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MICROFOUNDATIONS IN ECONOMIC MODELS: NOTES FROM THE PERSPECTIVE OF ECONOMIC HISTORY AND ECONOMIC DEVELOPMENT

MICROFUNDAMENTOS EN MODELOS ECONÓMICOS: APORTES DESDE LA PERSPECTIVA DE LA HISTÓRICA ECONÓMICA Y EL DESARROLLO ECONÓMICO

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Abstract

The concept of rationality that is behind economic models is crucial for the type of macro–outcomes they produce. For economic historians, the topic is highly relevant. The microfoundations adopted largely define the usefulness of the model for understanding historical processes and the space for a conversation between economists, economic historians, and other social scientists. This paper claims that models based on Keynesian uncertainty, bounded rationality, and evolutionary microeconomics are more useful for understanding two critical dimensions in the study of economic history, namely time and change. The argument is illustrated with a discussion of the determinants of structural and technological change in a peripheral economy.

Resumen

El concepto de racionalidad por detrás de los modelos económicos es crucial para el tipo de resultados macroeconómicos que pueden generar. Para los historiadores económicos, el tema es de gran relevancia. El tipo de microfundamentos adoptado define en gran medida la utilidad del modelo para entender procesos históricos y el espacio de conversación posible entre economistas, historiadores económicos y otros científicos sociales. Este trabajo argumenta que los modelos basados en incertidumbre keynesiana, racionalidad limitada y micro evolucionista son más útiles para estudiar dos dimensiones críticas en historia económica, tiempo y cambio. El argumento es ilustrado con unos análisis de los determinantes del cambio estructural y del cambio técnico en una economía periférica.

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Introduction

The microfoundations of economic models have been a hotly debated topic in the literature for a long time (see, for instance, Kirman, 1989; on macroeconomics, see Vercelli, 1991, especially chapter 6). The debate is important because microfoundations—the ways in which agents understand the world, form expectations, and make decisions—have implications that go beyond a specific firm, market or activity; they strongly condition macroeconomic outcomes. Microfoundations should address at least three crucial questions: a) the nature of agents' rationality, b) how they form expectations, c) and how they learn so

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that norms and capabilities can evolve, allowing for both adaptative and creative responses to a changing environment.

These three questions are interrelated; indeed, how the first question is responded by large determines the answers to the other two. For economic historians, the topic is highly relevant. The kind of microfoundations that are behind economic models define the usefulness of the model for understanding historical process and the space of conversation between economists and economic historians.

In sections 1 and 2 the paper revisits the concepts of rationality, uncertainty, and institutions. The key message of the literature is that in the presence of Keynes-Knight uncertainty and bounded rationality, decision making adopts the form of conventional rules or heuristics —*i.e.* institutions in a broad sense, which in turn are embedded in social relations. It is argued that the hyper-rational "representative agent" of the rational expectations world provides highly misleading outcomes in macro models and is of little help for economic historians. Economic history is concerned with time and change, topics for which the tools of mainstream micro are rather limited. Subsequently, in sections 3 and 4, the paper applies the insights of the previous sections to the study of a classical problem in economic history and economic development, namely the determinants of—and barriers to—structural change and technical change in peripheral economies. It is shown that macro divergence as a stylized fact demands a micro approach that is evolutionary, combining processes of learning, selection and path-dependence in domestic and international competition.

It is important to make explicit what the paper *does not intend* to do.

First, it is not a comprehensive discussion of the concept of rationality and its implications for economic modelling. Its aim is to argue that rational expectations models obscure or distort the importance of history and path dependence in the economic processes; and that it is possible and necessary to build models based on an evolutionary micro to understand those processes. The review of the literature is limited and certainly does not make justice to the richness of the contributions that already exists in the topic—but hopefully it suffices to make a statement in favor of evolutionary and post-Keynesian microfoundations for models in economic history.

Second, to argue in favor of certain kind of microfoundations in economic models does not imply an argument in favor of methodological individualism. Indeed, the analysis that will be presented in this article stresses the role of social norms and (institutional and structural) systemic constraints in shaping individual behavior. As clearly stated by Hogdson (2012, 1394) in his discussion of the behavior of the firm: "There is no organization without social relations" (see also Marmissolle, 2024; an early contribution is Mjøset, 1985).

Last but not least, the paper has no pretension of bringing a novelty for economic historians, who in general have always been well aware of the importance of adopting a dynamic, social-based view of agents' behavior. The aim is to build bridges with a body of literature in economic theory that may help economic historians to identify and articulate the various mechanisms of economic change.

