# Contributions to economics from the "periphery" in historical perspective: the case of Brazil after mid 20<sup>th</sup> century

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Abstract. This paper provides an overview of Brazilian economists' contributions to global economics since mid 20th century, from the perspective of economics as transnational science. The contributions are organized into three sections, after a methodological and historiographical introduction: economic development and income distribution, inflation and indexation, and "pure theoretical economics" coming from mainstream mathematical economists and heterodox (mainly post-Keynesian) authors.

**Key words.** Brazilian economists, periphery, transnational science, economic community, history of economics

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### **1. Transnational science, networks and the formation of the Brazilian** economic scientific community

It was only between the mid 1960s and early 1970s that Brazilian economists started to form a scientific community that would become part of the transnational economic community. There was no proper scientific economic community in Brazil until the 1950s, although, of course, economic issues – particularly those related to economic policy-making in the monetary field – had attracted close attention since the 19<sup>th</sup> century (see chapters by M. Coutinho, Flávio Versiani and André Villela in this book). This is in marked contrast with the history of most of the Brazilian scientific community, both in the natural and social sciences fields, which established itself in the 1930s, if not earlier (Schwartzman 1978, 1979, 1991; Ekerman 1989; Azevedo 1955a, b; Haddad 1981).

As pointed out by Raul Ekerman (1989: 118; 126-129), a participant in that process, the emergence of scientific economic discourse in Brazil was determined by the formation of a group of "economic scientists" inserted into the broad international community. The intensification of formal and informal networks between Brazilian and foreign economists in mid 1960s and early 1970s set the standards of economic research in the country and by that forged the beginning of an economic scientific community (see also Loureiro and Lima 1996). Unlike other fields, scientific immigration to Brazil was quite reduced in economics. The few economists who moved to Brazil during the great interwar scientific migration flow – the Austrianborn Richard Lewinsohn, the Czech Alexandre Kafka and the Italian Giorgio Mortara – did have an impact. However, with the exception of Mortara's key-role in the field of economic demography, that was not enough to warrant the formation of a national economic scientific community with strong ties with Europe and the United States (see Boianovsky 2021).

Historians and sociologists of science have recently become attracted to transnational perspectives, as witnessed by the September 2012 special issue of the *British Journal for the History of Science* and by Fourcade's (2006) study of the economics profession. As pointed out by Turchetti, Herran and Boudia (2012: 321-22) in their introduction to that issue, the current stress on "transnational" science as a cross-border activity should be distinguished from its traditional meaning as epistemic

universalism in the sense of a truth-finding activity that is not affected by national, class or ethnic differences. The latter approach was challenged by the development of science studies in the 1970s and 1980s, which emphasized the social history of science as contingent on social, economic and political features. That was accompanied by thick-descriptions, micro-histories of laboratories and research institutions, and investigation of the history of science in local contexts.<sup>1</sup>

The transnationalization of science has accelerated in the 21<sup>st</sup> century and turned science into a global enterprise. Some aspects of that process are the increasing role of both international linkages and scientists' global geographical mobility, accompanied by changes in traditional concepts such as scientific peripheries and "Brain Drain", replaced by hierarchical networks and "Brain Circulation" (see The Royal Society 2011; Van Noorden 2012; for the Brazilian scientific "diaspora" see Carneiro et al 2020).

Science studies attempts to produce a sociologically framed history of science led to detailed narratives of its current and past paths, while its international dimension was only surmised. The analysis of transnational scientific networks has extended the science studies notion of the production of knowledge as a complex process – in which different actors negotiate the meaning and acceptance of new theories – to the discussion of "how locally produced knowledge becomes globally accepted." The establishment of such networks "confers the authority needed to strengthen locally sourced scientific ideas and propel them beyond borders – by means either of patronage, or wider circulation, or adherence to international standards" (Turchetti, Herran and Boudia 2012: 331).

Polycentric and hierarchical alternative networks, competing for power and knowledge, form the transnational system of science, featuring connections between individuals and groups rather than nations. By focusing on flows and circulation of peoples and artifacts, on "what is emerging, what is new in the interstices of encounter ... on the fringes and 'peripheral' spaces", transnational science studies make it possible to contest the "unidirectional vision of the manufacture of the worlds" involved in the notion of colonial or peripheral science (Pestre 2012: 428-29). Gone is the center-periphery dichotomy in science, which cannot account for the emergence of "pockets of central science" on the periphery (see Medina and Carey

<sup>&</sup>lt;sup>1</sup> See Weintraub 2020 for an account of how that has influenced the historiography of economics.

2020; and Rodriguez 2013 for a transnational approach to the history of Latin American social sciences).

The call for a transnational approach to the history of science has entailed a new emphasis on historical studies of the role of agencies and organizations in shaping the international flows of scientists and ideas, including large-scale scientific migrations such as forced exile in the 1930s and early 1940s. Transnational forms of patronage (especially the Carnegie, Rockefeller and Ford Foundations) have been instrumental in the reconfiguration or creation of scientific institutions, and in settling local research into international networks (see Turchetti, Herran and Boudia 2012: 327).

The funding of academic research by international institutions (called patronage) has been a major instrument in the transnationalization of science. That was the case in Brazil in the 1960s, when USAID and especially the Ford Foundation begun to fund the first graduate economics programs in the country, which eventually led to the creation of Anpec (Associação Nacional dos Centros de Pós-Graduação em Economia, the National Association of Graduate Centers in Economics) in 1973. As part of its broad program for social sciences in Brazil (with emphasis on economics) at the time, the Ford Foundation and USAID also became involved in encouraging and supporting American professors and researchers for medium-term visits to Brazilian economic departments, as well as providing fellowships for Brazilian economic students willing to pursue PhD programs in the US (see Haddad 1981; Ekerman 1989; Versiani 1997; Fernandez and Supprinyak 2018).

It would be a simplification, however, to assert that Ford, USAID or other patrons *created* the Brazilian scientific economic community. Rather, such funding institutions operated in a space developed from the 1930s to the 1950s, when incipient economic research carried out by Brazilian economists at universities, think thanks and government agencies established a demand for steady international ties with some of the main centers of production of economic knowledge.

Ford Foundation's funding of Brazilian economics was part of its new overall strategy (adopted at the time by the Rockefeller Foundation as well) to fund large programs involving teams of economists instead of individuals. Around that period, Thomas Kuhn's (1962) *The Structure of Scientific Revolutions* argued that the scientific *community* was central to scientific activity and its history. That was not just a coincidence (see Weintraub 2007: 271). The new notion of science as a collective

enterprise – whose quality standards, research agenda and criteria for resources allocation for science are decided by the scientific community itself – was one the features of Kuhn's concept of "normal science." In the words of Michael Polanyi's (1962) concomitant article, the scientific community worked (or rather should work) as a "Republic of Science", with its own rules for the production of knowledge.

