Simon Schwartzman *Editor*

Higher Education in Latin America and the Challenges of the 21st Century

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Preface

In the first semester of 2013 I had the privilege of teaching the course on *Higher Education in Latin America and the Challenges of the 21st Century* at the UNESCO Chair of the Memorial of Latin America in São Paulo, which allowed me to invite several of the main scholars of higher education in the region to present and discuss their ideas and knowledge with an exceptional group of students from different institutions in Brazil and abroad. The first version of this book (Schwartzman, 2014), was a product of that course. I thank Prof. Adolpho José Melfi, then director of the Brazilian Center for Latin American Studies at Memorial, for inviting me to teach the course and for encouraging me to prepare this book; and the University of Campinas Publishing House for making these texts accessible to a wider audience. The chapters were extensively updated and expanded for this English edition.

The initial chapter, on "Higher Education in Latin America and the Challenges of the 21st Century", deals with two related themes that form the backdrop to the remainder of the book. The first is the origin of universities in Renaissance Europe and their evolution since then, together with the motivations and values that presided over their emergence and that still persist: The appreciation of knowledge, freedom of study and scholarship, and institutional autonomy and collegiality placed at the service of the education of new generations. This is also the story of the sometimes harmonious, sometimes conflicting relationships between universities and the powers of Church and state, and increasingly, the economy, which cannot be told in detail here. The universities of today are very different from those of the past and are merely part of a much broader higher education sector, which increasingly involves more people and mobilizes more resources. And yet, the original values and motivations, related to the place of knowledge, its production, preservation and transmission, and its importance for people and society, persist. This chapter also deals with the peculiar history of universities in Latin America, which were inspired by European models and developed mainly as a channel for the social mobility and political affirmation of new generations (in this sense no different from those of other countries) without, however, incorporating in the same way the values and functions of knowledge, study and research. Higher education

institutions in Latin America are still marked by the student movement of the 1918 University Reform of Córdoba, which has not yet completed its cycle in most of the continent. A further theme deals with universities as institutions whose functioning depends in part on the values and orientations of those who live within them—teachers, students, administrators—and, to a large extent, on the reciprocal demands and relationships they establish with the external environment, which includes governments and the market.

Jamil Salmi, in chapter "New Challenges for Tertiary Education in the Twenty-First Century", starting from the standpoint of the future, talks about the technological changes that are revolutionizing the modes of production and transmission of knowledge, and the needs for professional, scientific and technological training required by the new knowledge society. All over the world, there is a race to ensure that higher education systems are able to respond to these demands and thus participate in the new cycle of production and generation of wealth that is taking place. To what extent can these new technological resources be used to improve the quality, relevance and efficiency of higher education institutions, and thus bring to it the resources they need to play their new roles well? What are the most successful countries in this race, such as South Korea, doing and what should and can countries like Brazil do?

José Joaquín Brunner and Julio Labraña, in chapter "The Transformation of Higher Education in Latin America: From Elite Access to Massification and Universalisation", look at higher education in Latin America as a whole, and note that it has not only become massified, with millions of people seeking a level of training that was previously reserved for a few thousand, but is becoming universal, that is, becoming an aspiration of all people. In this process, the traditional universities, which functioned as relatively isolated islands, have been profoundly transformed and have been overtaken by a great variety of new public and private institutions that have little in common, apparently, with the ideals of the institutions that used to be their models. What is left, in this new scenario, of these old models and the values they embodied? Brunner shows us that, while intellectuals and educators such as Cardinal Newman in Ireland, Abraham Flexner in the United States, Humboldt in Germany and Ortega y Gasset in Spain praised and advocated maintaining and strengthening elite training and high-level research universities, in other parts of the world, starting with the United States, higher education grew and differentiated, with universities becoming multivariate, incorporating new functions and sources of funding, including those arising from a growing demand for educational services in the market. In today's world, the old metaphor of the classical university, symbolized by the University of Humboldt in Germany, a product of the emergence of the modern era and the formation of the nation states at the end of the nineteenth century, must be replaced by a new metaphor, that of the post-modern higher education institution, whose main characteristic is no longer adherence to a central core of values, but a multiplicity of demands, expectations and ways of functioning that transcend all attempts to fit it into a single coherent model.

Traditional university diplomas sufficed to ensure the professional and technical quality of their graduates, and the prestige and reputation of their teachers to ensure the quality of their intellectual work and research. In mass and post-modern higher education, this is no longer enough, and all countries in some way seek to establish systems of evaluation and certification of higher education, which is the theme of chapter "The Diffusion of Policies for Quality Assurance in Latin America: International Trends and Domestic Conditions" by Elizabeth Balbachevsky. She shows us that the main Latin American countries have, in one way or another, tried to adopt quality evaluation and certification systems developed in other parts of the world, requiring that the institutions go through more or less complex processes of certification that, however, have their limitations and end up serving different purposes. A very common difficulty is the resistance of traditional universities, which feel, not always wrongly, that external assessments are a threat to their autonomy; another is the difficulty that government agencies have to create quality assurance systems capable of effectively evaluating, and with credibility, the hundreds and thousands of higher education institutions that exist in different countries. There are questions concerning the criteria and standards of evaluation—can faculties focused on teaching be evaluated according to the same criteria as research universities?—and also those interested in their results—governments, which fund the institutions? Professional corporations, interested in preserving their labor markets? Future students? Business sectors?

Jorge Balán, in chapter "Expanding Access and Improving Equity in Higher Education: The National Systems Perspective", deals with a central question in all mass higher education systems, which is the inclusion of people and social categories that, historically, had no access to higher education in their countries. As higher education systems grow in size, so does the access of people who previously could not benefit from it. However, this access remains limited by selection mechanisms and evaluation systems whose results are strongly related to the social and cultural status of candidates—students from poorer families who have not had access to quality basic education, or those from linguistic and cultural minorities, enter these selection processes at a disadvantage and end up being excluded. Balán presents the experiences of inclusion of different countries in Latin America, calling attention to the different ways it takes place: differentiating institutions to serve different audiences, the expansion of public higher education systems, the financing of private higher education, and affirmative action policies based on criteria of race, ethnicity and social class, showing, in each case, the benefits achieved and the problems that arise.

In chapter "Privatization of Higher Education in Brazil: Old and New Issues", Helena Sampaio examines in depth the growth of private higher education and, more especially, for-profit higher education, which has proliferated in Brazil in recent years, with the private sector reaching 75% of enrollments, half in profit-oriented institutions. This expansion is partly explained by the fact that Brazil adopted, with the university reform of 1968, a model of university organization that tried to copy American research universities, with emphasis on graduate education, research and departmental organization, with full-time hired professors. This made

public universities in in Brazil extremely expensive by Latin American standards, and unable to absorb the explosion of demand for higher education that began just at that time. The alternative was to allow for the expansion of the private sector, in the illusory expectation that it would eventually converge to the model of public universities. If in the beginning religious and community institutions prevailed in the private sector, the space was increasingly occupied by profit-oriented institutions, which became legal by legislation enacted in 1997. Today, there are companies in Brazil working in higher education with millions of students, with shares in the stock market acquired by investment funds and acting mainly in the area of low-cost, large-scale education in the social professions. In the past, the rule was that private institutions should not receive public resources; in recent years, however, the federal government, as part of its policy of social inclusion, has begun to subsidize the private institutions, whether philanthropic or not, with a variety of tax exemption mechanisms in exchange for free places for low-income students (the Prouni Program) and a very broad student loan program fully guaranteed by the government.

In chapter "Return Scientific Mobility and the Internationalization of Research Capacities in Latin America", Sylvie Didou Aupetit addresses another central dimension of contemporary higher education, that of internationalization. In a certain sense, it is not a new theme: for decades, the theme of the "brain drain" from developing to richer countries has been the object of concern, with the United States, above all, attracting hundreds of thousands of professionals often trained with public resources in their own countries, which no longer benefit from the investments made in their education. Several countries, including Mexico and Brazil, have developed programs to stimulate the return of these professionals, with different degrees of success. But internationalization also has other aspects, many of which are positive, such as the arrival of teachers and researchers from Europe and the United States, the skills brought by those who return to their countries of origin and benefit their institutions, and the creation of international cooperation networks that cross borders between countries and regions. Today there is much talk of "brain circulation," rather than brain drain, signaling the positive aspects of internationalization, but, as the author warns, it is not enough to exchange one expression for another; it is necessary to understand more deeply the real problems and possible benefits of this process of internationalization and globalization that is, ultimately, inevitable.

In chapter "Technological Innovation and the "Third Mission" of Universities", finally, Renato Pedrosa deals with the theme of university research from the perspective of its "third mission," which is that of technological innovation. Although university research is concentrated worldwide in a small number of institutions (contrary to the axiom attributed to Humboldt University of the "inseparability of teaching, research and extension"), it tends to be organized in a very traditional way in these institutions, in departments arranged according to the classic areas of knowledge (biology, physics, mathematics, sociology, languages), with much of the work being done individually by teachers and, to a large extent, by graduate students in their doctoral theses. The main objective of this research is the publication

of results in specialized literature, and these publications are in turn used to evaluate and reward the work of teachers and researchers and their departments. Alongside this form of work, called "mode 1," there is, however, another way to develop research inside and outside universities, called "mode 2," the "third mission" or the "Pasteur's Quadrant": more interdisciplinary, with more teamwork, focused on practical results, establishing partnerships with business and government sectors interested in their results, generating both innovation and basic knowledge with no clear divide between them. In his contribution, Pedrosa shows how Brazilian science has developed over the years, as well as its current characteristics—on the one hand, a broad system of academic research and post-graduation, the most developed in Latin America, but, on the other hand, a great difficulty remains more adequately performing its third mission.

In Latin America, issues related to higher education tend to be seen very locally, lacking an awareness that, although each experience is unique, we are actually part of a much broader reality that we need to understand and know better, so that we can even learn from the mistakes and successes of other parties. We hope that this book will serve as a window to this wider world.

Rio de Janeiro, Brazil Simon Schwartzman

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Higher Education and the Challenges of the Twenty-First Century: An Introduction

Simon Schwartzman

Abstract This chapter deals, first, with the origin and evolution of universities in Europe and Latin America, seeking to highlight the motivations and values that have presided over their emergence and continue to serve the education of new generations, such as the value of knowledge, freedom of study and research, institutional autonomy and collegiality. This is also the story of the sometimes harmonious, sometimes conflicting, relationship between universities and the powers of Church and state, and then increasingly with the economy. Second, the chapter considers how university institutions establish themselves in both contexts and manage the different demands and expectations of teachers, students and the wider society, seeking to respond to growing pressures for access, relevance in human capital formation and quality research, and rising costs.

Keywords The functions of higher education · Scholarship and research · Mass higher education · The Humboldt model · The Córdoba reform

1 Origins and Transformations of Universities and Higher Education

Higher education has grown dramatically around the world since World War II. In 1900, there were 500,000 higher education students worldwide; in 2000, there were 100 million (Schofer and Meyer 2005); in 2011, 190 million, according to the UNESCO Institute for Statistics. In Latin America, as Brunner shows in his contribution to this volume, the number of higher education students rose from just 1.9 million in 1970 to about 25 million in 2011. In Brazil, there were 425,000 in 1970, 1,540,000 in 1990, and today there are about 7 million. There are several explanations for this growth, including the expansion of the well-paid labor market for more highly qualified people, both in industrial service areas; the growing appreciation of higher-level diplomas, which give degree holders access to these higher-paid and more prestigious jobs; the extension of what was termed "youth," which used to end

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when, at 18 or 20, people completed their studies, married and entered the labor market, but now lasts until age 30 or longer; and the massive access of women to higher education. Higher education is now part of the lives of a growing number of people, and consumes huge public and private resources, and its expansion and consolidation are seen as essential to enable countries to develop rich, productive and socially equitable economies.