1. Rationality

Most economic models assume rational behavior, which means that humans take decisions based on the best of their abilities and information they can obtain. This is too general. To define "rational" in a meaningful way requires making explicit assumptions about the ability of agents to collect and process information. Based on this ability they form expectations and decide what to do. As regards economic decisions, they have to form expectations about present and future prices, market shares, consumption patterns, the policy environment, and technical change—including the emergence of new goods and sectors in the economic landscape. One avenue to model micro decisions is to assume that a) agents have a perfect knowledge of the parameters of the economic system and the path the economy would follow from now until infinity; b) are able (at least on average) to make optimal decisions on production, consumption, and innovation; c) there are markets for all the relevant economic variables and hence prices always provide the correct incentives. Such assumptions are the basis of the rational expectation hypothesis which attributes to economic agents an almost infinite capacity to gather and process information. From this per-

spective, even if firms do not consciously optimize, the selection process in the market does, in such a way that only firms that behave as if they were following an optimization program with perfect knowledge would survive.

There are additional assumptions which are critical in the rational expectations approach. First, the artificial world constructed by the modeler herself is the one used by the economic agents to make decisions; second, this artificial world perfectly mimics the real world. As a result, agents' decisions are at the same time in full correspondence with the real world and with the world that the modeler has in mind[2]. As Thomas Sargent (one of the leading figures of the "rational expectations revolution", along with Robert Lucas) put it in an interview: "All agents inside the model, the econometrician, and God share the same model" (see Evans and Honkapohja, 2005, p. 3).

In general, setting aside random shocks or short-term disturbances, rational expectations place the economy in a path which is Pareto optimal. Transparency in the marketplace suffices to ensure optimal micro decisions which produce on the aggregate efficient macro outcomes[3]. Rational expectations have little to say about how firms learn, adapt, improve or innovate. Technology is a variable either fully incorporated into the process of dynamic optimization (as in the endogenous growth models) or takes the form of stochastic exogenous shocks. However, innovation is about discovering new things which, by definition, are not yet part of the agents' information set. Technical change is neither random nor perfectly predictable. Innovation and diffusion follow patterns that can be studied and understood, but this analysis requires removing the assumption of the strong (Lucas-Sargent) definition of rational expectations (see next section).

A second approach to rationality acknowledges that agents neither know the true parameters of the economic system nor the paths it will follow in the future. Information is partial and could only be gathered at a cost, which implies that decisions must be taken based on a limited amount of information. Some events or states of nature are just outside the horizon of the agents. The world is one of Keynes-Knight *fundamental uncertainty*, which is different to the concept of *risk* (see Keynes, 1937, pp. 113-14). The latter implies a known distribution of probabilities which can be used as the basis for maximizing expected utilities or profits; uncertainty on the other hand implies that we do not know all the possible "states of nature" in the future and is incommensurable. In the context of Keynes-Knight uncertainty, optimization based on a known (subjective or objective) probability distribution is not possible (see Kirman, 2021)[4].

Uncertainty is particularly acute when it comes to investment decisions (whose impact is felt many years after the moment in which the decision is taken) and/or when rapid technical change redefines competitive advantages. This means that uncertainty is at the heart of two key dynamic forces in the economic system, investment and technical change. In effect, investment plays a crucial role as a source of effective demand, creation of new capabilities and as a vehicle for technical change. It strongly depends on expectations whose bases are fragile, and which may vary swiftly and unpredictably, responding to waves of optimism, "irrational exuberance", panics, herd behavior and manias. Instability is part and parcel of the workings of the market system, particularly of financial markets, where assets are highly liquid, highly interconnected and can be traded at a very high speed. These features of the financial markets tend to amplify the impact of sudden changes in expectations and the "animal spirit".

In some cases, fluctuations in investment respond to systematic, predictable forces which could be monitored and controlled by policy makers. Markets generate cycles driven by their internal dynamics as

2 Sørensen and Whitta-Jacobssen (2005, p. 632) observe that "rational expectations are model-consistent: the rationally expected value of x is equal to the mean value of this variable which one could calculate from the correct stochastic model describing the determination of *x*".

3 There is a room, nevertheless, for welfare-improving policies. When there are externalities and increasing returns, the spontaneous working of the markets produces sub-optimal results which need to be corrected.

4 Davidson uses the concept of nonergodicity—the future does not reproduce the statistical patterns of the past, which means that past and present values (for instance, of asset prices) are not necessarily a good proxy of future values—to explain fundamental uncertainty. In his words, in a "nonergodic world, it is impossible to actuarially estimate insurance payouts in the future" (Davidson, 2009).

the classical works of Minsky show, and governments have instruments to prevent them from occurring or to at least cushion its worst effects (see Minsky, 1977; see also Kregel, 1998). But other types of fluctuations are much less predictable. Economic historians like Kindleberger have acknowledged and documented the importance of waves of pessimism and optimism in the behavior of the markets (on the close association between Minsky and Kindleberger ideas, see Mehrling, 2023).