Before the development of an economic scientific community in the 1960s-70s, the production of economic ideas in Brazil is better interpreted in terms of what Schumpeter (1954: 38-39) called "systems of political economy" and "economic thought", as distinct from "economic analysis" proper. Whereas the notion of "scientific progress" applies to the history of the latter, it was not, according to Schumpeter, a feature of the histories of systems of political economy – defined as a "set of economic policies", based on certain "unifying (normative) principles such as the principle of economic liberalism, of socialism and so on" – or of "economic thought" – understood as the sum of "all opinions and desires concerning economic subjects, especially concerning public policy bearing upon those subjects." From that perspective, economic policy mattered to the history of economics only to the extent that it was built on analytical work (Schumpeter 1954: 1145).

Schumpeter's distinction has been applied to historical studies in Brazil, carried out under the assumption of almost complete absence of proper analytical or theoretical work in Brazilian economic thought up to the 1950s – which has led to an emphasis on the history of "systems of political economy" as better suited to the Brazilian case (see e.g. the chapter by Bielschowsky and Mussi in this book). Although economic teaching in Brazil started as early as 1827 (as part of law and engineering schools, as in many other countries), usually featuring relatively update references to the international (European) economic literature, economic research did not become a practice until mid-20<sup>th</sup> century (Hugon 1955; Love 1996).

One should distinguish, while working on the history of economic thought in Brazil, two or three phases, according to the turning point represented by the formation of an economic scientific community in the country in the mid 1960s. The first, long one goes from early 19<sup>th</sup> century to the 1930s, when Brazilian economic thinkers essentially imported and adapted European and (later) American economic ideas to their own purposes (see e.g. Boianovsky 2013). The post-War II period marks a transition stage, when the first research institutions were established – including Latin American ones with strong links with Brazil, such as the United Nations

Economic Commission for Latin America (CEPAL), with headquarters in Chile – and the degree of originality of economic thought in Brazil started to increase, especially in the then new field of development economics. Finally, since the mid 1960s and early 1970s Brazilian economists have become part of the transnational economic community, connected through international hierarchical networks.

The model of "creative adaptation" as explanation of the international transmission of economic ideas to the "periphery" (see Mäki 1996; Cardoso 2003, 2017) assumes a very high degree of net imports of ideas from the "center", with virtually no exports or creation of original theories, hypotheses or analytical models on the periphery. It applies particularly to the first phase, even if "adaptation" continued to be a feature of the other phases.<sup>2</sup>

Basalla's (1967) seminal article provided a first analytical study of the international diffusion of modern science from Western Europe to the rest of the world, based on a three-stage model. Basalla's stadial model has been often compared to Rostow's (1960) modernization approach to growth through a succession of stages (see e.g. MacLeod 2000). Nevertheless, historians of economics have overlooked Basalla's model (Spengler's 1968 passing reference is an exception). In Basalla's stage 1, the new "non-scientific" society or nation provides a source for European science. Stage 2 corresponds to colonial (or dependent) science, when scientific culture. In stage 3 an independent national scientific tradition is established, so that scientists' major ties are within the boundary of the country where they work.

Basalla's center-periphery model was supposed to apply mostly to the successful historical experiences of the United States and Japan. However, it has been applied as well to particular or micro-historical episodes in other countries, as in Stepan's (1976) thesis that the Brazilian Oswaldo Cruz Institute – founded in early 20<sup>th</sup> century as a research center for tropical diseases – developed as far as stage 3. After some initial success, Basalla's model was criticized for its association of science with nation, disregard for the transnational character of science, and the assumption of a linear and unidirectional trajectory that did not acknowledge the multiple characteristics of colonial science (see e.g. MacLeod 2000). Despite its drawbacks,

 $<sup>^{2}</sup>$  Cf. Cosentino, Silva and Gambi's (2019) extension of the "creative adaptation" model to the Brazilian history of economic thought as a whole, regardless of the existence of an economic scientific community.

Basalla's framework calls attention to some features of colonial science that may be applied to the transition phase towards the establishment of a fully developed scientific community. Colonial science provides the "proper milieu, through its contacts with established scientific cultures, for a small number of gifted individuals whose scientific researches may challenge or surpass" the work of scientists from the center (Basalla 1967: 614). As put by Basalla (1967: 614), "colonial scientists cannot share in the informal scientific organizations" of mature scientific cultures, in the sense that they "cannot become part of the 'Invisible College' in which the latest ideas and news of the advancing frontiers of science are exchanged".

The notion of the "Invisible College" is reminiscent of Kuhn's notion of "normal" – as opposed to "revolutionary" – science. Schwartzman (1979: 7-8) has argued for a history of science in Brazil aiming at "understanding science not in its most spectacular and visible aspects, but in its permanence and continuity". The goal of the history of transnational science as produced in the hierarchical periphery is to understand "efforts to establish a 'normal' science … and a capacity to participate effectively, even if not centrally, in the contemporary frontiers of knowledge" (ibid). In other words, becoming members of the "Invisible College" formed by the international community. The following sections of the present chapter provide a narrative of some selected episodes of Brazilian economists' contributions to transnational economic knowledge, as illustrated by case studies from the fields of development economics, income distribution, inflation, mathematical economics, and heterodox economics.

#### 2. Economic development and income distribution

Celso Furtado (b. 1920; d. 2004) was the only Brazilian economist included in all first three editions of M. Blaug's *Who's Who in Economics*, covering approximately the time span from the early 1970s to the mid 1990s. The *Who's Who* was based on citation counts collected from the Social Sciences Citation Index. The third (1999) edition, covering the period 1984-1996, included also another Brazilian economist, Edmar Lisboa Bacha (b. 1942). Like Furtado, Bacha is a development economist (see Bacha's [2018] autobiographical piece, published in a series of "recollections of

eminent economists"). The fourth, last edition (Blaug and Vane 2003) of the *Who's Who* covered citations from articles published in the period 1990-2000. The mathematical economist José Alexandre Scheinkman (b. 1948) – who migrated to the United States in the 1970s but kept (mostly informal) links with Brazil – was the only Brazilian-born economist included in the fourth edition. Moreover, C. Furtado is featured in the *New Palgrave Dictionary of Economics*, together with the Brazilian macroeconomist and policy-maker Mário Henrique Simonsen (b. 1935; d. 1997) (see Boianovsky 2008a, b).

Furtado was one of the participants in the well-known World Bank twovolume celebration of the "pioneers in development", who established the new field of development economics in the post-war period (see Furtado 1987a). He was the first Brazilian economist to obtain a doctor's degree abroad, at the Sorbonne in 1947. His main analytical contributions took shape in the 1950s, when he directed the development division of the United Nations Economic Commission for Latin America and the Caribbean (CEPAL), as recollected in his autobiography (Furtado 1985, 1987b).

Together with the Argentinean economist Raul Prebisch, CEPAL's Executive Secretary at the time, Furtado investigated how the economic structure of the "peripheral" Latin American countries differed from those of the industrialized "central" nations (see Boianovsky 2010). Latin American *structuralism*, of which Furtado was a main formulator, provides an illustration of Gerschenkron's (1952) famous hypothesis of "relative economic backwardness", which asserts that a country's degree of backwardness brings about a corresponding set of innovative ideas, policies and institutions for the reasons and attempted cure of the economic lag. Surely, Brazilian economic development had been a mater of concern since the 1800s (see the chapters by Mauricio Coutinho and F. Versiani), but it was only in the 1950s that the new concept of *underdevelopment* became clear through Furtado's writings, collected in Furtado ([1961] 1964).