Higher education is today a specialized field of study and research, like other social areas such as health and basic education, with academic departments, scientific journals and a community of experts who share knowledge and meet in seminars and specialized congresses. All those who participate in some way in higher education, including teachers, administrators and students, have experiences and views on the sector that can be very valuable, but to understand it more deeply it is necessary to take into account the work that this professional community has been developing for decades in various parts of the world.[1]

The objective of this book is to try to understand the current state of higher education in Latin America and its prospects for the future in the light of the more general understanding that exists today about the sector. This chapter introduces the background to the emergence of universities in Europe, and their main lines of evolution and transformation, followed by a brief presentation of the history and evolution of universities in Latin America, with their peculiar characteristics—all in a schematic way, highlighting the more prominent ideas and issues, which can be expanded by readers willing to make use of the available bibliography. The terms "higher education" and "university education" are often treated as synonyms, although universities, in the narrow sense of the term, are only part of a broader set of post-secondary education institutions that exist everywhere. They are, however, the institutions of reference, and one of the central issues in all analysis of higher education is to understand in what sense the various modalities of higher education bring us closer to or distance us from what we can understand by university education, and what are the consequences of this proximity or distance.

This text is divided into two parts. In the first, we present a very synthetic vision of the development of universities, from their origins in the European Renaissance to the present day, with particular attention to the transformations in Latin America. The second part deals with universities as institutions, trying to understand how they function, how they relate to the wider environment in which they exist, and what dilemmas they face in today's world, particularly in the context of Latin America and specifically Brazil.

[1] A list of the main specialized journals include *Higher Education* (Springer), *Higher Education Policy* (Palgrave Macmillan), *The Journal of Higher Education* (The Ohio State University), *The Review of Higher Education* (Association for the Studies of Higher Education, Johns Hopkins University Press), and *Research in Higher Education* (Association of Institutional Research, Springer).

1.1 Historical Origins of Contemporary Universities

The human being is a cultural being, in the sense that to live in society, it is dependant on knowledge that is acquired in various ways, used in practical life, organized in systems of interpretation of the world, and passed from generation to generation by, for example, the verbal and the written language. In all societies, ancient and modern, people organize to feed themselves, protect their families and communities, and develop some understanding and interpretation of the world in which they live. In all of them there are people who, in different ways, occupy prominent or leadership positions to fulfill these different functions—the chiefs and shamans in the most primitive tribes, and the generals, politicians, priests and intellectuals in modern societies. It is necessary to know how to fight, to deal with the natural and supernatural forces that affect the cycles of nature, life and death of people, and to organize life in the community, establishing responsibilities and rights, punishing transgressions and managing conflicts. In complex societies, the exercise of these functions requires specialist skills and knowledge that few possess, which are valued assets, protected and handed over from one generation to the next. Complex societies also require people capable of writing and using numbers to draft, document and enforce laws, secure rights and privileges, and manage crops, trade and money flows, and so traditional and oral culture crystallizes into written records. Often a single person or group assumes different functions—in theocratic societies kings, military chiefs and priests are the same people, who occupy the positions of greatest power and influence, and accumulate and control most of the available wealth. Generally, however, groups or castes specialize in certain activities, such as the Cohanim in the Jewish tradition assuming the priestly functions, or, in India, the Brahmin castes assuming the priestly functions, the Kshatriyas the military and Vaishyas the trade functions.

It is in this context that universities emerge as institutions that specialize in the performance of activities associated with knowledge, and for this they seek both to gain autonomy and differentiate themselves from others, and at the same time convince other sectors of society of their importance. In part, it is a process of institutional creation, establishing forms of social organization that did not exist before; and also of social mobility, insofar as they are driven by people who seek access to positions of prestige and power based on their knowledge and culture, overcoming the characteristics of blood, tribe or caste with which they were born. Universities are not revolutionary institutions, which seek to break the established order and power; but they are often reformist institutions, which seek to open up new spaces, replacing the intellectual and moral dominance of dogma and traditional authority with the dominance of knowledge and reason, thus expanding the social position of their teachers and students. To this end, they preserve and seek to expand the thesaurus of available philosophical, technical and scientific knowledge through scholarship and research, and educate and certify new generations for the exercise of professions of greater prestige and importance in society. Although they may claim one, they do not in fact have a monopoly on these functions or knowledge

preservation and transmission, which are permanently disputed with other sectors such as the Church, artists, companies, government agencies and the military. It is not always a brilliant story—there are plenty of examples of university institutions that are sclerotic, lose their intellectual autonomy, resist the development of new knowledge and become just a mechanism for consolidating the established order and maintaining social inequalities. But at their best, universities have always been and continue to be part of the Enlightenment tradition of valuing competence, knowledge and the freedom to research and communicate ideas and values, as important in the past as in the present.

1.2 The Classical Universities, Their Functions and Their Development

The first Western universities originated at the end of the first millennium in the old monasteries and cathedrals of medieval Europe, which educated priests for the Catholic Church but were organized as independent corporations of teachers and students, in the same way that other craft corporations were being constituted in the cities, breaking away from control of the clergy and the feudal nobility, and opening the way for the Renaissance. With the decadence of the Roman Empire, the monasteries had remained the main and almost the only place where the traditions of reading and writing of past centuries were maintained and transmitted, especially religious texts. As the new city-states and reigns were constituted, the relevance of law also increased, alongside the ever-present importance of medicine and book-keeping. In their classical format, the first universities were dedicated to the initial education in the seven "liberal arts," the *trivium* (grammar, logic and rhetoric) and the *quadrivium* (geometry, arithmetic, astronomy and music), which were considered the cultural foundation for people of culture, followed by specializations in theology, law or medicine. The teaching was done in Latin, and the sources were mainly classical Greek, Roman and medieval authors.

Other societies and civilizations also had, even long before, high-culture institutions, from Plato's Academy to Chinese Mandarin education centers, which prepare for competitions that selected senior officials of the empire and included Buddhist temples and Islamic institutions such as Al-Azhar University in Cairo. What makes European universities special is that they gradually ceased to be mere dependencies of the Church and became autonomous institutions, controlled either by students, as in Bologna, Italy or by professorial colleges, as in England and the University of Paris, opening space for intellectual work of greater amplitude.

The intellectual work performed in these institutions, described by the term *scholarship*, was very different from what we understand today by scientific research, oriented to the observation of nature, inference and mathematical reasoning, and much closer to what is practiced today in the humanities, with the reading and interpretation of texts. But the Renaissance also brought about the development of the

natural sciences in scientific academies, which gradually began to defend their place as bearers of a new "natural philosophy," a way of seeing the world based no longer on the authority of the Church or tradition, but on the observation of nature and reason (Ben-David 1971). Gradually, in some places more than others, the empirical sciences also entered the universities, and grew in importance. The development of European universities was therefore part of a broader process of transformation brought about by the Renaissance that included the strengthening of professions, the growing use of new technologies for war, navigation and the discovery of new worlds, trade and the development of the natural sciences. It was also the period of the Protestant Reformation, which shook the hegemony of the Catholic Church, stimulated individualism and accompanied the strengthening of modern nation states.

By the end of the eighteenth century, universities had been profoundly transformed according to three main models that later spread to other parts of the world: French, German and English (Ben-David 1977). To these must be added the North American system which, despite being initially an extension of the English, brought important innovations. The old universities were, in great part, products of the Renaissance and the growth of the cities; in their new format, they became a product of the industrial revolution and the strengthening of the nation states. Thanks to the support of governments, they have grown in importance and influence, but this has also limited their autonomy, creating a dilemma lived differently in each country.

In France, the Revolution, by a decree of 1793, closed the old universities, which were replaced by state institutions such as the École Normale Supérieure, the École Polytechnique, the École de Mines and others, the so-called *Grandes Écoles*, some military, all laic, with a strong predominance of engineering and mathematics. They prepared for the high positions of public administration, in what is now described as the "Napoleonic model" of higher education, where the entire educational system is public and administered by the central government, and the university professors are civil servants. Scientific research remained apart, hosted in the Academy of Sciences and, later, in the Centre Nationale de la Recherche Scientifique. French universities were re-established at the end of the nineteenth century, became the bastion of lay and secular values in the polarized environment of French politics, in dispute with the Church, but never resumed the hegemonic position occupied by the *Grandes Écoles* (Weisz 1983).

In 1810, Prussia created the University of Berlin, founded by Wilhelm von Humboldt, which for the first time enshrined the idea of integrating teaching and research, not so much in the modern sense of experimental and empirical science, but rather in a broader sense, integrating philosophy and law–what the Germans call *Wissenschaft*. As in France, the University of Berlin depended on the imperial government to function, but was governed by professors, selected by strict criteria of competence (Nybom 2007). Initially composed of the traditional faculties of law, medicine, philosophy and theology, the university gradually incorporated the natural sciences while at the same time forming Germany's political and administrative intellectual elite. At the end of the nineteenth century, Germany was the most important scientific power in the world, and other countries, from the United States to Japan, were trying to copy its university model. Despite the myth that the German university integrated

teaching and research in an inseparable way (which became famous as the Humboldt Model), since the beginning of the nineteenth century research in the natural sciences has mainly taken place in a separate organization, the Kaiser William Society, which gave rise to the current Max Planck network of institutes.

In England, the old universities of Oxford and Cambridge, organized since the Middle Ages as associations of autonomous colleges, have remained and continue to this day in the same format while incorporating new departments dedicated to the natural sciences, without however losing their main function of forming the political, economic and administrative elite of the British Empire. In this, they were similar to the *Grandes Écoles* in France and the University of Berlin, but free from direct government control. England has not developed a parallel system of scientific and technological research, leaving technology mainly in the hands of the private sector. The English higher education system was very elitist, a situation that only began to change in the 1960s with the introduction of a network of public polytechnics and colleges, a dual system that was not unified until the 1990s (Rothblatt 1968; Rothblatt and Wittrock 1993).

The first American universities, such as Harvard, Yale, Princeton and Columbia, established themselves as independent colleges in the English model in the eighteenth century, still in the colonial period, and only began to incorporate scientific and technological research in the twentieth century, initially with private resources (Geiger 2004). In the mid-nineteenth century, American states began donating land for the creation of colleges that became known as the land-grant colleges, dedicated to education in "agriculture, military tactics, and mechanical arts," as well as to classical studies of letters, humanities and the arts for the poor, without, however, the extremely elitist character of European universities. To this institutional innovation, in the twentieth century the main American universities added another, that of graduate schools that established the careers of researchers and doctors, and were decisive for the United States assuming the hegemony of world scientific and technological production (Eddy 1973; McDowell 2003). As in England, the most traditional North American universities were constituted and maintained as independent institutions with their own endowments. The United States has never had a national public university, and many of today's more recently established state universities originated from former land-grant colleges.

1.3 Latin American Universities

The first universities in Latin America were created in the sixteenth century by the Catholic Church, which joined the Spanish in the conquest of the continent: among them those of Santo Domingo (Real y Pontificia Universidad de Santo Tomás de Aquino), Lima (Real y Pontificia Universidad de San Marcos), Mexico (Real y Pontificia Universidad de México), all from before 1600, and others that had a short existence. Molded on the traditional University of Salamanca in Spain, they all had the double approval of the Church and the state, and were dedicated to the teaching of

arts, theology, law and medicine in the medieval tradition. Unlike the Spaniards, the Portuguese did not think of Brazil as a place to take their institutions, but simply as a territory to explore; they did not create universities or schools of any kind, nor did they allow the press to function. It was only in 1808, with the forced transfer of the Portuguese court to Brazil, that the first institutions of higher education were created in a bid to emulate the French model of professional schools organized, maintained and supervised by the state: the Academia Real Militar Royal in Rio de Janeiro (with both a military and engineering school); the schools of medicine in Bahia and Rio de Janeiro, and, later on, the law schools of Recife and São Paulo. Other colleges and professional schools were created later, but the first Brazilian university, the University of São Paulo, was only established in 1934 (Schwartzman 1991).

