complicated network of interrelationships that characterize them. In contrast, analytical evolutionary models, like the ones mentioned above, produce clear-cut results, and do make a claim of generality but at a high level of abstraction. To be tractable, the models have to make

32 See: http://www.econ.iastate.edu/classes/econ308/tesfatsion/syl308.htm
33 The situation in this respect is very uneven in different areas. One finds for instance considerably more production of technology and industry level studies of technological change that of country level studies of growth and development.
simplifying assumptions and, thus, do not render themselves to direct empirical application.

Therefore, if evolutionary economics is going to displace the mainstream at least in the analysis of economic change related topics, which are going to be its basis? One line of the argument may rest on the unfulfilled promises of standard analysis, and there is something in the air regarding the general perception of economics that there may be receptivity to these criticisms. But the question that immediately follows is: what does it have to offer instead? The answer has to be: better understanding and more useful knowledge. Part of this answer passes for the difficult task of creating a different culture of what economics is about and what economists who not necessarily are academics should be able to do. We will not go, however, into this part of the answer which would lead us into the politics of the profession and would take us far from our present discussion. But keeping in mind this remark, let us go back to the relationship between models and reality and to credible promises of evolutionary economics. We start commenting on three interrelated points. First, the role of the two kind of models (analytical and simulation) is bound to be quite different in terms of what they have to offer and what they require in order to deliver it. Analytical models are in general bound to be related to high levels of abstraction and related by general refutable propositions, which as in conventional economics will have to be empirically tested. They would be related to whatever mathematical objects and theories are available, to their results and techniques. And this will be an endless task of theoretical refining which will become increasingly complicated as in conventional economics, but one would argue more relevant. Simulation models, in turn, play two functions: the first is to contribute directly or indirectly to the same task as analytical models, and the second is to be used for practical problem solving. That is, they will belong to the “technological” or “institutional engineering” part of economics used to solve real world specific problems. In this context, there can be a justification for “very theoretical” simulation models in terms of their heuristic value, but the final aim of such heuristics has to be helping to explore possibilities to arrive to general results either through simulation or, what is more likely, through its support to analytical work. They can also be justified as preliminary work paving the way for future practical problem-solving oriented simulation models. Second, the two kind of modelling techniques are closely interrelated, and that relationship is of key importance for the fulfilment of their roles. As Nelson and Winters’ 1982 book illustrates, the basic mechanism of selection in their simulation models is the key point in the specification of their analytical model. Theoretical models go first and feed simulation models. The latter, to a great extent, are extensions of the former and the equations in their specification will develop as a result of theoretical progress resulting from analytical work. Finally, general analytical models will tend to live long as part of theory but will have little practical application, whereas specific simulation models, while being useful as real world problem solving devices, will tend to be short-lived due to their specificity. The applicability of evolutionary simulation models for problem solving would be the most attractive feature, for the models-reality relationship in the hypothetical textbook problem that we have been discussing. However, as we have mentioned, this applicability is constrained by

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34 Here we are thinking about practical problem solving in a very broad pecuniary way: its contribution to the solution of the problem has to have enough economic value to justify the work.
theoretical advance, and, as we will see below, in the present state of evolutionary simulation models the promise of practical applicability has not materialized yet.\textsuperscript{35}

Silverberg and Verspagen (2005), on which we draw for most of what follows, provide a survey of evolutionary models on economic growth (these models are of particular interest since they deal with questions that are key topics for economic development). The authors cover both analytical and simulation models and offer a detailed account of what we may refer to as spin-offs of the original Nelson and Winter models.\textsuperscript{36} As they point out, the models surveyed do not share a common set of assumptions, neither do they point to a common set of results.\textsuperscript{37} The results of most of the simulation models, in particular, are not very specific and by the same nature of the models they do not lend easy to draw specific causal explanations. What they all have in common, as the authors also point out, is that they share some general evolutionary principles. Most of the Nelson and Winter spin-offs share, in particular, the representation of the dynamics that result from the operation of the selection mechanism through replicator equations. As we mentioned above, this was the key feature of Nelson and Winter’s simple analytical model, and is associated with what Mecalfe (1998) has called Fisher’s principle. This principle outstands as a common element of most Nelson and Winter inspired evolutionary models.\textsuperscript{38}