The 1954 translation of Furtado's 1952 article established his international reputation as a development economist, especially after its reproduction in the first ever collection of essays in the field, put together by Agarwala and Singh (1958). That was followed by Furtado's ([1959] 1963) historical account of the economic growth of Brazil since colonial times, with its methodological innovation of introducing (verbal) macroeconomic models into the analysis of each historical phase

or structure of the Brazilian economy (see also Boianovsky 2010, 2015). Partly inspired by the Brazilian experience, Furtado ([1952] 1954) distinguished between the economic dynamics of industrialized mature economies, based on internal supply-side elements such as technical progress, and the development of tropical backward countries, induced from without by the exports of raw materials and determined by the demand side. The upshot is that underdevelopment is not a necessary stage in the process of formation of modern capitalist economies, but rather a special process caused by the penetration of modern imported technology into archaic structures beset by capital scarcity. The resulting socio-economic heterogeneity (sometimes called "dualism") tends to perpetuate itself in underdeveloped economic structures.<sup>3</sup>

Some of Furtado's analytical contributions would only be acknowledge much later. Furtado's ([1957] 2008) analysis of what would eventually be named the Dutch Disease (an aspect of the Natural Resource Curse) is a case in point. In his report about the Venezuelan economy – produced anonymously for CEPAL in 1957, but censored at the time and eventually published much later – Furtado discussed the perverse effects of oil production on the economic structure of that country. The oil boom had provoked an overvaluation of the Venezuelan currency, which raised the dollar value of money-wages and hurt the profitability of other exports and sectors of the economy, accompanied by higher imports. "The terms of the problem are simple enough", Furtado ([1957] 2008: 54) explained: "The average level of money-wages", calculated in dollars, "is above the average productivity level. Therefore, any tradable good comes with advantage into the Venezuelan market…" Hence, although Venezuela was an exception to the balance of payments constraint faced by Brazil and

<sup>&</sup>lt;sup>3</sup> However, to his regret, Furtado was not able to put forward, before Lewis (1954), a full-fledged development model of dual economies. As het put it in a 1954 bitter letter to his CEPAL colleague Juan Noyola: "I am convinced that if we had not been discouraged to 'theorize' at that stage, we would have been able to present two years ago the basic elements of a theory of development along the lines of this important contribution by Lewis. We are left with the fact that ... we find ourselves today relatively behind and without anything of real significance to show for" (reproduced from Boianovsky 2010: 252).

other Latin American countries at the time, the absorption of a growing supply of foreign currency brought about problems of its own.

Furtado's 1950s approach to development naturally led in the 1970s to a theory of peripheral capitalism as "dependent" from the outside, involving domination and economic exploitation. Furtado (1987a) claimed that underdeveloped economies featured cultural dependence, as consumption patterns were transplanted from developed economies by the upper strata. Such modernized component of consumption brought dependence into the technological realm by making it part of the production structure through import-substituting industrialization and investment by transnational corporations that control the access to modern technology.

The most influential formulation of dependency theory came from an essay produced in Santiago in 1969 by Brazilian sociologist Fernando Henrique Cardoso and Chilean historian Enzo Faletto at ILPES (Latin American Institute for Economic and Social Planning), a sociological complement to CEPAL (Cardoso and Faletto [1969] 1979). Cardoso emphasized the existence of internal and external subsystems – so that the international capitalist system was not the only determinant – together with the mutual interests among social classes across center-periphery. Unlike Furtado's stagnationist corner, Cardoso pointed out the possibilities of unequal growth in the stage of imperialism dominated by multinational corporations.

Although the influence of the Marxian framework is visible in Cardoso, its full application would be found in another branch of dependency analysis led by Theotonio dos Santos (1970) and Ruy Mauro Marini (1972) under the influence of the Chicago trained German economist Andre Gunter Frank, who taught in Brazil in the early 1960s before the military coup d'état (see Love's [1996, chapter 12] detailed discussion; and the chapter in this book by Ricardo Bielschowsky and Carlos Mussi). They all fled Brazil and moved (temporarily) to Chile after that. Frank, Santos and Marini took the position that Latin American capitalism was nonviable and that dependency could not be broken under a capitalist system. Significantly enough, Santos (1970) was apparently just the second publication by a Brazilian author in the highly prestigious *American Economic Review*.<sup>4</sup> It was part of a session on "Economic Imperialism", chaired by Paul Sweezy, together with other papers by R.D.

<sup>&</sup>lt;sup>4</sup> Kafka (1968), also published in an *AER* "Papers and Proceedings" issue, was seemingly the first one. Like Santos (1970), it dealt with economic development issues, but from a distinct perspective altogether.

Wolff and H. Magdoff, held at the December 1969 meetings of the American Economic Association (AEA). Radical economics was then on relative high demand in the US, which accounts for such a session as part of the AEA program. The "consumption" of Latin American (mostly Brazilian) dependency analysis in the US continued at high levels throughout the 1970s (Cardoso 1977). It deeply influenced the well-known historical model of world capitalism put forward at the time by Immanuel Wallerstein (1974, 1980 and 1989).

CEPAL's structuralist development research agenda would continue and attract international attention in another guise in a series of formal models produced by Bacha, some of them joint with the American economist Lance Taylor. Bacha and Taylor (1971) provided a method to estimate the shadow price of foreign exchange, a key variable in development planning and social cost-benefit analysis. They proposed a new formula to compute the "equilibrium" exchange rate that would equilibrate the foreign exchange market in the absence of tariffs and other distortions. A few years later, Bacha (1978) tackled the issue of the distribution of gains from trade between "central" and "peripheral" countries, which had attracted the attention of Prebisch, A. Lewis, H. Singer, A. Emmanuel and others. The model indicated absence of crosscountry income convergence, since technical progress had asymmetrical effects in the periphery (unchanged wage-rates) and in the center (higher wages). Another influential model by Bacha (1990) built on the structuralist two-gap – the balance of payments and the saving constraints - approach to put forward a three-gap model incorporating as well the fiscal constraint under the assumption of complementarity between public and private investment.

After decades of economic growth based on import-substituting industrialization, Latin American countries (particularly Brazil) suffered from serious macroeconomic imbalances and economic recession in the 1980s and part of the 1990s. Under the impact of the experience of fast-growing Asian countries at the time, and as a reaction to the increasing influence of the "Washington Consensus" established in the early 1990s, "classical" structuralism was gradually replaced by neo-structuralism at CEPAL and by related "new-developmentalism" ("novo-desenvolvimentismo") theses advanced by a small group of Brazilian economists led by Luiz C. Bresser-Pereira (2010, 2020).