The Latin American nation states, established with the end of the Spanish colonial empire at the beginning of the nineteenth century, also sought to transform their old universities into more modern institutions that could participate in the construction of new nationalities, influenced by ideas that came mainly from France and Germany. Interestingly, despite England's strong presence in Latin America in those years, English universities never served as a model, probably because of their autonomy from the Crown and also because of the difficulty of understanding the English system of university colleges. In some countries, colonial universities were closed or transformed into state universities. Perhaps the most ambitious example was that of the University of Chile, instituted in 1843 under the leadership of Andrés Bello, which replaced the former Real Universidad de San Felipe as responsible not only for higher education, but also for the organization and supervision of an envisaged national public education system. Similar reforms have taken place in the universities of Córdoba and Buenos Aires, Argentina, and have served as models for the reconstruction of national universities in Mexico, Peru and other countries in the region, all as public institutions dedicated mainly to the training and certification of legal, medical and engineering professionals (Halperín Donghi 1962; Serrano 1994; Sosa 1999; Weinberg 2010).

It was not enough, however, to copy the European institutions to bring them to life in Latin America. The context that had allowed the emergence and expansion of European universities—the Renaissance, the Protestant Reformation, the growth of cities and commerce, the industrial revolution, the collapse of feudalism and the strengthening of nation states—none of this existed in Latin America, and Spain itself, like Portugal, had been left on the sidelines of these transformations. In almost all cases, universities became little more than a bureaucracy in charge of regulating the entrance of lawyers, doctors and engineers to their professions, administering contents copied from European textbooks that students had to learn by rote in order to pass. The professors were generally liberal professionals who devoted a few hours a week, if any, to teaching, and there was nothing that resembled research or academic work. As countries such as Argentina, Chile and Uruguay, among others, began to urbanize at the beginning of the twentieth century, it also became clear that these institutions could not meet the expanding demand for education and social mobility, nor did they have content to transmit that made sense to the new generations.

1.4 The University Reform Movement

This is the context for the University Reform Movement, symbolized by the mobilization of students from the University of Córdoba, Argentina, in 1918. It was a movement that was already occurring in several countries, including Uruguay, Peru, Argentina and Chile, and ended up also affecting higher education in Colombia, Venezuela, Paraguay, Bolivia, Puerto Rico, Ecuador and Central America (Aken 1971; Arocena and Sutz 2005; Delich 1993; Schwartzman 1996; Tedesco et al. 1986; Tünnermann Bernheim 2010). As we read the documents and proclamations associated with the movement, two aspects immediately attract attention. The first is the vehement condemnation of the quality of education, the denunciation that Latin American universities have failed to fulfill their central role as bearers of knowledge, expressed in a passage often cited:

> Universities have so far been the secular refuge of the mediocre, the refuge of the ignorant, the safe hospitalization of the disabled - and what is worse - the place where forms of tyranny and desensitization found the chair that dictated them. Universities have thus become the faithful reflection of these decadent societies that insist on offering the sad spectacle of a senile immobility. That is why science, confronted by these silent and closed houses, silently passes by or becomes a mutilated and grotesque bureaucratic service. (Silva Michelena and Sonntag 1984, pp. 26–27)

The second idea was that only students could change this situation. The Reform did not consecrate the government of the universities to the students, but rather the tripartite division of the governing bodies among students, professors and alumni, who had to register with the universities to elect their representatives. There is no evidence that alumni have ever been able to play a very significant role, and there were no professional university professors, as they emerged later, to participate more intensively. It was the students, through their organizations, who came to predominate. In the troubled history of the Reform Movement, conflicts between students and government authorities were often translated into party-political terms, often generating leaders of great national and international projection, such as Alfredo Palácios in Argentina, Haya de la Torre in Peru, Raul Roa in Cuba and Rómulo Betancourt in Venezuela. The demands for autonomy resulted in the establishment of a tradition of extraterritoriality for university campuses in many Latin American countries, giving students and teachers rights and privileges that ordinary citizens would hardly dream of. These privileges included the right of access to universities for all students completing high school, without selection exams and free of charge.

Thus, Latin American universities seem to have taken to the extreme a specific type of self-regulation and autonomy, based on students' capacity for political mobilization, and not on the effective occupation of a position of centrality among the institutions of generation and transmission of knowledge in their societies. The great expansion of urban centers in Latin America, especially since World War II, has caused the region's national universities to grow enormously, reaching hundreds of thousands of students. The Autonomous University of Mexico (UNAM) had 340,000 students enrolled in 2014, the National University of Buenos Aires (UBA), 263,000

students in 2011 (Silva Michelena and Sonntag 1984, p. 2), and several others had around 100,000 students each, such as the National University of Colombia and the University of the Republic in Uruguay. Despite consuming significant resources, these institutions are not in a position to create adequate conditions for good-quality education for most of their students by hiring qualified and well-paid professors, or to develop scientific and technological research on a significant scale. At best, they have created some selective schools, departments and well-funded research centers, while tolerating enormous rates of evasion and waste of resources.

This is the most visible part of higher education in Latin America, but not the only one. Public and laic universities, in general, have emerged in an environment of conflict with the Catholic Church which, in many countries, has chosen to create its own private institutions, with or without public subsidies. Because they were smaller and received students from richer and more educated families who could pay their tuition fees, many Catholic universities began to attract students, Catholic or not, who sought to escape the politicized climate and inefficiency of public universities, making room for the growth of private higher education. The concentration of universities in the big capitals also led to a growing demand from other regions of to have their own institutions, which could also function without the typical problems of the big national universities. These two trends, privatization and regionalization, caused national universities to lose the monopoly they had over the countries' higher education, thus losing substance or being forced to change, at least in some sectors.

Brazil is a great exception to this picture, because it never had a national university and it took a long time to expand access to higher education. Until the creation of the University of São Paulo in 1934, there were isolated faculties for teaching and certification, especially in the traditional professions of engineering, medicine and law, some state, others federal and some private, religious or not. At the end of the 1930s, the federal government created the University of Brazil in Rio de Janeiro, which has never really become a nationwide university; today it just is one of a network of approximately 60 federal institutions throughout the country. Unlike the rest of the continent, Brazilian public universities have always selected their students through knowledge tests, and since the 1960s they have implemented a system of hiring full-time professors, significantly increasing the cost per student, which has become much higher than that of any other country in Latin America. In the 1960s Brazil also began to develop a broad system of research and graduate education adapted from the United States graduate school model, with regular courses and academic departments, which had no equivalent in other countries of the region.

The price of these developments was to keep the public system very tight, and unable to absorb the growing demand for higher education in the country, especially from students who could not pass the increasingly competitive selection exams. This has made room for enormous growth in the private sector, which now absorbs about 75% of enrollments. While in most Latin American countries the private sector remained small and elitist, in Brazil it became massified and specialized in the provision of evening courses in social professions (business, law and others), charging little and demanding little from students, and developing almost no research or postgraduate activities. At the same time, pressure grew on public universities to admit

more students, creating evening courses and opening up admissions though a quota system based on social and racial criteria.

This is still an ongoing process, but it already has three important observable consequences. The first is that, as Brazilian public universities increase their enrollments and open up more space for low-income students and students with precarious educational training, they are becoming more similar to their counterparts in other countries in the region. Second, a space has been created for elite private institutions, especially in the social professions, which in practice did not exist before, and which today receive students who can afford and want to escape from the politicized and not necessarily better public universities. The third is the development of an enormous system of public subsidies for private higher education, in the form of tax exemption in exchange for subsidized free access for lower-income students (PROUNI) and a broad system of educational credit subsidized by the government. With Brazil in economic recession since 2014, educational credit to the private sector has been strongly reduced, leading to a strong trend in the private sector toward transferring its students to distance learning courses, to maintain scale and reduce its costs.

2 Higher Education Institutions

2.1 Higher Education in a Comparative Perspective

A historical vision is indispensable to understand how higher education has originated, developed and reached its current condition in different countries: whether we like it or not, the present depends heavily on the past (what economists call "path dependency"), and it is necessary to know the past to be able to depend less on it. But it is also necessary to think about higher education in a more analytical way, with categories that make it possible to compare different countries and types of institution, and to expand the map of alternatives and possibilities.

Higher education tends to be addressed in specialized literature from two main perspectives. The first, predominant among economists and international agencies, deals with the possible contribution of higher education to the development of "human capital" in the respective countries (Schultz 1970; Becker 1973). Economists are right to see education as a productive factor that requires specific policies to expand and improve its quality and relevance. But education, and in our case higher education, also occurs in private institutions, universities and similar bodies, which shape the lives of the people who work in them or pass through their facilities. The ways in which these institutions change and develop depend not only on government policies or market demands, but also on complex processes of social transformation and institutionalization that can go beyond and define the limits of what government and politicians can do and how markets operate. It is necessary to understand this sector not only from the point of view of its inputs and products, but also as a set of institutions that respond not only to the demands and restrictions that come from outside,

but also to its internal dynamics, which depend on the values, culture and practices of its members. Higher education today includes a wide range of institutions offering distinct types of certification, from post-secondary professional courses through to the doctorate, provided in traditional universities, institutes, academies, professional schools and distance education organizations. To function properly, they depend on the existence of professional communities that share a common sense of belonging, seek to protect their intellectual and professional autonomy from the demands of governments, churches, customers and public opinion, and are able to justify their special stand in society by the results of their intellectual activity, research and education (Carnoy et al. 2013; OECD 2008; World Bank 2011). These values, as we have seen, have their origins in the first universities created in Europe in the late Middle Ages and, as Burton Clark shows in his texts on the new entrepreneurial universities, they are equally present in the most successful higher education institutions today (Clark and Visakorpi 1987; Kehm and Teichler 2013; Teichler 2006). But in recent years, higher education institutions around the world have had to change very significantly the ways in which they have traditionally been organized, as well as their relationship with the wider society, and not all of them have produced the same results. In order to better understand what is happening, it is necessary to understand what these institutions are, how they work and the alternatives and dilemmas they face.

2.2 Institutions and Organizations

In very general terms, institutions are sets of norms and practices that govern and characterize the behavior of people who come together for certain common objectives or activities. Norms, whether written or unwritten, establish what people should do; and practices are what people actually do. Some institutions, such as companies and political parties, have well-defined objectives, such as earning money and fighting elections. Others, such as families, may have different objectives: providing stability to sexual relations, procreating, educating and maintaining children, caring for the elderly, and managing the tasks and needs of their members' daily lives. In all institutions, in addition to the explicit objectives, there are others that are not stated and remain latent, but are equally important. In all institutions there are tensions between people's expectations of norms and practices, and the art of institutional leadership and administration is to adjust them to each other. The concepts of "system" and "organism" are usually used when talking about institutions, to point out the fact that their different parts are interrelated, perform complementary functions and depend on each other, and also to point out that institutions need to relate to the external environment in which they live and, like organisms, can be born, grow and die.

Organizations are a type of institution deliberately created to achieve certain goals; for this they organize themselves in the most efficient way possible, with clearly defined authority and division of tasks and responsibilities among their participants, and act in a rational way, seeking to achieve maximum results with a minimum of

costs. They are also more ephemeral, created and dissolved according to the interest that exists in their results and their ability to obtain them. This rationality, however, has limits: organizations, especially large ones, develop internal cultures and work traditions that affect, for example, the distribution of positions of power and prestige among people, the flow of information between sectors and the ability of management to make others comply with their decisions and orientations. That's why they often survive even after losing their functionality, if they have the means to support themselves. Organizations may also have antagonistic groups within them, as may happen between bosses and unionized workers in an industry, and this antagonism is sometimes introduced from outside, through the cultural environments and other institutions in which its members also participate—class associations, professional categories, unions, political parties, religious groups.