The use of rational expectations has been defended on the basis that it provides a rigorous, universal norm of behavior that prevents the modeler form making arbitrary or ad hoc assumptions regarding the decision-making process. But at least since the late seventies many economists have been pointing out that the costs of misrepresenting in this way agents' decisions outweigh the risk of ad-hocery. As put by Shiller (1978, p. 40):

> some have argued that (...) we have no good alternative to rational expectations models. If we do not assume strict rationality, then we have no basis for attributing behavior to individuals that isn't in some sense arbitrary. In a sense this is true; one feels less secure in modelling behavior that is not rational. On the other hand, the problems of rational expectations models we have discussed may be so important that a model which postulates an arbitrary expectations mechanism may actually perform better. We may indeed have information that in certain circumstances people really do use ad hoc simple expectations rules.

The lack of realism of the rational expectations hypothesis, at the end of the day, generates outcomes that do not conform to the evidence, which is (or should be) the ultimate test of the usefulness of a model (Farmer, 2013). Simon (2000, p. 34), one of the founders of the concept of bounded rationality, calls for an "empirically grounded theory of decision making and problem-solving processes". Gradually, the literature is moving away of the traditional omniscient optimizing agent. The rise of complexity and behavioral economics indicates a change in the dominant perception (see Dosi and Roventini, 2019, and the recent macroeconomic textbook by Skott, 2023).

2. Institutions

In spite of uncertainty, agents have to make decisions. And there is a way out, which is to adhere to conventional patterns of behavior—social norms, rules of thumb or heuristics. Perfect knowledge and high rationality are beyond the agent's capabilities; but diffused, socially accepted norms provide a basis for decisions in a context of uncertainty and bounded rationality (Dosi, 1988).

A simple metaphor illustrates the difference between the two approaches to decision-making. Imagine a person that arrives to a different country where has to make decisions within a time period that severely limits her ability to collect information. This person is rational: she cannot optimize but knows that by relying on certain rules of behavior will do just fine—as the old aphorism suggests, "when in Rome, do as the Romans do". This is how the theory of bounded rationality explains behavior: the future—especially with respect to technology and investments—is a foreign country whose structural parameters one ignores. Moreover: when it comes to technical change, this foreign country is periodically invaded by high-tech tribes that redefine the parameters of the model in ways that not even the invaders could predict. The innovators themselves discover only gradually where creative destruction is taking them; in the same vein, the routine-driven agents of the Walrasian equilibrium slowly understand that the world is changing and that they need to do something to avoid extinction.

Skidelsky (2014, p. 100) suggests another metaphor:

> The future (...) resembles the past in the way that children resemble their parents and forebears: the genetic ingredients are the same, but the possible combinations are unlimited. Tiny differences in initial arrangements can make for huge differences in outcome. To cope with uncertainty, human beings fall back on conventions.

The rational response when one knows so little about the future is to follow conventional rules or heuristics for decision making that are a satisfying guide under uncertainty, even if one knows that such heuristics are not strictly optimal (Simon, 2000). A classical statement by Keynes (1937, p. 114) remains as the clearest expression of the link between uncertainty and heuristic-driven decision:

> Knowing that our own individual judgment is worthless, we endeavour to fall back on the judgement of the rest of the world which is perhaps better informed. That is, we endeavour to conform with the behaviour of the majority or the average. The psychology of a society of individuals each of whom is endeavouring to copy the others leads to what we may strictly term a conventional judgment.

Some rules are followed under ordinary circumstances, while others are devised to respond to exceptional circumstances, for instance, a change in the technological paradigm, the exchange rate regime or the industrial policy. There is a hierarchy of heuristics in which meta-heuristics are used to change the current ones, responding to the evolution of the external or internal context in which the firm operates.

Heuristics and social conventions, considered as devises that help agents to cope with uncertainty, are the basis for the definition of institutions. Just to quote some definitions of institutions: the behavioral rules upon which "actors' expectations converge" (Krasner, 1982) and "give a durable structure to social interactions" (Bowles, año, pp. 47-48). North (1990, p. 3[5]) defines institutions as "humanly devised constraints that shape human interactions". They may be formal or informal, written or unwritten, explicit or implicit—none of these attributes is crucial for the definition of institutions. What is crucial is their role in *shaping expectations and constraining behavior* so as to structure or "organize" interactions and generate identifiable patterns in a context of fundamental uncertainty.

In a world of atomistic competition strategic interactions are inexistent. The firm reacts to impersonal signals of the system, not to decision-making from any identifiable agent. The idea of institutions placing constraints to human behavior is alien to the world of atomistic competition since there is indeed just one rational response (optimization) for firms to survive. No "conventional rules" are needed. But in the real world most economic interactions are strategic, driven by big players whose decisions depend on expectations over decisions of other players. Interactions are not anonymous; on the contrary, each agent tries to guess how others will react to any move she takes. Institutions reducing uncertainty by (implicitly or explicitly) coordinating expectations and offering an anchor to decision making are still more important in a setting where their big players predominate (typically in international relations and political science, increasingly in the economy).