New-developmentalists share with neo-structuralists an emphasis on productivity and competitiveness in markets for traded goods as a main source of economic growth. New-developmentalists claim that firms in Brazil and other middleincome countries, due to both cyclical and chronic overvaluation of the exchange rate, are prevented from adopting the most efficient technologies in their investment decisions. Such overvaluation of the domestic currency is caused by cyclical balance of payment crises and by the permanent impact of Dutch Disease phenomena, further elaborates since Furtado's ([1957] 2008) original formulation. According to newdevelopmentalists, the severity of the impact of Dutch Disease on the Brazilian economy is indicated by the difference between the current exchange-rate equilibrium – which balances current account through time – and the exchange rate that brings about "industrial equilibrium" in the sense of competitiveness of the leading firms in the international market.

The links between natural resources and the Brazilian economy have been a persistent object of investigation by Brazilian economists from several perspectives. Those include: sustainable economic development, land conflicts and deforestation in the Amazon, and the interplay between natural resources and institutions. Good illustrations of the former may be found in Reis and Margulis (1991) – as part of a conference volume about global warming – and in articles by Bernardo Mueller and his American co-authors (Alston, Libecap and Mueller 2000; Alston, Harris and Mueller 2012). The inter-relations between institutional development and natural resources could be found already in Furtado's ([1959] 1963) account of the long-term trends of the Brazilian economy, particularly in connection with the persistence of the colonial heritage. Those links have been further investigated since the inception of neo-institutionalist economics in the 1970s and 1980s. Naritomi, Soares and Assunção (2012) have provided a quantitative examination of the determinants of local institutions and distribution of political power in Brazil, with emphasis on the long-term effects of the colonial sugar cane and gold booms.

By the early 1970s, as the first wave of Brazilian economists started to return from their PhDs abroad and the Brazilian economy was still experiencing high growth rates, an intense controversy took place – as new data showing a higher Gini coefficient of income distribution became available – about the causes of the unequal distribution of the fruits of economic progress. Those debates played a decisive role in establishing the Brazilian scientific economic community and its international links. The income distribution controversy engaged Brazilian policy-makers, foreign economists (particularly Fishlow 1972), international institutions (such as the World Bank and its president R. McNamara) as well as young Brazilian economic researchers.

That was the most important economic debate during the long period of military rule (1964-1985) in Brazil. It is apparently paradoxical that a relatively open economic debate that challenged the then prevailing economic policy, amidst the restrictions imposed by political repression, could take place. But the puzzle is solved if the international character of the discussion is taken into account, as well as government policy-makers' belief that they had the best side of the argument in the attempted econometric demonstration (see Langoni 1975) that increasing inequality resulted from the market effects of economic growth under conditions of skilled labor scarcity (see Andrada and Boianovsky 2020; Ekerman 1989). Economists opposing the military regime believed increasing inequality resulted mainly from economic policies – particularly a minimum wage squeeze – implemented by the Brazilian military rule after the 1964 coup d'etat (see Bacha and Taylor 1978 for a survey).

That heavily contested econometric debate attracted worldwide attention and contributed decisively to turn economic inequality into a main theme of the development economics literature. The concern with economic justice, over and above economic growth, became pervasive (Hirschman 1981). One of the key issues was the so-called perverse "Brazilian model" of economic growth accompanied (or even stimulated) by increasing inequality, as outlined by Tavares and Serra (1973), among others, and formalized by Taylor and Bacha (1976).<sup>5</sup>

Brazilian income distribution issues came to the fore again after data indicated a continuous, unprecedented decline of the Gini coefficient between 2001 and 2014 (see Hoffmann 2018, who had participated in the 1970s debates as well). This led to the hypothesis of the formation of a new middle class in Brazil, advanced by Marcelo Neri (2015, 2021) as part of an international UNU Wider project (see Kopper 2020 for a historical account). The role of minimum wage legislation continued to attract attention (see e.g. Brito, Fogel and Kerstenetzky 2017), although the long-term

<sup>&</sup>lt;sup>5</sup> Maria Conceição Tavares (b. 1931) stands out as the most prominent female economist in the history of Latin American economics. Born in Portugal, she immigrated to Brazil in the 1950s and did graduate studies in economics at the CEPAL office in Rio in the early 1960s (see Boianovsky 2000). More recently, the Brazilian mathematical economist Marilda Sotomayor (b. 1944) should be mentioned as an important woman economist (see section 4 below).

inequality trends shown by income concentration at the top seemed to persist (Souza 2018, whose research has kept links with T. Piketty's World Inequality Lab).

#### 3. Inflation, indexation and stabilization

As discussed in section 1 above, Schumpeter's (1954) distinction between "systems of political economy" and "economic thought" on one hand and "economic analysis" on the other has been sometimes applied to Brazil. From that perspective, economic policy matters to the history of economics as such only to the extent that it is built on analytical work, as Schumpeter (1954: 1145) acknowledged. That was the case of the successful 1994 "*Real* Plan" (*Plano Real*) of economic stabilization, which managed to curb the chronic accelerating inflation rate that had beset the Brazilian economy since the 1970s.<sup>6</sup> As put by Edmar Bacha, one of its architects, the *Real* Plan was based on a "homegrown monetary reform" conceived and implemented by members of the Department of Economics of the Catholic University of Rio de Janeiro (PUC-Rio) (Bacha 2003: 181). The development of the pure case of inertial inflation, and of its corollaries for economic stabilization in Brazil, may be seen as yet another manifestation of Gerschenkron's (1952) thesis about the influence of domestic economic problems on the creation of new ideas and policies at a national level.

Monetary economics, to a larger extent than other fields, has been influenced by historical events and institutions at both national and international levels (see e.g. Hicks 1967). South American monetary history is a case in point, as illustrated, for instance, by the pioneer detailed discussion of inconvertible paper money by Chilean economist Guillermo Subercaseaux (1912) in his *El Papel* Moneda. It attracted the attention of Knut Wicksell and other European monetary theorists at the time, in a rare case of transmission of economic ideas from the "periphery" to the "center" (see Alcouffe and Boianovsky 2013). Persistent inflationary conditions in the region would attract general attention again, when a large international conference on *Inflation and Growth in Latin America* was held in Rio in 1963. The 1964 conference volume, edited by Werner Baer and Isaac Kerstenetzky, has been regarded as the

<sup>&</sup>lt;sup>6</sup> For background information about the Brazilian economy and economic policy in that period see Baer 2008, especially chapter 8 on the *Real* Plan, and Andrade and Silva (1996).

climax of a decade of intense debates between Latin American "structuralists" and "monetarists" – a term coined by Brazilian economist Roberto Campos in the late 1950s (see Boianovsky 2012, and the chapter below by Bielschowsky and Mussi).