Inspired by Nelson and Winter’s contribution, a line of fundamental research has developed to push forward evolutionary theory by deriving, analytically, general results pertaining the population dynamics summarized by Fisher’s principle, establishing theoretically, for instance, the generality of logistic processes. This research has also made progresses to provide statistical concepts aimed to move from theory to measurement, something that is of great importance for empirical validation of theory and for subsequent practical application of evolutionary models. In the present context, this is to be seen as the analytical spin-off of the original model in Nelson and Winter (1982, chapter 10). This line of enquire has produced a series of results that relate population dynamics with the characteristics of its micro structure. It has also led to what Andersen refers to as “the incipient field of Evometrics”, which, as the name suggests, is concerned with the development of statistical concepts and methods aimed to measure those aspects of evolutionary change that can be approached from the population perspective.\textsuperscript{39}

The simulation spin-offs of the Nelson and Winter model surveyed in Silverberg and Verspagen, on the other hand, are richer than their analytical counterparts, but as the authors acknowledge, most of them have not been able to generate very specific result.\textsuperscript{40} They could be seen as explorations, within a range of possible specifications of

\textsuperscript{35} Nowadays, what could perhaps be sold to a non-academically inclined student is that doing simulation models gives him a grasp of how the real world works and is more fun that following the maths of a model.

\textsuperscript{36} Silverberg and Verspagen (2005), p. 515-530.

\textsuperscript{37} Although the authors make this remark with regard to a subset of macro models, the same applies when the whole set of analytical and simulation models inspired by Nelson and Winter’s work is considered. Silverberg and Verspagen (2005), p. 524.

\textsuperscript{38} Mecalfe’s analytical work has contributed to develop the implications of such principle and push forward the derivation of fundamental results that can be obtained by analyzing economic change from a population perspective. Along this line, his 1989 paper (which corresponds to the 1988 mimeo surveyed by Silverberg and Verspagen) deals with the relationship between growth and trade and an evolutionary notion of dynamic comparative advantage.


\textsuperscript{40} Two of their own co-authored models appear as an exception, as they provide an empirically testable statement in relation to the long-run pattern of technical change, which in a previous work of Silverberg and Lenhert was also found and associated with long-run waves.
micro to macro models, that study the patterns that emerge from the interplay of the evolutionary mechanisms of selection and variety generation. The problem associated with establishing the robustness of the results of these models, that in some cases is attempted to be solved through extensive and systematic exploration of parameter constellations, is clearly presented in their exposition of the various models.\textsuperscript{41}

Regarding the connection to real world data, leaving aside the specific concerns of each model, they have concentrated on generating simulation outcomes whose behaviour is similar in some respect to observed data. Thus, the empirical concern of these models has been directed mainly towards an empirical validation of the evolutionary perspective by establishing the connection between the patterns observed in the data generated by their models and real world data. Finally, it is also worth mentioning, that only two of the models surveyed by Silverberg and Verspagen are aimed to simulate real world economies (and thus, presumably, practical problem solving oriented). This reflects the fact that most of the evolutionary simulation modelling following from Nelson and Winter has been theoretically oriented.\textsuperscript{42}

After this admittedly narrow, both in coverage and scope, discussion of evolutionary modelling, let us go back to our initial point and summarize our thoughts on the role of formal modelling within the development of the evolutionary approach and in particular regarding its application as Developing Economics.

1) Evolutionary economics is largely about economic development so there is no question about its relevance for the topics traditionally covered by development economics. The question of the extent to which it can and will be widely and usefully applied is related to the progress of the approach and its diffusion as the result of its competitive/complementary relationship with other approaches. These are interrelated processes.