The "representative", hyper-rational agent does not interact with its environment or with other agents in any relevant sense. For she takes decisions at time zero and from this very moment incorporates all possible feedback from the environment (except for random shocks). An agent with bounded rationality, on the other hand, moves over time through trial and error, using heuristics to decide and changing them when consistently receives positive or negative feed backs from the system. In their seminal work, that can be considered the starting point of the modern evolutionary micro literature, Nelson and Winter (1982, pp. 19-20, 276) saw the transformation of firms and their environment as a Markovian process driven by selection and learning. In this sense, heuristics and institutions are context-specific and exhibit path dependence—meaning that decisions taken in the past change both actors and context, in such a way that they irreversible close or open certain paths in the future. This is a persistent source of heterogeneity in the economic system.

Time and change are dimensions that are at the core of any analysis that "takes history seriously" (see Büthe, 2007, especially pp. 484-486). In this sense, the evolutionary literature, with its emphasis on emerging properties, uncertainty, disequilibrium, and disruptive technical change is particularly suited to this kind of analytical problems. Capone *et al*. (2022) suggest that history friendly models should be

5 For a critical analysis of the different meanings that the word "institutions" has taken in the literature, see Hodgson (2006).

based on heterogenous agents and computer simulation of learning and selection to generate disequilibrium paths. Other nonmainstream schools of thought may provide as well solid basis for discussing time and change in aggregate models whose parameters depend on specific historical and political restrictions shaping the behavioral rules of the economy —see Hein and Vogel (2008), Stockhammer (2022), Hein (2022), Porcile *et al*. (2023), Bianchi *et al*. (2024), and Marmissolle (2024) for a discussion of how post-Keynesian and Structuralist insights may be combined to discuss different growth trajectories and "growth regimes" arising from different political economy settings.

An important caveat should be raised here. The previous discussion focused on the shortcomings of rational expectations in economic models for discussing central concerns in economic history and economic development. However, not all mainstream models use such a radical version of high rationality. A significant part of the mainstream tradition represented by (at least some) of the neo-institutionalists addresses the role of institutions in a very similar way as that suggested by evolutionary or post-Keynesian economists. This tradition claims to have a neoclassical lineage, a topic which cannot be discussed in depth in this paper. Still, in two points mainstream neo-institutionalists substantially differ from rational expectations theorists: a) many new institutionalists do not endorse the "Max-U" assumption which is the starting point of most neoclassical models (see Greif and Mokyr, 2016); b) certain approaches to economic change explicitly adopt a view which is similar to the evolutionists, in particular by considering the interplay between political and economic power as in Acemoglu and Robinson (2006).

In spite of some points of convergence, and potential cross-fertilization between evolutionists and neo-institutionalists, the evolutionary approach tends to be closer to the historical institutionalists than to the neo-institutionalists and the rational choice school (see the interesting discussion by Immergut, 1998). An important difference is that evolutionists and post-Keynesians do not see the Arrow-Debreu perfect-competition market as the ideal benchmark towards which the economy should move. On the contrary, the acknowledgement that non-convexities are pervasive in the real world leads them to see institutions defying comparative advantages as a necessary condition for economic development, as will be discussed in the next section (Chang and Andreoni, 2020).

Summing up, the hypothesis of bounded rationality represents a more realistic approach to how agents behave and to how policies should be formulated in a context of uncertainty. Rather than optimal growth trajectories, what requires explanation in economic history are large and persistent differences in productivity, technological capabilities, and the complexity of the production structure, along with divergence in real wages, income levels and institutional arrangements. To understand asymmetries and divergence—so pervasive in the real world—, bounded rationality and institutions are a more useful starting point than optimization and perfect knowledge of technology and preferences. The point is illustrated in the next section by discussing structural change, divergence, and catching up in an asymmetric international system as an evolutionary process. A more specific, learning-focused approach to institutions is suggested, using the concept of National System of Innovation. In this context, God, the economic agent and the economic modeler, no longer can be fruitfully considered to have common knowledge.

3. Learning, competition and structural change

Localized learning and tacitness

The way in which economists look at technology has changed dramatically in the past twenty years. In the sixties technology was largely seen—as Joan Robinson put it—as given by "God and the engineers". Cost minimization implied that the firm could choose the optimal combination of capital and labor along the isoquant for a given technology. Technical change was deemed to exogenously shift upwards the production function, allowing the firm to produce the same quantity with less capital and labor. This view

was abandoned in most growth models since the early eighties[6], although exogenous technical change still pervades empirical work measuring total factor productivity.