Shortly after that, Brazilian policy makers – in an attempt to avoid or minimize the negative impact of stabilization measures on employment and output, as well as the perverse effects of inflation on economic agents' decisions – introduced widespread indexation of economic contracts, the first of its kind in international monetary history. Again, that would not fail to draw the attention of American and European macroeconomists alike, especially after Milton Friedman approved of and supported the Brazilian indexation system upon visiting the country in December 1973, when Brazil was experiencing high economic growth accompanied by declining inflation rates. As Friedman pointed out, Alfred Marshall had advanced the theoretical argument for indexation back in the 1880s, but it was the first time it was put into practice. From Friedman's perspective, escalator clauses eliminated the effects of differences between actual and expected inflation, turning the short-run Phillips Curve into a vertical line (Friedman 1974; see also Boianovsky 2020 and references cited therein).

Between the mid 1960s and early 1990s Brazil became the laboratory of indexation experience. Two international conferences on indexation were held in 1975 at the University of São Paulo (published 1977) and in 1981 at Getulio Vargas Foundation in Rio (published 1983), including papers about the Israeli indexation record (Nadiri and Pastore 1977; Dornbusch and Simonsen 1983). By then, models of wage indexation by Jo Anna Gray (1976) and Stanley Fischer (1977a) had become influential. Brazilian economist Mario H. Simonsen (1983) formally showed, in an extended version of the Gray-Fischer model, that, in the absence of supply shocks, *full* widespread indexation – as Friedman had suggested – relieves the output loss of anti-inflationary policies, as price expectations are eliminated from contracts. However, the type of indexed wage contract found in Brazil was based on a staggered rule, with money wages adjusted at time intervals according to previous inflation rates. As first modeled by Simonsen (op. cit.) lagged wage indexation, under the assumption of rational expectations, led to a Phillips relation analogous to the one with adaptive expectations. Simonsen's demonstration supported the policymakers' contention that, in practice, wage indexation made disinflation more difficult.

The 1970s-80s international discussion about indexation and its effects was related to a broader debate about rational expectations, policy effectiveness and stabilization (see also Boianovsky 2022). It is in that context that the contributions of Brazilian economists to what became known as the theory of "inertial inflation" – and particularly to its original implications for the design of stabilization policy in Brazil – should be placed. As put by Tobin (1980a: 789, italics added), the "main practical controversy of the day is to what extent, if any, the ongoing inflation is *inertial* – i.e., reflects sluggishness in the adjustment of paths of nominal wages and prices – as well as expectational." Tobin (ibid; 1980b: 62-63) claimed that lagged prices and wages, resulting from institutional inertia and disequilibrium adjustment, challenged the new-classical policy-ineffectiveness proposition and vindicated the traitional Keynesian approach. Tobin did not provide a model of inflation inertia, but referred to the literature on contracts under rational expectations for analytical foundations (see e.g. Fischer 1977b; Taylor 1979).

In his suggested inflation taxonomy, Tobin (1981: 23) defined *inertial inflation* as "the self-replicating pattern of wage and price inflation", later called an "autoregressive process" in the sense that inflation depends essentially on its past values. Brazilian economists in the early 1980s identified staggered backward-looking wage indexation as a key feature of high chronic inflation that affected the country, as opposed to forward-looking rational expectations. From that perspective, backward-looking lagged indexation was the mechanism by which distributive conflicts between economic agents worked out in the Brazilian economy at the time (see e.g. Williamson 1994). This contrast – between the international emphasis on expectations and policy credibility issues on one hand and the role played by lagged indexation in Brazilian inflation on the other – became conspicuous among Brazilian economists from PUC-Rio (see e.g. Lopes 1984; Arida and Lara-Resende 1985; Bacha 1988). They pointed out that, in heavily indexed economies like Brazil, the main influence over the current inflation rate was not its future expected path but the past observed one, with crucial implications for the economic stabilization strategy.

Brazilian economists were, of course, aware of Taylor (1979) and other influential rational expectations articles featuring staggered wage contracts, which introduced price level inertia in the sense that the price level fully adjusts to a monetary shock only after a continued departure of employment from its natural level. Accordingly, it was often asserted in the international literature that Taylor's model accounted for inflation inertia as well. However, as shown by Simonsen (1986), that model generated only price level inertia, not inflation inertia (see also Lopes 1983 for a similar criticism). Taylor's (1979) model inertia was *weak*, in the sense that a contractionary monetary rule was consistent with painless stabilization, contrary to the *strong* inertia proposition put forward by Brazilian economists (see also Andrade and Silva 1996: 441, n. 16). A similar point – that staggered price and wage changes à la Taylor do not account for the difficulty of reducing inflation through deflationary monetary and fiscal policy – would be made by Ball (1994), without referring, as one might expect, to the Brazilian literature (see also Romer 1996: 272-73).

Simonsen – a member of the Vargas Foundation in Rio, and a policy maker and adviser from mid 1960s to mid 1970s – put forward an early intuitive model of inflation inertia. The inertial element – then called "feedback component" ("coeficiente de realimentação" in Portuguese) - together with the "autonomous component" (supply shocks that change relative prices) and the "demand regulation component" (excess aggregate demand) – decide the rate of inflation according to a linear formula. Simonsen's model differed from the then fashionable accelerationist Phillips curve by explaining inflation acceleration as a result not of revised expectations but of a reduction in the price and wage adjustment interval, captured by changes in the feedback coefficient.

. Simonen's (1970) model implied that even if inflation expectations fell to zero, the feedback inertial mechanism would keep working due to wage staggering in the indexation process. On the assumption of zero excess aggregate demand and a less than unity feedback coefficient, the lower limit to the current rate of inflation was given by the autonomous component divided by 1 minus the feedback coefficient. In particular, any attempt to reduce the inflation rate below its limit value would bring about a permanent reduction of the rate of growth. The limit value may be seen as the expression of purely "structural" inflation to distinguish it from price rises determined plainly by excess aggregate demand.<sup>7</sup>

<sup>&</sup>lt;sup>7</sup> The notion of inertial inflation can be found in incipient form in Furtado's (1954, p. 179; [1959] 1963, p. 252) concept of "neutral inflation", defined as inflation without any apparent real effects. Neutral inflation occurs if economic agents develop defense mechanisms to prevent the income redistribution required by the introduction of some disequilibrium in the system. As observed by Furtado, it would seem that it would not be difficult to stop a neutral inflation, "since none of the groups would have anything to lose as a result of stabilization." However, if one takes continuous time instead of

With a few exceptions, Brazilian economists involved in the debates about inertial inflation and stabilization policies published relatively little abroad. Members of the department of economics at PUC-Rio formed a "closed" and "protected" community from the late 1970s to the mid 1980s that gave priority to debates among its own members - mainly Edmar L. Bacha, Francisco L. Lopes, André Lara-Resende, Eduardo Modiano and Persio Arida, later joined by Gustavo B. Franco instead of extensive intellectual interactions with other groups either domestically or internationally. According to Arida (2022), that was behind the progressive research program à la Lakatos, on inertial inflation in indexed economies, carried out by that small set of economists. It predicted new facts and accounted for the empirical evidence by performing econometric tests, as revealed by going through the large number of Working Papers about inertial inflation produced at PUC Economics Department during that period. Although its members had studied economics and obtained PhDs at well-known universities abroad, the main goal of the group was not to achieve international academic recognition as such, but to influence domestic formulation and implementation of macroeconomic stabilization policies.