Organizations become more permanent institutions when they develop common values that are shared by their members, as well as cultures, knowledge and practices that distinguish them from others. When these values, cultures, knowledge and practices crystallize, they shape the identity of the institutions, as well as the identity of their members, which distinguish them from the broader society. It is therefore possible to talk about processes of institutionalization, when these values, standards, knowledge and practices are consolidated and acquire coherence, and also about processes of deinstitutionalization, when these elements lose strength and the institution ends up falling apart.

2.3 Universities as Institutions

Universities, when fully functioning, are complex institutions, very different from organizations set up for practical and immediate purposes. They have histories and traditions that form institutional "myths," which make them unique and valuable to their members and to society. They incorporate some consolidated core values, such as the professor's academic autonomy, the merit system and the appreciation of research, scholarship, institutional autonomy and collegiality. Their main asset is the intellectual and professional competence of their members, and their objectives are multiple and often conflicting—specialized professional training, education, community services, academic and applied research. They are institutions with a high degree of autonomy, with authority and the ability to determine their own course, but at the same time they are highly permeable and depend on public and private resources to survive. In addition to teachers and researchers, who form their core, they include students who bring their own culture, in permanent renewal, who are their main "clients" and one of their main *raisonsd'être*; and administrators with different levels of responsibility. In addition to courses, departments, and teaching and research institutes, modern universities often run hospitals, museums, model schools, extension and technology development centers, each requiring specialized academic, technical and administrative staff.

Although the departments and institutes may be large, and the research they carry out may be complex, universities are not characterized by complex teamwork, as in companies, but above all by the freedom and intellectual autonomy of each one of their professors. The counterpart of this individualism is the shared values of intellectual freedom and collegiality. There is a hierarchy of merit and responsibility, ranging from full professors to assistants, but all participate in departmental councils and meetings, are free to work or not in cooperation with colleagues from their own and other institutions, and share common expectations about professional ethics and standards.

Power, especially in the largest institutions, tends to be decentralized and to reside in the academic departments and institutes, since the central administration does not have the knowledge and skills that belong to the professors. In many cases, the rectors and presidents of universities have merely symbolic functions, representing the institution on ceremonial occasions; in other situations, they create their own administrative structures that negotiate with and obtain the constant support of the different segments of the institution, particularly for the distribution of resources and for new initiatives. The role and format of the central administration depends very much on how resources are obtained and distributed among the university's sectors. If resources routinely come from the public budget and are distributed directly to departments or colleges according to, for example, their number of professors or students, then the power of the central administration is minimal. If resources arrive centrally and are distributed by the central administration, then its power to influence and negotiate with the parties is much greater. If the institution depends on efficient strategies to obtain external resources, whether private, such as student fees, or public, such as competitive research funding systems, this may strengthen the central administration, creating what has been called "entrepreneurial universities," or strengthen the decentralized units, when they have autonomy to seek and manage their own resources. The rectors and directors of universities and colleges are usually academics and members of the institution itself, expressing the power and authority of their professors, but there are exceptions. In elections for rector positions in Latin America, those preferred by students and staff are often chosen in preference to teachers. In many countries, there is a tradition of bringing in deans from other institutions so that they have greater autonomy from academics, and in the United States, deans are often executives who have not necessarily had their own academic career.

2.4 A Typology of University Institutions

To account for the variety of university institutions in Europe today, Johan P. Olsen has developed a typology that allows us to see clearly how the current universities are constituted to reconcile and manage the various expectations and demands that fall upon them (Table 1). His typology draws from the European experience, but also

Table 1 A typology of universities

	Prevalence of internal factors	Prevalence of external factors
Shared norms and goals	Universities as autonomous academic communities	Universities as instruments of national agendas
Conflicting norms and objectives	Universities as representative democracies	Universities as enterprises in competitive markets

Source Adapted from Olsen (2007)

incorporate ideas deriving from American studies on entrepreneurial universities (Clark 2001; Dill 2012; Olsen 2007).

For each of the four main types, it is possible to identify which is the predominant internal logic of the institution, how it is evaluated, the basis on which it claims its autonomy, and which are the factors of change that affect these.

The first type is the classic university model. There is a strong consensus between professors and students about their values, and it has its own resources or stable and guaranteed funding. Its internal logic obeys the principles of merit, rationality and freedom of research, and is strongly collegial. It justifies its autonomy, internally and externally, because it is an institution governed by the most competent. It is a stable model, but it depends on the capacity of its leadership to renew itself permanently, giving way to new generations, and introducing new knowledge and new technologies. Its risk is of becoming more rigid, closing itself off from the outside world, and thus losing its position of intellectual leadership and the recognition and support of society.

The second type is a university where there is consensus on values and objectives, but that needs to respond to the policy agenda of government, which sets goals and creates external evaluation systems. This type depends on a stronger, more managerial administration, responsible for ensuring that universities meet government expectations in the area of teaching and research, as well as the efficient use of public resources. Its autonomy depends, above all, on the efficiency of its management in meeting these expectations. As these expectations may change as a result of changes in government or in public policy, it also needs to be able to change and adapt to new expectations.

In the third group, universities are autonomous and do not depend on external resources, but there is no consensus among teachers, students and staff about their values and goals. In this situation, different sectors and groups organize themselves to assert their interests and points of view, and the internal logic is similar to that of representative democracies, in which the authorities are elected by the majority or by coalitions and govern by making concessions and accommodating the interests of different sectors when necessary. What legitimizes authority in these universities is neither academic nor managerial competence, but the political process of their election. The factors of change in these institutions are the variations that may exist in the relative strength of their different sectors.

In the fourth group, finally, there is no consensus of values or autonomy, and this is typical of educational institutions operating as service companies in competitive markets. They usually have strong leadership, nominated by the people who have control over the institution (owners, shareholders and others) who define the objectives of the institution and whose legitimacy depends on their ability to generate resources. They approach the model of private companies, in which professors are employees, and students, customers. They are extremely sensitive to changes in the market and quick to adapt to find their niche opportunities and maximize their profits.

Although developed with Europe and the United States in mind, we can ask to what extent this typology applies to universities in Latin America. The predominant types in the region are clearly the third, in the public sector, and the fourth, in the private sector. In the public sector, there is little consensus on the values and objectives of universities, with major differences between faculty, staff and students. Even among faculty, there are profound differences between those with more academic backgrounds, who are more involved in cutting-edge research, and those who dedicate themselves mainly to teaching, as well as differences between teachers in basic and technological areas, as well as between the most basic or applied research areas. The existence of different professional cultures and orientations between departments and areas and knowledge occurs everywhere, but in Latin America it is especially pronounced, making it impossible to think in terms of a minimally integrated and coherent academic profession like that of countries where there is a more crystallized teaching profession (Arimoto et al. 2013; Schwartzman and Balbachevsky 2009). The private sector is not homogeneous, and includes, alongside traditional private universities, especially Catholic ones, which seek to preserve many of the characteristics of classical universities, a growing predominance of for-profit organizations organized as business enterprises (Levy 1986; Sampaio 2015).

3 Conclusions

Higher education institutions in Latin America enter the twenty-first century in a difficult situation. Traditional public universities in particular still seek to maintain the old ideals of autonomy, appreciation of knowledge, and freedom of chair and collegiality that date back to the ancient medieval universities, without, however, adapting to the new context of massification, conflicting values and pressures for external accountability. Access to these institutions continues to be an important factor in social mobility, which is expressed in the continuous growth of enrollments and in the benefits in terms of income and social prestige of its graduates. Yet they have failed to keep up with the most recent transformations in higher education, which, on the one hand, place increasing emphasis on the quality of scientific and technological research, and, on the other, seek to make higher education systems much broader, more diverse and more relevant to the economy and the labor market than in the past, when they were restricted to training and certification for the more traditional professions. Those who follow the debates and political stands of students, faculty

and authorities in the region might gain the impression that the reform agenda that prevails today is still that of Córdoba in 1918, and not that of the twenty-first century, characterized, among other things, by the Bologna Process in Europe, the emphasis on investments in international standard universities in Asia and also in Europe, the large flows of students between countries, the internationalization of the market for talent, the new forms of partnership between universities and the productive sector, the emergence and consolidation of a large educational services industry of all kinds, and the growing introduction of new individualized and distance education technologies, with still unpredictable consequences for education at all levels.

With their own day-to-day problems in mind, higher education institutions in Latin America find it very difficult to understand all these overwhelming factors and learn how to deal with them. This book is an attempt to open a window to this new world.

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New Challenges for Tertiary Education in the Twenty-First Century

Jamil Salmi

Abstract Developing countries face significant new challenges in the global environment, affecting not only the shape and mode of operation but also the purpose of their tertiary education system. Among the most critical dimensions of change are the convergent impacts of globalization, the increasing importance of knowledge as a driver of growth, and the information and communication revolution. Both opportunities and threats are arising out of these new challenges. The role of tertiary education in the construction of knowledge economies and democratic societies is now more influential than ever. Tertiary education is central to the creation of the intellectual capacity and critical thinking on which innovation depend. Another favorable development is the transformation of curricular and pedagogical practices by the opportunities offered by the new information and communication technologies. Against this background, the chapter focuses on the new challenges faced by tertiary education systems in developing countries.

Keywords Tertiary education · Universities · Knowledge economy · Curricular and pedagogical innovations · Globalization

1 Introduction

In the future, attendance at university will be compulsory for all young people, and universities will no longer recruit their new students on the basis of test scores or high school grades but mainly by assessing their Facebook comments history. Candidates with top academic grades will be rejected for fear that they might be too nerdy. In countries where students are not so interested in studying engineering, universities will reach out to kindergartens to motivate their future students about the importance of studying math and science. In the future, incoming students will get a free iPad or Kindle with all the textbooks for their course of study, while engineering students will be given a toolbox for their projects and a VR headset for simulations. Students in need of financial assistance will not seek a scholarship or loan from a government

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agency but will instead participate in an online auction on eBay to obtain financial aid. In the future, elite universities will have only 5,000–10,000 students while mass universities will teach classes to 500,000 students at the same time all over the world.

The good news about the future is that we will not be using e-mails anymore because they are too slow. We will have instant communication through MySpace, WhatsApp, Twitter, Facebook, Orchard, Blogger, Life Space, Bebo, etc. Students will take open Internet exams and the degrees conferred by universities will only be valid for five years—which is bad news for the academics, because it means that they will have to redo their courses every three years. But not to worry, because by then the average duration of a class will be only ten minutes and most of the classes will be online anyway. And students who need tutorials will go to an online tutor in Bangalore for help. In the future, if new graduates do not find a proper job within six months of finishing their studies, their university will have to reimburse them the cost of their studies.

The bad news for public universities is that, in the future, they will receive no more than 10% of their income from government. But they will be so successful in raising funds that mid-way through the academic year they will be letting the philanthropists know: "enough for this year, please come back next year with your donations." Good news for university presidents whose average annual salary will be more than a million dollars, but it will be indexed to the ranking of their university, going up or down as the international position of the university improves or deteriorates.

In countries where English is not the native language, parents will have surgery performed on their young children to cut the little skin that ties the tongue to the mouth to improve their English language pronunciation. And for those who think that the MBA is a good degree, in the future it is the MFA, the Master in Fine Arts, which will be the "in" degree, because creativity and design will be so important in all walks of life.

These examples may sound like science fiction stories, but each and every case mentioned above is a genuine example encountered by the author during his travels all over the world. These striking instances of disruption are symptomatic of the revolution that higher education is going through in the twenty-first century. And so the main question that all higher education systems must ask themselves is whether they are ready to face this revolution and take advantage of the opportunities offered to them. To answer this question, this chapter is divided into three parts. It looks first at the importance of knowledge in support of economic and social development. It then examines what these changes mean in terms of new education needs and practices for higher education institutions. Finally, it attempts to assess some of the implications for developing nations.