Two early dissenters of the isoquant approach to technical change are Atkinson and Stiglitz (1967), who point out that learning is localized. Learning happens around to, and in connection with, those technologies that the firms effectively use and in which they have accumulated experience. In other words, there is no smooth, continuous isoquants perfectly defined *ex ante*, but rather "points" clustered around (or moving in the vicinity of) existing production processes and capabilities. Nelson and Winter (1982, pp. 76–82) suggested the concepts of "tacit knowing" and routines. Such concepts contain and extend that of localized technical change.

A central theme of Nelson and Winter is that firms' capabilities are embodied and reproduced in "routines" which in turn have a tacit content, meaning that they cannot be fully translated in words or learnt from manuals. Routines are based on systematic repetitions, on heuristics that agents perform almost automatically. They are the crystallization of experience: as such, they are context-specific, idiosyncratic and could not be encapsulated in or transferred through codified instructions. The central role that experience plays in learning gives rise to the well-known Arrowian increasing returns function, in which production costs fall as the experience in production, investment and innovation accumulates.

The concept of routines in firms is symmetric to the concept of skills in individuals. The skills of a person are her ability to almost unconsciously execute a set of articulated steps which could not be explained in words, and which are rooted in the person's experience. In the words of Nelson and Winter (1982, pp. 124–125):

> Routines are the skills of an organization. The performance of an organizational routine involves the effective integration of a number of component subroutines (themselves further reducible) and is ordinarily accomplished without 'conscious awareness'[7].

Technology is not information that can be bought, taken from shelves, and put into use immediately. It emerges from experimentation, failures, corrections, and adaptations. Technical change is not made at the moment in which a new machine is bought in the market; this is just the starting point of a learning path as this machine is incorporated to production routines and adjusted to specific market, technological and cultural conditions.

Learning and capabilities based on tacit knowing and routines change the dynamics of specialization and the emergence of competitive advantages in open economies. This is addressed below.

Co-evolution: innovation, catching up and structural change

The potential for learning varies across technologies and sectors. Some of them are more conducive to innovation and increases in productivity than others—what has been labelled as "technological opportunity" associated with a certain technology or sector. Different technologies also differ in the importance of tacit knowledge and increasing returns. The higher the tacitness, increasing returns, and technological opportunity, the more powerful the forces leading to market share concentration and international economy divergence.

Tacit and localized learning imply that the latter does not take place in a vacuum, but emerges within the limits and stimuli provided by the existing capabilities and production processes (Narula, 2004; Cimoli and Porcile, 2011). In open economies, what the country produces and learns depend on its pattern of specialization. The present international division of labor has significant learning consequences: the pioneer

6 Endogenous growths models made innovation a function of variables within the economic system, in some cases the result of deliberate efforts by the firm to create monopoly rents.

7 It is interesting to note the similarity between the concept of routines in the firm and institutions in the social system. Both concepts refer to "standardized patterns of human transactions and interaction" (Nelson and Nelson, 2003). This makes these authors refer to institutions as "social technologies".

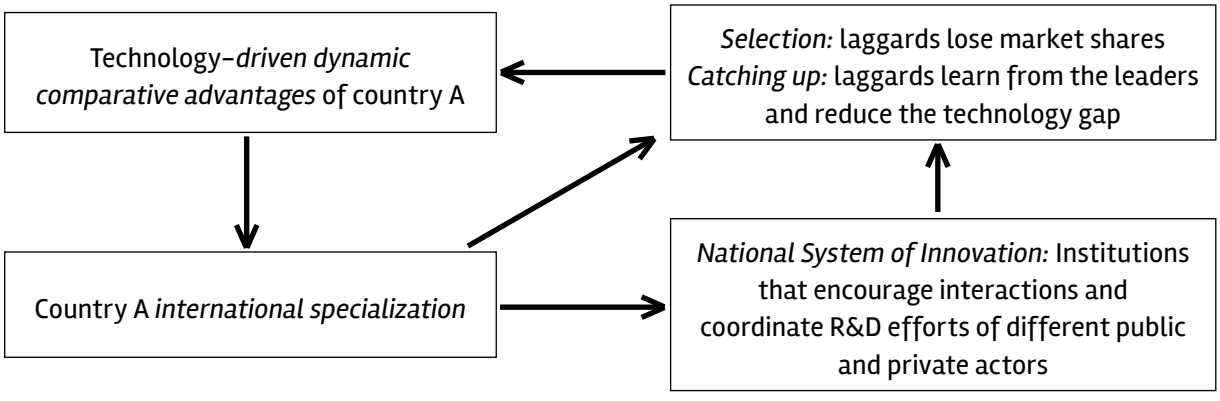
contributions of Lall (1992, 2000) and Pavitt (1984) already provided provide strong empirical support to the idea that different sectors play different roles in innovation and diffusion of technology. There are leading sectors which generate learning spillovers to the rest of the system, while other sectors are "supplier dominated". The perception that some sectors are the crucial loci of innovation is widely acknowledged in technological and business literature, although it is less pervasive in the economic profession. An economy whose firms mostly compete in sectors with high technological and growth opportunities will attain a better performance in macroeconomic variables (GDP growth, wages, exports, investment) than an economy whose firms are mostly located in low-tech sectors.