Faria's (2005) model of a trade-off between international (mostly American) and domestic publications by academic economists is useful in this connection. Faria argues that, under the assumption that productive scholars are reputation seekers in their own countries, they have an incentive to publish in journals in their home country and spend time outside academia. This is largely accounted for by the degree of government intervention in the economy, which induces academic economists to invest their human capital in specific knowledge of local economic problems and institutions, as was the case of Brazilian inflation. The argument implies that productive rankings, which value international top journals, are biased against economists outside the United States.

PUC-Rio economist Francisco Lopes (1999: 335) was clear about the "dilemma" between publishing abroad and domestically, that is, between gaining international academic recognition or trying to influence national economic debates and policies. Lopes (ibid) singled out his colleague Edmar Bacha as an author who managed to find balance between international and domestic publications. In his entry

discrete periods, the "difficulty in stopping the price rise in a neutral inflation process" becomes clear (see Boianovsky 2012).

in the *Who's Who in Economics* – which lists his main publications and contributions – Bacha regarded the successful implementation of the "novel stabilization program" represented by the *Real* Plan his "most important contribution to economics" (Blaug 1999: 52; see also section 6 of Bacha's 2018 autobiographical piece prepared for the international series of "Recollections of eminent economists").

Nevertheless, Brazilian economists did publish, on occasion, about Brazilian inertial inflation in international outlets, often because of connections with foreign economists who had an interest on the Brazilian economy and its chronic instability. John Williamson (from the Institute for International Economics, now the Peterson Institute for International Economics), Rudiger Dornbusch (from the Massachusetts Institute of Technology, known as MIT) and Lance Taylor (then at MIT, now at the New School for Social Research) played key roles in providing an international audience for some Brazilian economists' ideas about inertial inflation and stabilization, and by that turning those ideas into part of transnational economic networks.

British economist John Williamson moved to Rio in the late 1970s upon getting married to a Brazilian economist. For a couple of years he taught at PUC-Rio, where he produced a joint paper about "The theory of consistent indexation" (Lopes and Williamson 1980). In the early 1980s Williamson accepted an appointment at the Institute of International Economics in Washington, where he remained until retiring in 2012. He would become well known after advancing in the early 1990s the so-called "Washington Consensus" of economic policy guidelines for Latin America. In December 1984 Williamson put together an international conference on *Inflation and Indexation* (Williamson 1985), for which he invited Persio Arida and André Lara-Resende to present their new paper on "Inertial inflation and monetary reform" in Brazil (Arida and Lara-Resende 1985), which would eventually turn into one of the foundations of the 1994 *Real* Plan. Arida and Lara-Resende (1985) was the focal point of the conference.

Shortly after the implementation of that stabilization plan, Williamson participated at a conference held at Duke University about the "internationalization of economics" (see Coats 1996). Williamson (1996: 367) agreed that there was a general trend of internationalization or "Americanization" of economics, but pointed out that the "theory of inertial inflation in Brazil" was one of the instances illustrating that

there was still an "important reverse flow of ideas" going on. As recalled by Williamson (2005),

I agree that countries can sometimes benefit from heterodox proposals. We at the Institute for International Economics once sponsored a conference when the ideas that ultimately flowered into the Real Plan first took form, with the objective of trying to ensure that if Brazil did implement the plan it would not be sabotaged by the IMF's dinosaurs. To my mind the Real Plan was one of the most brilliant heterodox plans ... and was totally country-specific. Its essence was not the use of the exchange rate as a nominal anchor, which was an unfortunate belated add-on, but the use of the indexation unit as the new monetary unit following monetary reform (Williamson 2005: 50, n. 13).

R. Dornbusch, who discussed Arida and Lara-Resende's paper at the 1984 conference, called it the "Larida" proposal (Dornbusch 1985). Dornbusch, like Williamson, was an expert on the macroeconomics of exchange rates. He was familiar with the economic instability of Latin American economies (see the essays collected in Dornbusch 1993). Both Arida and Lara-Resende had been PhD students at MIT in the late 1970s and early 1980s. By that time, Dornbusch and some other MIT economists started to show interest on macroeconomic and stabilization problems in Brazil and other indexed economies (see e.g. Modigliani and Padoa-Schioppa. 1978 on Italy). As recalled by Arida (2019: 16), Dornbusch was an important influence on his intellectual formation at MIT. Furthermore, a few days after the 1984 Washington indexation conference, Dornbusch set up a seminar at MIT about the Larida proposal, involving, besides Arida, Lawrence Summers, Franco Modigliani and Mario Simonsen (Arida 2019: 24).

In 1981 Dornbusch co-organized in Rio with M.H. Simonsen a large international conference on inflation and indexation that brought together some of the main experts in the field (Dornbusch and Simonsen 1983). That was the beginning of his collaboration with Simonsen, which would result in a couple of joint papers on the topic (see e.g. Dornbusch and Simonsen 1988) and in Simonsen's exposure to the international academic community (e.g. Simonsen 1988).<sup>8</sup> On the other hand,

<sup>&</sup>lt;sup>8</sup> Werner Baer had written a couple of papers with Simonsen about inflation and its effects in the mid 1960s (see Baer and Simonsen 1965; Baer, Kerstenetzky and

Dornbusch's interaction with Simonsen – together with the fact that he was married to the Brazilian macroeconomist Eliana Cardoso – stimulated the MIT economist's interest in the Brazilian indexation mechanisms and stabilization plans, both the failed *Cruzado* Plan of 1986 and the successful *Real* Plan of 1994 (Dornbusch and Simonsen 1988; Cardoso and Dornbusch 1987; Dornbusch 1997). Shortly

Lance Taylor, who cultivated long ties with the Brazilian neo-structuralist tradition of PUC-Rio, was then editor of the *Journal of Development Economics* and published a couple of influential articles about Brazilian inertial inflation at the time. Years later, Bacha (2003) would put out his detailed account of the *Real* Plan as a chapter contributed to L. Taylor's Festschrift. Lopes and Bacha (1983, section 2) formally established the relationship that, for a given initial real wage, the average real wage is lower the higher is the inflation rate for a given indexation lag from prices to wages. Moreover, the larger the number of readjustments in a given period, the more responsive wage increases become to the current inflation.

Lopes and Bacha (1983: 15-16) argued that full wage indexation would eliminate the recession bubble associated to economic stabilization, as well as the forced savings effect. Their conclusion – that a "distributionally neutral increase" in the intensity of wage indexation reduces the output loss of a deflationary monetary shock – was reminiscent of Milton Friedman's original proposition, as the authors observed. Furthermore, their policy conclusion adumbrated the notion of stabilization via an indexed currency, as later put forward by Arida and Lara-Resende (1985), further elaborated in Arida's (1986, section 9) *JDE* article and eventually implemented in the 1994 *Real* Plan.<sup>9</sup> Apart from Simonsen and economists at PUC-Rio, inertial inflation also caught the attention of Brazilian economists L.C. Bresser-Pereira and Y. Nakano in articles and a book published from 1983-87 (see the chapter by Bastos and Bastian below). Bresser and Nakano's (1987) book was positively reviewed in the *Journal of Economic Literature* (Gapinsky 1988).