2 Importance of Knowledge for Economic and Social Development

Figure 1, which compares the economic evolution of Brazil and the Republic of Korea between 1958 and 2000, illustrates the significant difference that a knowledge-based development strategy made for two countries that had the same per-capita GDP in 1958. The graph, based on the standard Solow method of accounting for economic growth, represents a stylized attempt to estimate the relative contribution of two types of production factors: tangible factors such as the accumulation of physical capital and additional years of schooling in the labor force, and other factors linked to the use and application of knowledge such as quality of education, strength of institutions, ease of communicating and disseminating technical information, and management and organizational skills (Solow 2001; World Bank 1999). Empirical measures are applied to assess the extent to which growth is attributable to increased inputs (more labor and capital) or to the use of inputs in a more productive way (total factor productivity). In this model, the difference in economic growth between Brazil and Korea is a telling example of a situation where it is total factor productivity that explains the bulk of the differences in economic growth.

To complement this picture, it is useful to compare the evolution of educational attainment in the two countries. Figure 2 shows the contrast between Korea, where the proportion of adults with a tertiary education qualification grew dramatically, and Brazil, where investment in secondary and tertiary education was much less significant. While it is impossible to demonstrate a strictly causal relationship between

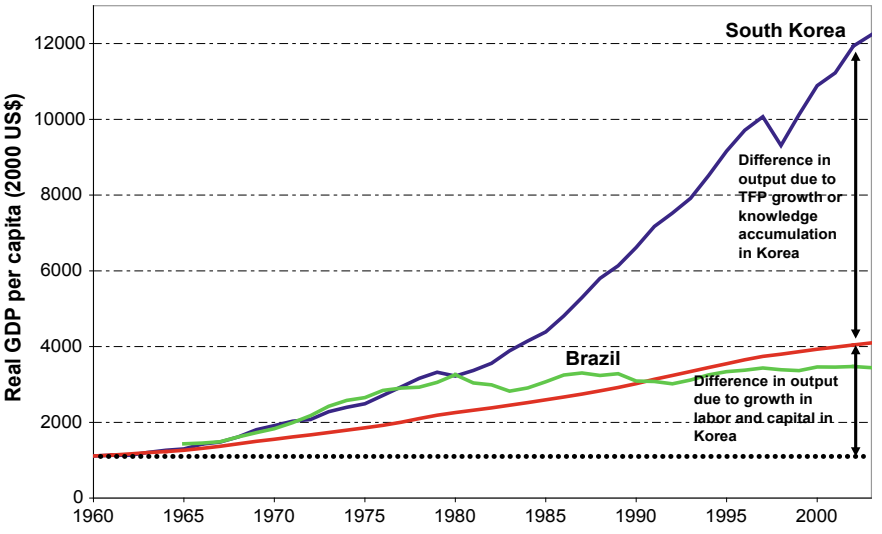

Fig. 1 Knowledge as a key factor in income differences between Brazil and the Republic of Korea, 1956–2000. *Source* Rodriguez et al. (2008)

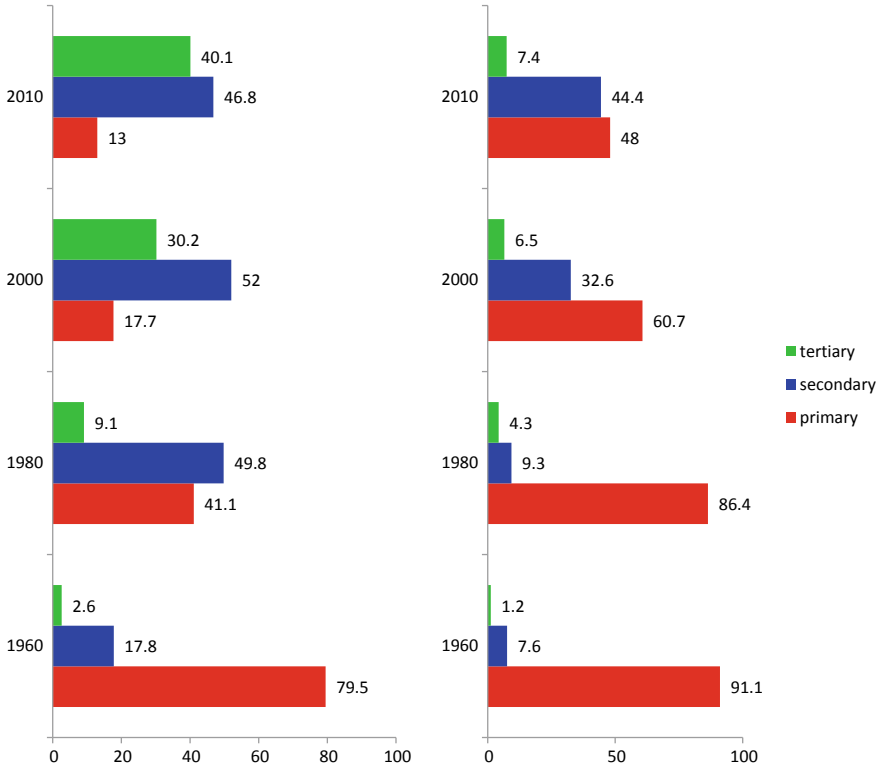

Fig. 2 Evolution of the educational attainment of the labor force in South Korea and Brazil, 1960–2010. *Source* Barro-Lee (2012)

educational attainment and economic growth in both cases, the 2008 study of Brazil prepared by Rodriguez et al. clearly indicates that innovation and productivity growth have been heavily constrained by the low proportion of adults with tertiary-level qualifications and the lack of linkages between universities and the productive sectors.

Generally speaking, the success of East Asian economies illustrates the symbiotic relationship among tertiary education, innovation and growth through the production of research and skills. Recent studies have shown the positive links between economic growth and tertiary education as measured by the tertiary gross enrollment ratio, science test scores, levels of R&D investment, and the number of scientists and engineers relative to a country's population. Firm innovation surveys undertaken in Indonesia, the Philippines and Thailand, for example, showed that the active innovators are those with higher levels of R&D expenditure, more highly qualified staff and located in more R&D-intensive industries (World Bank 2011).

Recently the prime minister of the Canadian province of Ontario traveled to the US state of Minnesota and gave a speech in which he observed that "in today's world all countries are alike, you can borrow your capital, you can copy technology, you

can buy raw materials. There is only one thing left to make a difference and that is talent." And that is why the province of Ontario advertises itself by announcing proudly: "We have three major advantages to attract foreign investments. Our tax rate is very low, we co-finance research expenditures and 63% of our adult population has a tertiary education qualification."

Another story to illustrate the importance of knowledge comes from the Nordic countries. In northern Finland, 500 km north of the capital city Helsinki, there is a small city called Oulu in the middle of a forest. The main company established in the city used to cut trees, making paper and cardboard. But, back in the 1970s, the CEO of that company started to get worried about the future of his industry and he challenged the national government: "If you establish a technology university in Oulu, I commit to investing in modern labs and bringing more private sector investors." Rumor has it that academics in Helsinki were not so keen to move to this small city in the middle of nowhere, but the national government took up the challenge and established a university in Oulu. Today, the City of Oulu and the University of Oulu share a single website as an illustration of the fact that their development has been so closely interlinked. And the company whose CEO had an inspiring vision? It was Nokia, which moved from being a company producing paper, cardboard and cables to becoming a world leader in electronics, contributing during its best period 20% of Finland's balance of payments and two-thirds of the country's R&D funding. The second lesson coming out of the case of Nokia is that being a leader at one point in time does not guarantee in any way continuing to be a leader, unless one keeps investing and innovating to remain at the cutting edge.

The last point about knowledge is the acceleration of the speed of creation of new knowledge, which makes it challenging for universities to operate as in the past, because in many disciplines what the students may learn in their first year of studies may have become obsolete by the time they graduate.

3 Changing Education and Training Needs

What is happening in the labor market as a result of these changes? How are the education and training needs of firms evolving? What do all these changes mean for universities? The first observation is that, on average, there is a demand for higher skill levels. Statistics from the OECD show that, in all member countries and for both males and females, the gap in earnings between the tertiary and the lower levels of education has grown even though the supply of graduates has increased, reflecting the higher demand for college and university graduates (OECD 2014). Similar statistics are available for a number of developing countries such as India, the Philippines, Brazil, Mexico and Argentina.

A second, related dimension of change is the need to train young people to have a flexible mindset and to acquire the capacity to adapt easily to a rapidly changing world. Recent research carried out by Levy and Murnane on the skills requirements for the tasks performed in the US labor market shows the types of skills for which

there is less demand or which have been taken over by computers and those for which there has been increased demand (Levy and Murnane 2004). In their path-breaking study, the authors divided the tasks performed in firms into five broad categories:

1. Expert thinking: solving problems for which there are no rule-based solutions, such as diagnosing the illness of a patient whose symptoms are out of the ordinary.
2. Complex communication: interacting with others to acquire information, to explain it or to persuade others of its implications for action; for example, a manager motivating the people whose work they supervise.
3. Routine cognitive tasks: mental tasks that are well described by logical rules, such as maintaining expense reports.
4. Routine manual tasks: physical tasks that can be well described using rules, such as installing windshields on new vehicles in automobile assembly plants.
5. Non-routine manual tasks: physical tasks that cannot be well described as following a set of "if-then-do" rules and that are difficult to computerize because they require optical recognition and fine muscle control, for example, driving a truck.

They found that tasks requiring expert thinking and complex communication grew steadily and consistently during the 1970s, 1980s and 1990s. The share of the labor force employed in occupations that emphasize routine cognitive or routine manual tasks remained stable in the 1970s and then declined over the next two decades. Finally, the share of the labor force working in occupations that emphasize non-routine manual tasks declined throughout the period.

The third dimension of change in education and training needs is the growing importance of continuing education because of the need to update knowledge and skills on a regular basis as a result of the shorter "shelf life" of knowledge. At the post-secondary level, for instance, the traditional approach of studying for a finite period of time to acquire a first degree or to complete graduate education before moving on to professional life is being progressively replaced by continuous practices of lifelong education. Regular training is becoming an integral part of one's working life, and it can take place in a myriad of contexts: on the job, in specialized higher education institutions or even at home through online education (World Bank 2002).

Lastly, an important consequence of the acceleration of scientific and technological progress is the diminished emphasis in tertiary education programs on the learning of facts and basic data per se. There is a growing focus on what could be called methodological knowledge and skills, that is, the ability to learn in an autonomous manner. The learning process now needs to be increasingly based on the capacity to find, access and apply knowledge to problem solving in an autonomous manner. In this new paradigm, learning to learn, learning to transform information into new knowledge, and learning to translate new knowledge into applications is more important than memorizing specific information. In the new mode of learning, primacy is given to information seeking, analysis, the ability to reason and problem solving. In addition, transversal competencies such as learning to work in teams, peer teaching, creativity, resourcefulness and the ability to adjust to change are among the new skills that employers value in the knowledge economy.

> To be a good doctor, you have to know a lot of facts. Medical training does a very good job of teaching those facts. But a good doctor also needs to have many other skills: to keep up with an ever-changing body of medical knowledge; to efficiently find information that it is not possible to memorize; to learn how to make decisions such as how to balance the benefits of a test or treatment against its risks; to sense a patient's unexpressed fears or misunderstandings; to elicit a patient's wishes; to explain things clearly, and, above all, to care. It is a lot harder to teach these skills than to give medical students facts to memorize. At our medical school and at many others the curriculum is being changed to emphasize such skills. (Professor Anthony Komaroff, Harvard School of Medicine)[1]

Faced with new training needs and new competitive challenges, many universities have undertaken important transformations in their governance, organizational structure and modes of operation. A key aspect is the ability of universities to organize traditional disciplines differently, taking into consideration the emergence of new scientific and technological fields. Among the most significant are nanotechnology, molecular biology and biotechnology, advanced materials science, microelectronics, information systems, robotics, intelligent systems and neuroscience, and environmental science and technology. Training and research for these fields require the integration of a number of disciplines that have not necessarily worked together in the past, resulting in the multiplication of inter- and multidisciplinary programs cutting across traditional institutional structures.