The importance of specialization from a learning point of view is sometimes addressed in the literature through the distinction between static and dynamic comparative advantages. Static comparative advantages depend on the existence of abundant natural resources and/or a large supply of cheap labor which allows for lower production costs. Dynamic comparative advantages, on the other hand, depend on leads and lags in innovation and technological capabilities which give rise to leads and lags in productivity and quality between firms located in different countries. In the long run, dynamic comparative advantages play the leading role in shaping growth and market shares in the international economy. Exports based on static comparative advantages fluctuate along with the "commodity lottery" and may experience a decline as technical change reduces the content of natural resources per unit of production or create substitutes whose dynamics is knowledge-driven (and hence unskilled labor and natural resources loss importance as competitive assets). Conversely, rents based on knowledge and on the ability to move upwards in the quality and productivity ladders allow the firm to respond faster to economic shocks. Rents from knowledge do not tend to decline, but are continuously recreated through innovation (Reinert, 1995; Saviotti and Frenken, 2008).

In the real world both kinds of comparative advantages, static and dynamic, coexist in different degrees. A key challenge to development policy is to use initial static comparative advantages to build up dynamic comparative advantages. The pattern of specialization of a catching up economy should increasingly rely on dynamic comparative advantages and knowledge-intensive sectors. To move in this direction, it is necessary that firms be able to learn and approach the best practice faster than the velocity at which the international technological frontier moves. There is a race between innovation by the leaders and catching up by the followers that redefines what firms and countries do.

Figure 1 offers a schematic representation of the interplay between learning, capabilities, the technology gap, and international specialization.

Figure 1. The race between innovation, diffusion, and selection in the global market



Source: Own elaboration

Figure 1 tells the story about diversification and technology-driven leads and lags in productivity and quality. Assume that there are asymmetries in productivity between firms in laggard country A and firms in the advanced country B. These asymmetries are in part the result of accumulated capabilities within the firms themselves and in part derived from externalities and complementarities in learning activities in the whole system (the National System of Innovation, more on this below). These asymmetries entail

that firms in country A will be competitive mostly in sectors which are less knowledge intensive, which define country A's comparative advantages. The existing pattern of specialization is efficient (from a Ricardian, static perspective) in the sense that any other arrangement would imply higher production costs. However, the specialization of A may be inefficient from a dynamic perspective, as the country production concentrates in sectors or activities with lower technological opportunities (lower Schumpeterian efficiency) and a lower rate of demand growth (lower Keynesian efficiency).

Assume now that some firms in country A aim to enter a new, more knowledge-intensive sector whose growth prospects and potential profits are higher. Their initial move towards diversification is based on some static comparative advantage (such as lower wages, natural resources) or policy-generated "distortions" (tariff protection, public financing or export subsidies). But the space conferred by static comparative advantages decline in the long run. For wages tend to increase, natural resources to be exhausted, and subsidies discontinued if the productivity gap is not reduced through time. Sooner or later firms in country A will have to reduce asymmetries in technological capabilities in order to survive.

There are two kinds of forces that define whether firms in country A will survive or not in the new sector they entered. First, the *selection process* concentrates market share in the firms closer to the technological frontier. If the initial gap and the intensity of the selection process are high, the new entrants (from country A) in the market will not survive. In the opposite direction, the *diffusion process* allows firms in country A to learn from best practices in country B and reduce the technology gap. If catch up is faster than selection, firms in country A diversify and hence the country changes its pattern of specialization by increasing the share of knowledge-intensive sectors in the production structure. Such an increase will in turn accelerate the learning process, producing a virtuous feedback loop from capabilities to learning. But the efforts of imitators may be impaired by increasing returns that widen initial asymmetries (falling costs of production due to accumulated experience by the first comers). This is why catching up is rarely a spontaneous process. Most frequently, it requires strong industrial and technological policies in the laggard economy to speed up learning and compensate for the initial disadvantage. The higher the tacitness, increasing returns, and the institutional barriers to the international diffusion of technology (for instance, strong property rights on some crucial technologies), the more important the role of these policies.