2) Modelling is bound to play a key role for theoretical progress of evolutionary economics and as an instrument for the diffusion of the perspective. The contribution of models to obtain fairly general theoretical results are likely to arise largely, but not exclusively, from analytical models; while simulation is likely to play a more prominent role in application and in the diffusion of the approach.

3) For simulation models to play their role in the diffusion of the approach, greater emphasis and progress have to be made in practical problem solving applications. Their development will be closely related to theoretical advances in terms of concepts, principles and results.

4) In order to strengthen the role of simulation modelling in the diffusion of the evolutionary approach, greater agreement is required in fundamental concepts and results derived from theory and from the modelling practice. Convergence is required in modelling tools and in methods and standards to establish the robustness of results. The strength of evolutionary simulation modelling would also be increased by convergence in broad methodological principles and conventions that make communication possible.

5) Above all, a substantial impact in the role of simulation modelling for the diffusion of the evolutionary approach would result if it were able, for instance, to contribute to teach students how to build simulation models that, since the early stages, help them in their own every day economic decisions. This would provide a big contrast with

\textsuperscript{41} Issues related to robustness and validation figure, understandably, high in the agenda of evolutionary simulation modelling. Although progress has been made, many issues remain open.

\textsuperscript{42} We must stress that we do not mean that these are the only two empirically problem solving oriented evolutionary simulation models. Clark, Perez-Trejo and Allen (1995), for instance, is an example of empirically oriented models within an evolutionary complex system perspective. We are focusing on the models within the survey and in particular on those related to the Nelson and Winter tradition.
conventional economics and a real confirmation of the capacity of the evolutionary approach to provide better and more useful knowledge.

6) The practical side mentioned above is also very important in relation to development economics. This technical “engineering” side of models as a tool giving support to decision making would be very important. The approach could get a strong hold in the profession if it could effectively outperform conventional applied models as tools for decision making. This is of course a difficult and risky step. However this is an unavoidable task. Sooner or later, gradual piecemeal attempts have to be done to move towards more policy oriented applied evolutionary models.

The fact that to date evolutionary modelling is not fully involved in practical problem solving and that its “engineering” side is insufficiently developed does not mean that the evolutionary approach is useless from a political economy point of view. The first and most valuable thing it has to offer is its vision, whose key characteristics were described above. Whether to adopt the approach or not at the present time is a personal gamble, but once this is done real world economic problems are certainly seen under a different light. Its concepts and theories, the results from its models and its detailed empirical studies provide a framework of thought, lessons, insights and information that can definitely have an influence in decision making. In the next section we turn to a brief discussion of the approach from the perspective of the political economy of development.

5. The political economy of development

The justification of science and the basis on which scientific research is able to make a claim for the resources required to undertake it rests ultimately on its capacity to produce useful knowledge. In the case of social sciences, as held by Ruttan in a recent paper, the demand for institutional change is one of the sources of institutional change. But it is not the only one. At the individual level the largest part of the population of a country has little to do with a direct promotion of institutional change. However, social knowledge can be helpful to muddle through in an environment in which institutions and their possible changes condition them heavily and affect their possibilities to fulfil their aspirations. These remarks are relevant for the assessment of development economics from a political economy perspective.

In the political arena, at the local, national and supranational levels, economic development appears as a collective enterprise. The quest for development usually ranks high as justification for economic programs, and in the discourse of politicians and high level bureaucracy in governments and international agencies. With arguments related to development other “collective” objectives, property rights and regulations are established and modified, and the institutional setting in general is changed as a result of public policy interventions. Whatever ideological position one may have regarding the desirability of such interventions, the fact is that they take place. The role of an evolutionary political economy of development is to provide analytical frameworks, methods and tools to make sense of these phenomena and to give effective guidance for individual decision making, regardless of their degree of political involvement, and for those directly involved in making proposals concerning collective action. From a political economy point of view, it is the fulfilment of this requirement what determines

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43 The bad press got by cybernetics in the past associated with the failure of its related applied models to fulfil expectations immediately comes to mind.
whether research is relevant or not setting on it an additional constraint beyond the scientific requirement of deriving and testing empirically testable propositions and predictions. Thus, to be successful, evolutionary theory must be able to generate useful knowledge to guide the innovative and adaptive behaviour of purposeful agents. It has to help people to better imagine the possible scenarios that they may face and the consequences that may result from their actions.