The evolution toward lifelong learning means that young high school graduates will gradually cease to be the primary clientele of universities. As a result, universities must organize themselves to accommodate the learning and training needs of a very diverse clientele: working students, mature students, stay-at-home students, traveling students, part-time students, day students, night students, weekend students, etc. One can expect a significant change in the shape and demographic configuration of tertiary education institutions, whereby the traditional structure of a pyramid with a majority of first-degree students, a smaller group of post-graduate students, and finally an even smaller share of participants in continuing education programs will be replaced by an inverted pyramid with a minority of first-time students, more students pursuing a second or third degree, and the majority of students enrolled in short-term and medium-term continuing education activities. Already in the United States, almost half of the student population consists of mature and part-time students, a dramatic shift from the previous generation. Both Brazil and Poland have more working students than young undergraduate students fresh out of high school.

Tertiary education institutions are also changing their admission practices to respond in a more flexible way to growing student demand. In 1999, for the first time in the United States, a number of colleges decided to stagger the arrival of new students throughout the academic year, instead of receiving them all in the fall semester. In China, similarly, a spring college entrance examination was held for the first time in January 2000, marking a sea change in the history of that country's entrance examination system. Students who fail the traditional July examination no longer have to wait a full year to get a second chance.

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[1] Quoted in *Newsweek*, December 12, 2005, p. 84.

4 Implications for Developing Countries

These changes in education needs and paradigms have four major implications for developing countries, in the areas of (i) quality and relevance, (ii) equity, (iii) funding and (iv) governance.

4.1 Quality and Relevance

With the proliferation of private providers in many parts of the world, many higher education institutions still operate with insufficient standards. Governments must therefore make sure that the programs offered are adequate, not only in terms of the professional skills that the students acquire, but also in terms of the new generic competencies that are needed for the knowledge economy, such as critical thinking, teamwork and good communication skills. The quality assurance criteria must take these aspects into consideration.

There is also a whole new debate in the US and other parts of the world about the importance of measuring student learning outcomes, which means moving away from judging the quality of an institution by looking only at inputs, at the qualifications of the professors or at the curriculum, and assessing what students actually learn. This may lead to challenges for the most prestigious universities of this world, pushing them to take a hard look at their actual contribution. After all, if they are able to recruit top academics and are in a position to select the best students on the planet, how much value are they adding to the incoming students? In the United States, for example, the presidents of second-tier teaching universities and community colleges are arguing that, because they receive a much more diverse student population, they may be adding more value to what the students learn than elite universities that are so selective that they get the best students. Tools are being developed to assess what students actually learn in an international perspective, as the AHELO project organized by OECD indicates.[2]

It has also become increasingly important to develop the knowledge and criteria for properly assessing the effectiveness of programs offered online, be they blended programs or online only. Indeed, e-learning is not about just doing online the same thing as was traditionally done in the classroom. Research shows that e-learning is fundamentally different. Carnegie Mellon University in Pittsburgh has developed self-learning courses using software based on artificial intelligence. To assess the effectiveness of their new online statistics course, for example, they randomly assigned some students to the traditional classroom course and others to the online only course. At the end of the term they compared their results and were somewhat disappointed because the results were similar. They had hoped that the online

[2] AHELO stands for the Assessment of Learning Outcomes in Higher Education. Universities from about fifteen countries participated in the pilot study that was implemented in 2012, with a focus on generic skills and specific professional skills in economics and engineering.

course would yield higher scores. But then somebody thought of framing the experiment in a different way. This time the online students—also randomly chosen—were allowed to study at their own pace and allowed to take the exam whenever they felt ready for it. On average, they took half the time to finish the course for equivalent learning outcomes. Thus, much more work is needed to be able to deal effectively with the assessment of e-learning.

4.2 Equity

The second topic is equity, a growing preoccupation for ministers of higher education all over the world. The rapid growth in enrollments all over the world has not always meant reduced disparities. In many instances, while enrollment rates increased for all income groups in society, the gap between the top quintile and the bottom quintile has also risen. What does it mean to look at equity in higher education? First, it is essential to recognize that a lot of disparities at the higher education level are a direct result of what happened—or did not happen—in primary and secondary education. Then, when it comes to higher education proper, one should acknowledge the financial barriers that many students face, especially in countries where universities charge fees. Finally, it is necessary to identify the many non-financial factors that affect the equity outcomes of disadvantaged groups in terms of information about academic and professional choices, motivation of first-generation students who have no positive role models to guide them, and academic preparation because they attended low-quality public primary schools and high schools. In an analysis of the reading scores in the latest PISA results, the OECD calculated the equity index measuring the degree to which social background predicts the scores of students (OECD 2014). In France, Germany, the United Kingdom and the United States, social background has a very high impact on the reading score results, much more than in other countries such as Canada, Italy and Finland, where there are fewer differences in the distribution of students across schools. A study by the Sutton Trust in the United Kingdom showed that children attending expensive private schools are 50 times more likely to get into Oxford or Cambridge than children from lower income groups (Torgerson et al. 2014).

The importance of ensuring equal opportunities is reinforced by recent advances in biology, neurology and genetics, which are challenging traditional views of the distinction between innate and acquired abilities. A growing body of evidence is showing that the line between what is attributed to genetic heritage and the psychological, on the one hand, and cultural and social factors that shape each individual's development, on the other hand, is much finer than previously thought. According to Robert Sternberg from Tufts University, the new paradigm views intelligence as a set of competencies in development (BBC 2001).

> It would be folly to suggest that anyone can literally do or become anything. But the new science tells us that it's equally foolish to think that mediocrity is built into most of us… And there are no environmental factors that function independently of the genome. [A trait]

> emerges only from the interaction of gene and environment… Our abilities are not set in genetic stone. They are soft and sculpt able, far into adulthood. With humility, with hope, and with extraordinary determination, greatness is something to which any kid - of any age - can aspire. (Shenk 2011)

The results of a global study conducted by the World Bank indicate that the most effective equity promotion policies to increase opportunities for disadvantaged students are those that combine financial aid with measures to overcome non-financial obstacles—addressing the comprehensive equity environment instead of following piecemeal approaches to individual barriers to entry. First, there is strong evidence that well-targeted and efficiently managed financial aid can be instrumental in reducing financial barriers to tertiary education. Financial barriers to tertiary education can be reduced using a combination of three methods to help students from disadvantaged groups: (i) no tuition fees or low fees; (ii) grants; and (iii) student loans. Second, many countries have successfully implemented outreach and bridging programs to secondary schools, and retention programs to improve completion rates (Salmi and Bassett 2014).

4.3 Financing Challenges

The third point worth raising is the impact of the financial crisis on the level of funding available to higher education. Many countries have found themselves in a situation where they had to deal with the same number of students or an increasing number of students with fewer resources, at the risk of deteriorating quality. This situation can also have, potentially, an adverse impact on equity, as reduced financial resources are available to support needy students. For many developing countries, therefore, the big challenge is to address the tension between the quantitative growth of enrollment and the protection of quality. In many cases, the only viable strategy will be to find an appropriate balance between public and private funding to compensate for the reduction in public budget resources linked to the fiscal crisis.

4.4 Governance

This leads to the last point about the need for appropriate governance so that higher education institutions can operate with flexibility in a rapidly changing world. Many universities—especially public universities—tend to be conservative and resistant to change. They are set in their ways and often overlook the fact that the world around them is changing rapidly, and that they need to analyze what is happening and how it affects their mission and mode of operation. It is therefore important to develop good feedback mechanisms and undertake strategic planning to orient change.

5 Conclusion

Two hundred years ago, in a small school in Boston, Massachusetts, a professor of mathematics visiting a new secondary school saw something that he had never seen before in his life: a blackboard, some chalk and a piece of cloth. He wondered what it was meant for. Now it is common knowledge that for the past two hundred years the blackboard has been the main pedagogical support in the classroom. The question worth asking today is whether the Internet and related digital resources are likely to revolutionize education in the same way as the blackboard did. In this context, it is worth mentioning Arthur Levine, the president of Teacher's College at Columbia University in New York City, who predicted the death of traditional universities characterized as the "brick universities," to be replaced by "click universities."

While the demise of the traditional pedagogical model is not a foregone conclusion, it is certain that schools and universities are being called upon to change drastically under the pressure of increased competition and growing demands for accountability. But the successful integration of technology into the learning process will require a cautious approach. Notwithstanding the many advantages that modern technologies can offer, their effectiveness depends on a clear strategic vision of their role in support of a new pedagogical project. It is important to define first the new pedagogical approach that a school or a university wants to implement and then to look for the most appropriate technology that can effectively prop up that pedagogy. As the Roman philosopher Seneca wrote more than two thousand years ago, "there is no favorable wind for those who do not know where they are going."

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The Transformation of Higher Education in Latin America: From Elite Access to Massification and Universalisation

José Joaquín Brunner and Julio Labraña

Abstract Using the latest information available on the recent evolution of Latin American higher education and following Trow's hypothesis on the and cultural effects of access expansion, we analyze the impact of massification and universalization of national systems in the region and how these changes have fundamentally altered their institutional platforms in a context of advanced academic capitalism. Based on these developments, we explore how Latin American higher education, especially after consolidating a growing private sector, is currently moving away from the previously dominant idea of universities as institutions for educating societies' elites, an idea that is now being replaced by the increasing acknowledgment of the essential role of academic organizations in meeting demands for access to information, knowledge, job market qualifications and social mobility. Throughout this process, the very concept of university has changed radically, leading to mixed positive and negative reactions among the region's academics and intellectuals.

Keywords Higher education · Massification and universalization · Idea of a university · Latin American universities

1 Introduction

The importance of universities has grown continuously in recent decades. The transition towards a knowledge-based economy, as well as the democratization of higher education access, has led to fundamental changes in this respect. The idea that the main purpose of these institutions is to shape cultural elites and modern professions—a discourse that was previously widely accepted—has become less important in a new context in which the economic relevance of universities is increasing (Bell 1976; Castells 1996; Steinbicker 2011).

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Specialized literature records this transformation in different ways. On one hand, there is a critical—and normally nostalgic—interpretation of the change to the cultural significance of universities in previous decades (Hayes and Wynyard 2002; Readings 1996). According to this view, the idea of university is in crisis because they are being subordinated to economic demands. On the other hand, other types of analysis, instead of lamenting such changes, emphasize how desirable they are, since they create the opportunity for universities to overcome their "ivory tower" image and instead commit themselves to their countries' economic development (Beerkens 2008; Shattock 2008).

Discussing the transformation of universities in terms of the characteristics we would like them to either have or not have makes it difficult to think adequately about their link to changes in higher education's political economy. In this chapter we explore the impact of access massification to higher education on the idea of the university, along the lines of the hypothesis developed by Trow (1973, 2007).

As Trow shows, changes to access directly influence national systems' institutional platforms and the way in which universities' functions are primarily conceived. By distinguishing between elite access (an enrollment rate of less than 15%), massive access (an enrollment rate of between 15 and 50%) and universal access (an enrollment rate of more than 50%), Trow suggests that each of these phases is associated with system characteristics and universities' specific social functions.

In systems with elite access, the institutions' attributes tend to be homogeneous, mainly dedicated to creating leaders for roles in government and in areas such as the humanities, the law and medicine. However, systems with massive access have different standards and their function—although still restricted to educating elites—begins to include the teaching of technical, administrative and business degrees. Lastly, during the universal access phase, higher education systems tend to achieve a high degree of diversity; institutions and programs are vertically and horizontally differentiated, and the very notion of standardization becomes problematic, with continuous conflicts arising around the organizations' nature, functions and boundaries. Institutions are now aimed at educating the population as a whole, in a context in which knowledge becomes societies' and individuals' main economic capital and a mechanism for social mobility.