The Brazilian *Real* Plan involved a two-stage process of substitution of the old inflated currency by a new stable one, initially as a unit of value, and finally as a

Simonsen 1965), but that did not lead to a continuous flow of international publications by Simonsen.

<sup>&</sup>lt;sup>9</sup> Arida and Bacha (1987) – who worked out a disequilibrium fix-price model of balance of payments dynamics in order to sort out the historical debates between IMF and CEPAL based alternative stabilization frameworks – was another macroeconomic piece by Brazilian authors published in *JDE* in the 1980s.

means of payment. It was based on the Larida proposal (Arida and Lara-Resende 1985) to curb chronic inflation in the Brazilian indexed economy through a monetary reform preceded by full indexation. In March 1994 the government introduced an inflation index (URV, meaning "unit of real value") to serve as an optional unit of account and to align the most important relative prices in the economy. Since the index had stable real value, economic agents adhered massively to the unit of account. In July 1994 the old money was extinguished and the URV became the new currency, named "real", at a semi-fix par with the US dollar. The 4 months URV period led to the elimination of backward-looking indexation without the need of ensuing price and wage freeze as in the failed 1986 "Cruzado Plan". The inflation rate fell abruptly from 45% a month in June to 6% in July 1994, and kept falling after that. Contrary to the interpretation prevailing among some foreign economists (see e.g. Fischer, Shay and Végh 2002), the plan was much more than a mere foreign-exchange-based stabilization (see Bacha 2003).

The success of the *Real* Plan was striking, given its low credibility due to previous stabilization failures (see Almeida and Bonomo 2002). Thomas Sargent (1983) had stressed the credibility factor in an influential essay about the painless end of hyperinflation episodes following the introduction of fiscal reforms. According to Sargent, the sudden end of hyperinflations, especially in Germany and other European countries in the 1920s, was mainly due to expectational effects of regime changes brought about by fiscal reforms. Economists at PUC-Rio disputed that view and stressed instead the stabilizing effects of the 1923 German monetary reform represented by the introduction of the *retenmark*, and its similarities with the Brazilian indexed currency proposal (see Lopes 1984; Arida 1984; Arida and Lara-Resende 1985; and especially Franco 1987 and 1990). A main lesson from the end of German hyperinflation, from the point of view of Brazilian economists, was the shrinkage of the inflationary memory of the system as contracts were indexed for shorter periods of time.

Sargent – like M. Friedman (see Friedman and Friedman 1998, as quoted in Boianovsky 2020) – regarded the monetary reform introduced by the *Real* Plan as just a "cosmetic" measure, as much as the German *retenmark* (see Sargent 2013; Sargent, Williams and Zha 2009). That betrayed Sargent's (and Friedman's) misunderstanding of the main features of the monetary reform carried out as part of the *Real* Plan. Sargent (2013: 242) – in a paper titled "Reasonable doubts about the Real Plan" originally written in 1995 and published at the time in the "Economic Letter" of a Brazilian investment bank – acknowledged the "technical skill and creativity of Brazilian monetary authorities", but charged that "the de-indexation of the economy accomplished by the Real Plan is a technical detail, a side-show that hasn't touched on the fundamental causes of inflation." The success of the stabilization plan, Sargent claimed, was due to the monetary and, especially, fiscal policies adopted. Indeed, the first stage of the *Real* Plan was a balance budgeting constitutional mechanism, known as "social emergency fund" (see Bacha 2003). Once that was taken care of, the monetary reform would tackle the main inertial component of Brazilian inflation.

Research about inertial inflation significantly diminished in Brazil after the 1980s-90s, as the indexation mechanism were largely removed from the economy and inflation stabilized at relatively low rates as part of the new "inflation targeting" policy. Contrary to some accounts (see e.g. Carvalho 2019), the "decline" of the inertial inflation hypothesis in Brazil and its absorption by New-Keynesian economics was a natural process that reflected the new historical circumstances and the working of international economic networks. Hence, as part of his New-Keynesian/neo-Wicksellian framework, Woodford (2003) worked out in his influential book the analytical consequences, for the theory of inflation targeting, of indexation to past inflation. Michael Bruno (1989), the main responsible for the successful Israeli stabilization in the 1980s and frequent interlocutor for some PUC-Rio economists before and during the implementation of the *Real* Plan, had argued, against Sargent and others, for the theoretical and policy relevance of the concept of inertial inflation. Referring to Arida and Lara-Resende (1985), the IMF acknowledged the theoretical status of that notion (see Chopra 1985), even if it did not endorse the 1994 *Real* Plan.

## 4. Contributions to theoretical economics by mainstream mathematical economists and by heterodox economists

Brazilian economists' contributions to purely theoretical economics – that is, economic models and ideas that are not immediately motivated by or applied to economic policy matters – over the last 60 years or so have increasingly reflected the "pluralism" of economics in the country. According to Dequech (2018), Brazil has been a conspicuous case of economic pluralism, as reflected by the institutional

distribution of academic and political power and prestige, to such an extent that such terms as "mainstream" and "heterodox" economics must be applied with care to Brazil. Nevertheless, for the purposes of this chapter, that distinction shall be kept, as we are interested in how theoretical contributions by Brazilian economists are connected to the international debates.

Heterodox research programs have been particularly strong in Brazil, going back to the structuralist approach put forward by Furtado and other CEPAL economists in the 1950s, as discussed in section 2 above. Since the 1970s – when different sorts of heterodox economics took form and were institutionalized at the international level as reactions to dominant neoclassical theory (see Backhouse 2000) – a significant fraction of Brazilian economists has become integrated into distinct forms of international heterodoxies. This is well illustrated by the Brazilian prominent post-Keynesian economist Fernando Cardim de Carvalho (b. 1953; d. 2018). That is also true of Latin American neo-structuralism, which has adopted the modeling strategies of international heterodox streams (see Barcena and Prado 2015). Brazilian economists Cardim de Carvalho and David Dequech were the only Latin Americans interviewed by Mearman, Berger and Guizzo (2019).

Brazilian mainstream economists' international contributions to economic theory have been particularly relevant in the field of mathematical economics. The extensive international spreading of mathematical economics from the 1950s on (see Weintraub 2002) found a fertile ground at IMPA (Instituto de Matemática Pura e Aplicada), the Institute of Pure and Applied Mathematics, established in Rio in 1952. From the beginning, IMPA attracted highly qualified mathematicians from Brazil and abroad. Prominent mathematical economics (e.g. C. Azariadis, E. Prescott, H. Sonnenschein, A. Mas-Colell, J. Heckman) visited the institute in the 1980s and 1990s. IMPA has played a key role in the development of the Brazilian community of mathematicians and mathematical economists as part of international networks (see Silva 2004, and especially Assaf 2022, chapter 3).