In principle evolutionary theories and their associated models may prove useful to the extent that they provide a world view that is focused on change. It has theories that may be applied to understand the working of organizations, of the political process and of different aspects of the functioning of the economic system (industrial dynamics, innovations, consumer behaviour and so on). This world view and these theories can find practical application through the incorporation of the relevant details of the specific economic problems being addressed and can help to organize the available information and data. As we argued in the previous section, to date, most evolutionary formal models are either quite abstract or, in the case of those empirically oriented, centred on the empirical validation of the theory and far from being susceptible of being directly applied to practical problems. Thus, at the present time, what evolutionary economics can offer to development, from a political economy perspective is: firstly, its broad world view: its concepts and theories as a framework to organize information and ideas. Secondly, the insights and messages suggested from its appreciative theories and its associated formal models. Finally, a substantial body of empirical research in which reality is interpreted through the lenses of those concepts and theories. We conclude our brief comment regarding the usefulness of the evolutionary approach to the political economy of development by pointing out that both from its theoretical and its empirically oriented literature both policy makers and people in general can extract valuable insights/lessons and knowledge on real world economic dynamics. Such knowledge would no doubt be valuable for decision making to model through within a complex system that is in a context process of endogenously driven change and adaptation.

6. Conclusions

The framework that evolutionary economics has put forward for the analysis of economic change: its concepts, theories and models represent a significant progress in economic thought. This approach can contribute significantly to a positive change of perspective in development economics. Its population oriented analysis allows us to build a bridge between micro and macro levels analysis. By doing so, it provides a better understanding of the phenomena of structural change, of the way in which observable macro patterns emerge, and of how its dynamics depend on the characteristics of its micro structure. In order to materialize its potential, the evolutionary approach faces the challenge of building a more unified approach to formal modelling. This is the same challenge that other heterodox schools have faced in their attempts to increase their weight within economics. This does not mean building a set of economic models intended for general applicability, in the way current mainstream orthodoxy has attempted. What is needed instead is greater convergence in tools methods and principles in order to provide a solid and at the same time flexible environment in which there is room for creative attempts to model specific aspects of economic change.

The evolutionary approach has built a solid critique of the equilibrium method and has also challenged the algebraic excesses within mainstream economics. It has also put forward an alternative theoretical framework and fundamental elements for formal
modelling which are appropriate for the study of structural change and its relationship with the coordination problems of the economic system. In evolutionary modelling we find both analytical and simulation models coexisting and complementing each other. However, much work remains to be done within the community of evolutionary economists in order to build a more unified set of principles on the use of deductive and inductive reasoning. Work is also required to achieve a broad consensus on the status of the knowledge that emerges from such models. This is particularly relevant in relation to the use of simulation model. This is so not only because, being a more recent formal tool for scientific analysis, it still has to solve important methodological question, but also because applied simulation models have a great potential as a problem oriented tool. Advances in this area may contribute significantly to the diffusion of this approach.

Finally, an evolutionary perspective of development implies to focus the attention on the interrelationship between the dynamics of institutions and technology. It also leads to a view of economic development as an evolutionary process of change of complex open system. The adoption of this approach would contribute to introduce a more creative and open-minded attitude in the analysis of the problems of underdevelopment. However, the success of the evolutionary perspective in providing policy guidelines will depend to a great extent on the progress made to integrate simulation models and computable methods as tools that can be of help in decision making. A coherent and broadly shared view on evolutionary models of economic development is essential in order to build widely accepted and applicable models that can help to better imagine the future under different policies and development strategies.

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