This study uses Trow's hypothesis and his distinction between higher education access phases to examine the changes in Latin American systems. Although Trow's ideas about university access expansion have been the source of numerous studies in developed countries (Marginson 2016a, b; Scott 2019), they have had less effect in developing countries' specialized literature, mainly concentrating—in Latin America—on their consequences for how institutions are managed and on the governance of national systems (Brunner 2009; Brunner and del Canto 2018), the economic relevance of education for innovation (Schwartzman 2012) and how student characteristics have changed due to these new trends (Araneda-Guirriman et al. 2018; Barreyro and Costa 2015).

This region is of particular interest since Latin American countries underwent the transition from elite to massive access and—in the case of some countries—to universal access in the context of an academic capitalism variety with a high level of

privatization of both higher education provision and funding (Brunner et al. 2019). To put this idea to the test, this paper is divided into four sections. First, we will examine the changes to higher education access in different world regions. Next, we will show how increasing enrollment rates have been associated with intense privatization and increasing institutional system diversification. Third, we will explore how changes to the systems' political economy have altered the traditional understanding of higher education's role in society. We close with a brief summary and suggestions for further studies.

2 The Great Transformation in Higher Education

Over the last four decades, global enrollment in higher education has increased dramatically, rising from 33 million students in 1970 to 67 million in 1990 and to around 220 million in 2017. The Latin American student population, for its part, has increased at an even greater rate—from 1.7 million in 1970 to 7 million in 1990 and 27 million in 2017. In this last year, it represented 12.4% of the total number of students enrolled in higher education worldwide, four percentage points more than the proportion of the Latin American population worldwide (UNESCO Institute for Statistics 2019; World Bank 2019).

Thus, there has been a general, global, trend towards access massification in higher education. Measured as a percentage of students enrolled compared to the relevant age group, higher education has expanded constantly in recent decades. It overcame the threshold between elite and mass systems for the first time in 1995, reaching a worldwide average of 15.7%. Nevertheless, as Trow himself indicates, this process occurred at different speeds in different parts of the world. As can be seen in Table 3.1, in Arab states, Asian countries and Small Island Developing States, the this first threshold was overcome for the first time at the beginning of the 2000s. In contrast, in other regions—such as North America and Europe—this boundary was surpassed as early as the late 1960s and early 1970s, with a majority of national systems pertaining to these regions already in the universal access phase at the beginning of the twenty-first century. In comparison, Latin America occupies a mid-way position. Although it moved to mass access in 1984—with a 16.9% gross enrollment rate—it has currently achieved universal access with a 50.4% average gross enrollment rate (UNESCO Institute for Statistics 2019).

The latter threshold was already reached by several Latin American countries during the first decade of the twenty-first century. In fact, countries such as Argentina, Chile and Uruguay were already showing enrollment ratios higher than 50% before 2010, with numbers similar to those of France, Italy, the Netherlands, Portugal and Switzerland (Unesco Institute for Statistics 2019).

Table 3.1 Evolution of enrollment in higher education worldwide, 1970–2017 (%). *Source* UNESCO Institute for Statistics

Region/Year	1970	1975	1980	1985	1990	1995	2000	2005	2010	2015	2017
Arab States	6.1	7.7	9.9	11.3	11.3	14.1	18.5	22.2	25.5	31.1	32.4
Central and Eastern Europe	30.2	29.2	30.5	33.4	34.2	32.6	43.1	58.8	69.1	77.2	80.3
Central Asia	–	–	24.2	24.6	25.4	22.8	22.2	27	24.9	25.3	26.6
Eastern and Pacific Asia	3.1	3.8	5.3	6.9	7.4	10.4	15.6	23.2	27.9	43	46.7
Latin America and the Caribbean	6.9	11.3	13.5	17.5	16.8	18.6	22.6	30.7	40.6	48.6	50.6
North America and Western Europe	30.6	35.6	38.4	41	48.8	60.1	59.5	70.1	76.7	77.7	78.4
Western and Southern Asia	4.3	4.4	4.5	5.5	5.7	5.6	8.8	10.3	17.3	24.9	24.9
Sub-Saharan Africa	0.9	1.1	1.8	2.4	3	3.7	4.4	5.9	7.5	8.8	9
Small Island Developing States	3.8	5.7	8.4	10.3	12.2	11.7	15.7	25	33.5	25.5	26.1

3 Institutional Diversification and Privatization of Provision and Funding

In the international context, access expansion in Latin America has a peculiarity; it has been primarily driven by mixed funding and provision, that is, through state and private institutions and public and private funding sources. As shown in Table 3.2, private funding plays a key role in Latin American systems, although to different extent (Garcia Guadilla 2007). For example, according to the latest available statistics, 91.6% of higher education funding in Argentina comes from the national budget, while in Guatemala 70% comes from household and other private entities (Unesco Institute for Statistics 2019).

In turn, Latin America's mixed higher education funding is accompanied by a high degree of private provision, compared to other world regions (Table 3.3). Of particular interest are the higher education systems of Brazil and Chile, where more than 70% of students are enrolled at private institutions (Unesco Institute for Statistics 2019).

Table 3.2 Initial government and household expenditure in higher education (percentage of GDP, latest year available). *Source* UNESCO Institute for Statistics

Country	Latest available year	Government spending	%	Household spending	%
Argentina	2016	1.1	91.7	0.1	8.3
Bolivia	2011	2	87	0.3	13
Brazil	2015	1.3	–	–	–
Chile	2017	1.4	60.9	0.9	39.1
Colombia	2017	1.0	62.5	0.6	37.5
Costa Rica	2013	1.4	58.3	1	41.7
Cuba	2007	3	–	–	–
Dominican Republic	2007	0.3	–	–	–
Ecuador	2015	2.2	–	–	–
El Salvador	2017	0.4	28.6	1.0	71.4
Guatemala	2008	0.3	30	0.7	70
Honduras	2015	0.9	75	0.3	25
Mexico	2015	1.1	73.3	0.4	26.7
Nicaragua	2010	1.2	–	–	–
Panama	2012	0.7	–	–	–
Paraguay	2010	0.5	38.5	0.8	61.5
Peru	2017	0.7	41.2	1	58.8
Uruguay	2011	1.2	–	–	–
Venezuela	2009	1.5	–	–	–

Table 3.3 Higher education enrollment in private institutions worldwide, 2010 (percentage). *Source* PROPHE (Programme for Research on Private Higher Education)

Region	%
Sub-Saharan Africa	17.8
Arab States	17.4
Asia	42.1
Canada, Australia and New Zealand	10.1
Europe	14.9
Latin America and the Caribbean	48.8
United States	27.5

The number of higher education institutions in Latin America is currently around 10,600 (Brunner and Miranda 2017), of which 4,081 are universities (38.6%) and 6,508 are non-university higher education institutions (61.4%). Within universities, 1,328 (32.5%) are state-run and 2,753 (67.5%) are private (Table 3.4).

Table 3.4 Latin America: higher education institutions in 2016. *Source* Brunner and Miranda (2017)

	Universities		Non-universities	
	Public	Private	Public	Private
Argentina	66	65	1023	1190
Bolivia	19	40	313	
Brazil	122	220	176	1850
Chile	16	44	0	103
Colombia	59	142	21	66
Cuba	52	0	0	0
Costa Rica	5	53	2	27
Dominican Republic	1	30	16	
Ecuador	33	26	143	133
El Salvador	1	23	8	9
Guatemala	1	14	40	
Honduras	6	14	0	0
Mexico	851	1816	144	89
Nicaragua	6	51	2	0
Panama	5	28	4	21
Paraguay	8	45	7	30
Peru	51	91	977	
Uruguay	1	4	0	12
Venezuela	25	47	32	70
Total	1328	2753	6508	

As a result of institutional differentiation, Latin American national higher education systems have become more complex and variegated, leaving behind the simple distinction between state and private (Brunner 2011) and, in the case of the latter, between religious and non-religious, for profit and non-profit, and dependent or not dependent on state institutional subsidies. At present, Latin American higher education institutions may be differentiated additionally according to their funding (age), history, location of their main campus, size, missions, functions, faculty, student body, organization, management style, reputation, degree of internationalization, and whether they are only teaching or research institutions (Brunner and Miranda 2017). Regarding this last variable (i.e., to what extent research is involved), only 217 of a total of 4,081 Latin American universities have a continuous scientific output of at least an average of 100 SCOPUS-indexed publications per year during the period 2012–16 (Scimago 2019). Altogether, these research institutions represent 5.3% of the total number of universities in Latin America. In contrast, most universities limit themselves to teaching, although there is a group of universities somewhere in the middle, with some consistent initial research being carried out (Bernasconi 2011; Pineda 2014, 2016).

4 Changes in the Latin American Idea of a University

As a result of the dynamics of institutional privatization and diversification already described (Brunner 2009), the number of strictly teaching institutions in Latin America has multiplied, which is significantly different from the selective university model dedicated to educating leaders that applied during the elite access phase. In effect, state and private institutions have proliferated—the latter in particular—with the aim of meeting a growing demand for higher education and to include an increasing number of less favored social groups. The discourse that has accompanied this institutional proliferation and the expansion of educational opportunities has two different sides. On one hand, it draws on the historically accepted notion of universities closely linked to social critique and national/working-class projects; on the other, it relates to the idea of institutions linked to modernization and development projects, with an important emphasis on incorporating the masses into the sphere of professionalism and consumption (Brunner and Ganga 2016; Mollis 2007; Pineda 2016).

Simultaneously, the concept of the socially committed and politically mobilized Latin American university (called "militant" by Medina Echavarría (1967)), based on the native myth of the Reform of Córdoba in 1918 (Requena and Ahumada 2018), is losing ground (Bernasconi 2008), although it is still relevant as a beacon of ideological-cultural orientation (Leihy and Salazar 2017). In turn, an entrepreneurial university model has started to spread—open to markets and subject to competition. Its main function is to efficiently prepare and certify technical and professional workers (human capital), while at the same time generating income and a surplus

needed to further develop the organization. This model, however, lacks a narrative to accompany its robust practical development.

In fact, the Latin American idea of a politically committed university has now been relegated mainly to the humanities and social sciences in a few private and state universities, although these are currently also being imbued with an entrepreneurial spirit in a context of increasing managerialism (Brunner et al. 2019). In their place, the idea is now emerging that universities' function is to develop human capabilities and employability, with the dual aim of contributing to national productivity and competitiveness and generating intergenerational educational mobility.

It is clear from the Latin American literature that this transformation is understood as a result of the intervention of ideologically motivated international bodies, whose aim is to lower the power and influence of public (state) universities that operate as a paradigm of the "teaching state" (*estado docente*). However, as the dynamics explored in this chapter show—changes in access to higher education and institutional diversification in a privatized framework—these factors seem to be as important as or even more important than the dissemination of policy ideas and models from the center to the periphery. In Latin America, privatization dynamics (Brunner 2009) cause teaching-only institutions to multiply in response to an increasing demand for tertiary education. However, these new institutions—as opposed to the traditional ideal of the Latin American university that educated political and cultural elites, conscious of their social status—act rather as socialization agencies, massive teaching organizations and certification bodies, producing professional and technical personnel in a relative standardized way (Mollis 2007).

In almost all Latin American countries, this type of institution—and not the model of the socially committed, critical or militant university—predominates, although the latter still acts as a normative ideal, as previously mentioned. Overall and in practice, the majority of students study at teaching-only universities and non-university higher education institutions that are less selective and, therefore, have a lower unit cost—these being the only ones that can guarantee mass and eventually universal access, including young people from lower socioeconomic groups (Brunner 2011; Labraña Vargas and Rodríguez Cisternas 2017).