Taking stock: technological capabilities and the production structure (and with it the pattern of specialization) co-evolve; their mutual interactions are the driving force behind development success or failure. Catching up in income per capita requires convergence both in terms of capabilities and in terms of the production structure. Both goals are difficult to achieve, and few countries have succeeded in this endeavor. What makes convergence so difficult? There are strong inertial forces in the pattern of specialization which explain why catching up is relatively infrequent, which are related to tacitness, increasing returns in technological change, and the institutional setting.

4. Institutions and the National System of Innovation

If learning evolves and is context-specific, related to institutions and to the previous experience that firms, markets and technology have gone through, there are several possible equilibrium growth paths and history matters. Which of them the economy will eventually reach is neither given nor can it be predicted with certainty at the initial moment. Institutions are a significant force in selecting which path the economy will eventually take. They are also crucial for overcoming lock in phenomena.

As noted by Bowles (2006, p. 13):

> If generalized increasing returns are common, many different outcomes may be equilibria. Of these, the sates most likely to be observed will depend critically on institutions governing the relevant dynamics, including such things as the exercise of power, collective action, and other forms of noncontractual social interactions.

In particular, there is a subset of institutions which are especially important in shaping learning and structural change, which will be called the "National System of Innovation" (NSI, see figure 1; see Freeman, 1995; Freeman and Lundvall, 1988; OECD, 1997; Lundvall and Rikap, 2022). These institutions coordinate

efforts at learning by different actors (universities, R&D centers, firms, policymakers, offices for standardization and quality control, training, labor unions, among others) so as to foster interactions, complementarities and knowledge spillovers throughout the economic system. The concept stresses the systemic nature of learning—there is more in innovation than learning and R&D within the firm, for a substantial part of the learning process is based on interactions—and recognizes its national specificity—the NSI evolves and varies with the history and policies of each country, and also depends on its pattern of specialization (which as mentioned reflects existing capabilities).

OECD (1997, p. 9) argues that the "innovative performance of a country depends to a large extent on how these actors relate to each other as elements of a collective system of knowledge creation and use as well as the technologies they use." Lundvall (2004, p. 7) in turn argues that the concept of NSI might be seen as

> 'Schumpeter Mark III' (not designed by Schumpeter though). While Mark I referred to individual entrepreneurs, Mark II referred to big corporations as major drivers of innovation and growth. The innovation system perspective brings in a broader set of actors and institutions as shaping the innovation process. It takes collective entrepreneurship one step further by bringing networking among firms and knowledge institutions into the picture.

In other words, the concept of NSI aims to fully take into account the heterogeneity of the agents involved, the importance of interactions, and the specificities (historical and institutional) of the evolution of learning.

Innovations in this context include not only the development of new products and processes but also the diffusion of knowledge based on minor, incremental innovations and adaptations of technology to the specific (technological, production, institutional) context in which firms operate. This approach sheds new light on the dynamics of the international diffusion of technology (catching up). If firms react to specific institutional, market and technological conditions, it is not possible to make a clear-cut distinction between innovation and diffusion. Diffusion always requires adaptation, adjustments and (minor) improvements to function in a new environment. Taken in isolation, each of these changes, that are the outcome of learning by doing and learning by using, has little impact. But taking their cumulative effects through time they set in motion a transformation that could have a large impact on productivity and competitiveness.

Cumulative minor innovations are a driving force for catching up when the international technological frontier moves slowly. Investments in building technological capabilities may take place on formal R&D departments, but in many cases are part of the so-called informal R&D— the resolution of specific problems (related to the specific competitive and technological conditions of the country in which the firm operates) that come up in the production process (Katz, 1987; Cimoli and Katz, 2003). Engineers and workers use part of their part for troubleshooting which represents an idiosyncratic but significant source of learning. On the other hand, in periods of emergence of new technological paradigms, of swiping transformation in the structure of production—as those brought about by information and communication technology, and increasingly by biotechnology and nanotechnology—this cumulative process of learning could fall short of what is required to participate in global trade. The role of NSI becomes still more important in periods in which there is a transition between technological paradigms. Opportunities and challenges change radically in these periods, as argued in chapter 1.

The emergence of new technological paradigms has a loose relationship with market demand and relative prices. They are more closely related to scientific and technological breakthroughs spurred by public support in leading areas (frequently, but not exclusively, associated with objectives of national security) than with market guidance. As set forth by Mazzucato (2011, pp. 48–49):

> By being more willing to engage in the world of Knightian uncertainty, investing in early stage developments, for example dreaming up the possibility of the internet or nanotech when the terms did not even exist, it (the state) in fact creates new products and related markets. It leads the growth process rather than just incentivizing or stabilizing it.

This point has been reinforced by Stiglitz and Greenwald (2014, p. 21) when he discusses the reasons why the United States was (and probably is) the technological leader. He emphasizes that this position could hardly be attributed to cut-throat competition. Instead, it was "the result of government actions, in response to the Cold War that led to heavy investments in military research, which had large spillovers to the civilian sector (including, arguably, the development of the internet)."