M.H. Simonsen's (1964) formal discussion of the cash-in-advance constraint, three years before Clower (1967) turned it into a main monetary model, provided a first instance of the impact of IMPA on economic analysis in Brazil. Simonsen (1964) explicitly introduced the cash-in-advance constraint as an inequality in a nonlinear programming problem featuring the Kuhn-Tucker mathematical approach. It represented an attempt to reinterpret the controversy over Don Patinkin's critical assessment of classical monetary theory (Boianovsky 2002; Walsh 2003: 100). Simonsen was trained as an engineer. That was shortly followed by mathematical studies at IMPA in 1955, where he also taught the first course in applied mathematics soon after.

Simonsen's (1964) article, as well as his general mathematical stance in economics displayed as professor at the Vargas Foundation, grew out of his period at IMPA. This is clear in his 1994 book, which collected essays on the philosophy of science, history of mathematics and physics, and history of economics mathematically contemplated. In part because of Simonsen's initial influence, mathematical economics eventually became an important area of graduate teaching and research at IMPA in the 1970s, leading to its further internationalization and several contributions by Brazilian mathematical economists (sometimes based abroad) published in top journals ever since.<sup>10</sup> In the late 1980s, as part of the debates about inertial inflation, Simonsen (1988) used game theory to model inertial inflation. He modeled inflation inertia as consequence of a coordination failure between wage and price setters. Incomes policy can be used to resolve this coordination failure, in the sense of providing information to speed up the location of Nash equilibria by economic agents.

The leading figure concerning the teaching and research of mathematical economics at IMPA has been, since the 1980s, Aloisio Araujo, who, together with J.A. Scheinkman, had finished his master degree at that institution in 1970. They both left to pursue PhD degrees in the US, and came back to IMPA in 1978 – for a brief period in the case of Scheinkman, who soon resumed his position as professor of economics at Chicago University and later at Princeton University, although he kept coming back for visits to IMPA. The main research topic of IMPA's mathematicians was dynamical systems, which proved to be instrumental when Scheinkman and Benveniste (1979) applied envelope theory to establish important new results for growth and macroeconomic dynamics. Sheinkman's background from IMPA also played a role in his pioneer study of chaotic non-linear systems in the capital market (Scheinkman and LeBaron 1989). Asked about his Brazilian roots, Scheinkman

<sup>&</sup>lt;sup>10</sup> For a list of the number of articles – published by IMPA graduates in *Econometrica, Journal of Economic Theory, Journal of Mathematical Economics, Review of Economic Studies* and *International Economic Review* – see Assaf 2022: 152).

(1999: 285) replied that, although he had a permanent interest in the Brazilian economy, his academic output as an economist had no links with Brazilian issues. He regarded it a "signal of maturity" when "economists are able to do academic work that is not necessarily connected to the economic problems of their country" of origin (see also Blaug and Vane 2003: 739-40).

Araujo's main contributions to mathematical economics have focused on the working of capital and financial markets in general equilibrium, formed by influential papers, e.g., on the role of collateral constraints (Araujo, Páscoa and Torres-Martinez 2002), financial crises and bankruptcy (Araujo 2015), and the notion of homogenous expectations under complete markets (Araujo and Sandroni 1999). Alvaro Sandroni studied with Araujo at IMPA. That was also the case of Marilda Sotomayor and Sergio Werlang, among others. After her solution, with Alvin Roth, of the "Colleges admission problem" as a model of many-to-one matching in two-sided markets, Sotomayor joined forces with Roth again in their classic book about processes in which two disjoint groups of agents – e.g. in labor markets – meet and make bilateral transactions (matching) through cooperative games. Game theory was also the subject of a couple of well-known papers by Werlang. Dow and Werlang (1994) defined Nash equilibrium for two-person normal-form games in the presence of Knightian uncertainty. Tan and Werlang (1988) provided informational foundations of iteratively undominated strategies and rationalizable strategic behavior in noncooperative games. Surely, Brazilian contributions to mathematical economics were not restricted to economists connected to IMPA. USP economist Juan Moldau's (1993) demonstration, that the existence of demand functions does not depend on the assumption of strict convexity of preferences, is a case in point.

Uncertainty was also the dominant topic in Cardim de Carvalho's post-Keynesian agenda, but from a distinct perspective altogether. As acknowledged by leading heterodox economists, Brazil has been since the 1980s a center of heterodox – particularly post-Keynesian – economics (see e.g. Chick 2004: 3). Cardim de Carvalho's first exposition to post-Keynesianism took place when he attended the first summer school in Trieste (Italy) in 1981. The year after that he went to Rutgers University (US) to study with Paul Davidson. Cardim de Carvalho's main theoretical contributions to post-Keynesian economics include the study of the notion of a monetary production entrepreneurial economy, the analysis of decision-making and portfolio-choice under non-probabilistic uncertainty, liquidity preference theory (with attention to banking decisions) and the analysis of the finance-funding circuit (see Oreiro, de Paula and Machado 2020; and also Dymski 2020). Those are found in two books (Carvalho 1992, 2016) and in a number of articles published in the *Journal of Post Keynesian Economics* and the *Cambridge Journal of Economics*, among others. The study of how the economic system deals with uncertainty and expectations may be also found in contributions by other Brazilian economists to the international literature, particularly David Dequech, a former student of Geoff Harcourt in Cambridge. Dequech (1999, 2006, 2013) has approached those issues mainly from the institutionalist point of view.

As a by-product of his agenda, Cardim de Carvalho advanced the scholarship about Keynes (see e.g. Carvalho 2003). Edward Amadeo is another Brazilian economist who contributed significantly to the reinterpretation of Keynes's ideas and their evolution. Amadeo (1989), which arose from his Harvard PhD dissertation, has been regarded by Harcourt (1990) as the definitive account of the transition from the *Treatise on Money* to *The General Theory*.

Mathematical modeling has attracted as well the attention of Brazilian economists off mainstream, who have put forward contributions to post-Keynesian Sraffian and neo-Schumpeterian economics involving formal modeling. The 1970s Brazilian debates on income distribution (see section 2 above) led to the investigation of Piero Sraffa's Cambridge approach as an alternative to marginal productivity theory. Bacha, Carneiro and Taylor (1977) set out to tackle, through the use of the Sraffian framework, some analytical puzzles faced by David Ricardo and Karl Marx in their respective treatments of income distribution. Contributions to a related tradition established by Luigi Pasinetti may be also found, as illustrated by Teixeira's (1991) generalization of Pasinetti's model for an open economy with direct and indirect taxation and a fraction of the capital stock owned by profit-making public companies. The Pasinettian multi-sector macro-dynamic framework has been deployed to derive the equilibrium growth rate for economies constrained by the balance of payments (Araujo and Lima 2007). Multi-sectorial simulated models have been explored from a neo-Schumpeterian perspective in economies subject to structural change and shocks (Possas and Dweck 2004). The essentially pluralist character of Brazilian economics over the last 50 years or so is clear enough, even if Brazil has not featured in recent histories of "pluralist economics" (see e.g. Sinha and Thomas 2019).

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