A paradigmatic example of the problems of decision-making under uncertainty, institutions, and structural change is the case of the debate on climate change. Knowledge, formal institutions, and rules of the game have been being torn apart by the power dynamics. Scientists have made clear statements arguing that that the current pattern of economic growth (which the literature calls BAU, business as usual) is unsustainable from an environmental point of view: global warming and the depletion of natural resources would lead to a serious environmental crisis in the future, with large-scale (even catastrophic) effects on the ecological systems and the economy.

On the other hand—given the nonlinearities inherent to complex ecological systems—they cannot predict the timing, nature, and intensity of future environmental crises (Stern, 2013). Neither can they produce precise estimates of the impact of CO_2 emissions on the temperature of the Earth, or of rising temperatures on GDP and consumption. These two relationships (from CO_2 to Earth temperature and from Earth temperature to GDP losses) form the so-called "damage function", which is crucial for computing the negative externalities of climate change (Pindyck, 2013, p. 865). As a result, although there are many economic models that aim to measure the negative impacts of climate change, they offer little help to decision-makers. Moreover, they could even be counterproductive for policy analysis. In a recent review of the findings of these models, Pindyck suggests that they convey a deceiving sense of precision, while grossly downplaying the risks and potential costs of climate change. And yet decisions and actions must be taken. What is to be done? Pindyck concludes that to "the extent that we are dealing with unknowable quantities, it may be that the best we can do is rely on the 'plausible'". From a Keynes-Knight standpoint, this means that one should abandon the idea that it would be possible to find an optimal growth path in which the marginal effects of increasing contamination are matched by the marginal increase in welfare or GDP. Instead, the call is for the international system to generate and enforce rules based on what the scientific community considers reasonable to expect, given the existing scientific evidence. There is neither perfect knowledge nor optimization in the policy proposal and effective rules of the game. The latter reflects the concerns of the scientific community, but at the same time such concerns are thwarted by political power (in spite of public discourses in favor of sustainability)

In sum, the velocity of diffusion and its impact on productivity depend to a large extent on the domestic efforts (of firms and other actors that belong to the NSI) at learning. Firms are not passive "recipients" that simply select the most profitable technology from the shelves. Once a new capital good is imported, a new process adopted or the production of a new good started (even if this process/ good is already used/ produced in other countries), a learning process begins which gives rise to an idiosyncratic technological path, based on minor innovations. Again, diffusion, imitation, catching up are not automatic nor spontaneous: the word "imitation" should not carry a negative connotation when referring to catching up with the technological frontier. Successful imitators took advantage of international spillovers, but success depends on the NSI. Using foreign technology to build endogenous capabilities is an extremely difficult process that requires major local efforts to succeed.

Concluding remarks

This paper discussed what kind of microfoundations may be helpful to study persistent divergence in macro performance and the asymmetric dynamics of structural change. There is still a long way to go in the methodological discussion as regards how to build economic theory on a solid basis. One should not expect full agreement: economics is a plural discipline in which different approaches and schools of thought coexist. But pluralism by no means implies that all theories are valid. They must be not only internally consistent; the ultimate test should be empirical, not only in terms of econometric tests, but also in terms of adherence to the rich evidence produced by economic historians.

As argued by Farmer (2013, p. 384):

> Economics would be a more successful science if it were both more empirical and more open minded. These two go together: when empirical confirmation is the arbiter of success or failure, theories are judged on their merits rather than on their cultural lineage.

The discussion presented in this paper suggests that bounded rationality and institutions offer a better starting point to formulate models of 'micro' behavior that are consistent with the very high levels of heterogeneity and divergence observed (both in the international system and in domestic economies) than models that assume perfect knowledge of the future and optimal paths for the economy. This assertion was illustrated with a discussion of institutions and learning in structural change. The main message is that when time and change are at the center of the analysis, as it is usually the case in economic history, the analysts will find a more useful theoretical framework in post-Keynesian end evolutionary thinking than in mainstream microeconomics. More generally, it seems that a sounder strategy for thinking of models relevant in economic history is to think what kind of micro is congruent with the heterogeneity macro, path dependency, and divergence, rather than to formulate the macro behavior of the economy based on extremely unrealistic assumptions as those adopted in the rational expectations model.

Perhaps it is high time to admit—contradicting Sargent—that God, the modeler and the economic agent do not share the same economic model. It would be better to keep a God-like maximizer out of the story. The answer of Laplace to Napoleon, who in 1802 wanted to know the role that God played in Laplace's model of the planetary system, remains as valid as ever: "Sire, I have had no need of that hypothesis". Instead of imposing on the economic agent an extremely unrealistic assumption about perfect knowledge, one should ask the modeler to consider the empirical evidence on how real people and firms do make decisions and learn.

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