In this respect, the contemporary hegemony of human capital discourse reflects the erosion of the "condition of possibility"—as used by Kant (Piché 2016)—of the previously dominant narrative of the politically committed (public) university (Brunner 2014). On one hand, the massification and universalization of access to higher education brings with it the inclusion of new middle-class sectors, whose interests are more aligned with economics, productivity and consumption than with public-good values of the older middle class (Barozet and Fierro 2011). On the other hand, the emergence of new types of institutions whose mission statements, educational projects and organizational cultures differ from the ones formulated on the basis of the founding myth of the Córdoba Reform (Naidorf 2016) results in the loss of the higher education sector's homogeneity and the subsequent change in the discourse on universities' authentic role (Brunner 2019). Universities become organizations for satisfying demands for access to information, knowledge, job market certification and social mobility; commitment to public issues—so self-evident in previous

decades—is less obvious in the current activities carried out by Latin American universities.

5 Conclusions

We have examined how changes to access and to the institutional platform for higher education provision have led to changes in how the aims of Latin American universities are understood. To this end, we described how, in recent decades, access to higher education has expanded, altering national systems' institutional organization in an environment of advanced privatization, both in terms of funding and enrollment. Our analysis suggests that these developments have led to a decline of the traditional idea of a Latin American university, due to the loss of both their elitist nature and their institutional uniformity.

Based on this analysis, further studies could comparatively examine how changes in higher education access and its consequences on institutions alter higher education's normative discourse in different world regions. There is a growing literature that describes these changes as a game of either critique or praise, without reflecting on the social conditions that make the emergence of these normative discourses possible. It seems worthwhile to delve deeper into a sociology of the idea of a university, including the most valued in Latin America, in order to account for the material and intellectual conditions that increase the probability of certain ideas becoming more relevant than other, previously dominant ones, while the latter lose their importance.

Similarly, more detailed examinations of how local, national and global factors (Marginson 2004) shape the political decisions related to higher education provision and access need to be carried out. In the case of Latin America, these decisions cannot be understood without considering the importance of privatization and the emergence of higher education markets (for students, academic staff and managers, resources and prestige), elements that decisively characterize the variegated academic capitalism that exists in the region.

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The Diffusion of Policies for Quality Assurance in Latin America: International Trends and Domestic Conditions

Elizabeth Balbachevsky

Abstract This chapter investigates the dissemination of national initiatives to build quality assurance regimes in higher education in Latin America. In some countries, it took place amid comprehensive reforms; in others, it was a byproduct of the country's participation in processes of regional integration. For still others, institutional innovation was mostly symbolic. Whatever the path, institutional mechanisms to assess and certify course programs and institutions spread throughout the region over the first years of the twenty-first century. In all cases, it was superimposed on the institutional framework already in place for regulating and overseeing the content of what was taught in higher education institutions, which, in many cases, limited innovation and institutional differentiation.

Keywords Policy diffusion · Quality assurance in higher education · Latin America · South America

This chapter investigates the dissemination of national initiatives aimed at building quality assurance regimes in higher education in Latin America. The development of policies for the evaluation, recognition and accreditation of institutions and programs is a recent trend everywhere. In Latin America, these systems were created over the first years of the twenty-first century. As Lemaitre points out, the development of quality assurance schemes represents a new way of organizing the relationship between higher education institutions, governments and societies (Lemaitre 2003). In Latin America, different types of quality assurance procedure are present. In some cases, they verify whether the course programs being offered comply with minimal standards; in others, they assess whole institutions; and others go further, assessing the quality of the education, based on tests applied to students completing their degrees.

The current accreditation policies may be new in Latin America, but the notion that government should supervise higher education institutions is quite old. This tradition is rooted in Latin higher education after the colonial era (Schwartzman 1993). In the Napoleonic model, the higher education institutions are both educational

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establishments and agencies for professional certification, and the higher education degree is both a certificate of completion of a study program and a legal entitlement giving access to the privileges associated with a particular profession. For this reason, in Latin America, ensuring that different institutions provide similar curricula has always been a central policy issue. Thus, the presence of non-academic organizations in charge of licensing programs and recognizing diplomas is a common and long established experience. It is on top of this old layer of regulations that the new experiences of evaluation, accreditation and quality assurance are being built.

Latin American public universities share a particular understanding of university autonomy inherited from the Córdoba Movement dating from 1908, which creates strong barriers against any form of government interference (Bernasconi 2014; Figueiredo-Cowen 2002). Public universities are considered part of the civil service and are funded through a traditional incremental budgetary model, but strongly resist the interference of any external stakeholder in their internal affairs. In some countries, barriers against government interference are written into the constitution, which proudly establishes that universities should have "autonomy from all external powers" (Weise 2017). A major component of the autonomy is co-governance, the belief that universities are autonomous if and only if their authorities are chosen through internal elections with the participation of all internal stakeholders: students, employees and academics.

The main change introduced by the new policies for quality assurance is their focus on ex-post measures of quality. As pointed out by Brunner and Ferrada Hurtado (2011), these policies seek to certify programs and institutions according to the quality of training they offer and their management practices. The rationale is to correct and compensate the information asymmetry that characterizes the educational market. When successful, these assessments should (a) make the provision of higher education more transparent to society; (b) offer a guide for future students and their families to choose their careers and institutions, and (c) broaden the knowledge in the labor market about the specificities of the qualifications offered by different institutions.

1 Sustaining the Diffusion of Quality Assurance Policies in Higher Education

The literature usually associates the development of quality assurance policies with the intense changes experienced by higher education globally. Some of these dynamics are well known and have been extensively documented (Altbach et al. 2017; Braun and Merrien 1999; Trow 2000): the massification of access and the consequent diversification of the higher education clientele; the institutional diversification and the emergence of new private (some of them for-profit) providers; the dissemination of distance education; the diversification of training programs; and the rising cost that higher education imposes on families and society as a whole. All these changes

worsen the asymmetries that traditionally exist in the higher education market. On the other hand, international mobility worldwide creates the need for quality standards for professionals in different countries. From this perspective, the new certification schemes are an isomorphic, independent set of responses to pressures that equally affect all countries.

However, also according to the literature, the diffusion of quality assurance policies is strongly associated with initiatives coming from different international agencies and the demonstration effect of successful experiences, presented and extensively evaluated at various conferences, seminars and international networks that link together experts, academics and officials from different countries (Botto 2016). In Latin America, the international organizations most committed to promoting frameworks for higher education reforms are the United Nations Educational, Scientific and Cultural Organization (UNESCO), the Economic Commission for Latin America and the Caribbean (ECLAC), The World Bank and the Organization for Economic Cooperation and Development (OECD). It is worth mentioning the relevant role played in the 1990s by the World Bank supporting higher education reforms and the adoption of quality assurance mechanisms in the region. Finally, it is necessary to take account the dynamics opened up by the most relevant regional integration process in the region, the MERCOSUR, which has been developing a regional scheme for certification and quality assurance since the end of the 1990s (Lemaitre 2014). So, it is possible to see dissemination of quality assurance policies in Latin America as an example of policy diffusion.

The central issue in the policy diffusion literature is to distinguish policy changes that result from the influence of the international context from the adoption of exemplary policies implemented by other countries and organizations. This literature explains policy diffusion through two orders of variables: changes in the incentive structure that delimit a government's choices; and changes in perceptions of its elites, that is, processes of social learning (Braun and Gilardi 2006; Dobbin et al. 2007; Gilardi 2010; Lemaitre 2014; Shipan and Volden 2012).

The diffusion of policies produced by incentives occurs when a country changes its policy to benefit from opportunities created in the international environment or to avoid sanctions. Countries can change their policies, for example, to keep up with their competitors and ensure continued access to investments or markets. Another mechanism is the response to sanctions imposed by more powerful governments, or coercion coming from international organizations, countries and/or non-governmental actors which usually take the form of conditionalities. Policy diffusion through coercion is quite a popular framework in the literature on policy changes in developing countries, but a number of analyses point out its limits (Eichengreen and Ruehl 2001; Santiso 2001, 2003; Svensson 2000). Also, governments often deliberately use these conditionalities as a strategy for circumventing strong internal opposition to the adoption of policies they were already considering (Przeworski and Vreeland 2000).

But policy diffusion could result from a genuine learning process. Governments can change their perception of policy based on the evaluation of the results achieved by other countries when facing similar problems (Braun and Gilardi 2006). The

social learning process can be described as following two different pathways. First, it can be seen as a process of Bayesian actualization. New information from international experiences provokes the revision of some assumptions held by domestic elites, leading to changes in policies. Second, social learning could be presented as a rhetoric move, where well-known programs and policy initiatives are promoted in the international arena as flags of success and are then adopted by different countries. This is what Gilardi (2010) calls a symbolic diffusion, when a policy is adopted for the status it lends to the country in the eyes of the international community, not for its substantive content. However, such pathways may just spread stereotyped policies, with low adherence to reality and, therefore, little effectiveness (Simmons and Elkins 2004).

The understanding of the complex processes related to social learning has been revisited recently by different strands of the literature of public policy analysis, considering, among others, the contributions coming from Sabatier and associates (Jenkins-Smith et al. 2014; Jenkins-Smith and Sabatier 1994; Sabatier 1987; Weible et al. 2011). According to these authors, policies express specific theories about the nature of the problems they intend to solve and, therefore, they contain implicit causal beliefs. Social learning happens by introducing minor changes in these causal beliefs or other values sustained by different advocacy coalitions that strive for policies addressing their beliefs in the policy arena.

Another relevant contribution comes from the literature that deals with the role of international norms in framing domestic policies. Here, a new strand of work focuses on the processes by which international norms enter the domestic debate in a policy arena. One relevant contribution comes with the concept of localization (Acharya 2004, 2010). According to Acharya:

> localization does not extinguish the cognitive prior of the norm-takers but leads to its mutual inflection with external norms. In constructivist perspectives on socialization, norm diffusion is viewed as the result of adaptive behavior in which local practices are made consistent with an external idea. Localization, by contrast, describes a process in which external ideas are simultaneously adapted to meet local practices. Hence, in localization, the existing normative order and local practices are made consistent with an external idea. (Acharya 2004, pp. 251–252)

Higher education reforms in Latin America have been strongly influenced by international dynamics. In the 1990s, reform proposals were imposed on a number of countries by strong international organizations, mostly the World Bank. Since then, new understandings, parameters and modes of governance have also been promoted by other agencies such as UNESCO and OECD. National elites, officers and university leaders have been exposed to exemplary experiences and local universities have been pushed to change in response to the impact of global leagues and rankings. The spread of new quality assurance regimes is a core element of these processes. Following Acharya (2010), this chapter looks at the adoption of the new quality assurance policies and the development of new institutions to implement them as part of the process of localization of new frames for higher education policies and university governance. However, it would be naive to consider the diffusion of the new policy as simple transplantations of new norms, ignoring the complex process of social

learning that takes place. This process brings specific local features to the diffused policy, resulting in distinctive designs and outcomes. Ka Ho Mok and associates, for example, show how the reforms that were undertaken by different South-east Asian countries in the 1990s, because of the different domestic context, resulted in quite different institutional arrangements (Chan and Mok 2001; Mok 2000; Mok and Welch 2003).

This perspective allows us to grasp the significance of the differences in the quality assurance policies adopted in Latin America. In all cases, building quality assurance regimes entails two tasks: first, the standardization of institutional evaluation procedures and benchmarks; and second, the building of an institutional instance outside the university sector in charge of assessing the university's practices and outputs, and making a public judgment about their quality. Despite this common design, quality assurance policies have very different meanings in different national contexts, respond to different goals, and, more important, impact in different ways the national context, as we will explore below.

2 The Building Blocks of the Quality Assurance Policies: A Brief Overview

The institutional centerpiece of quality assurance is old. The "accreditation agency" was born in the late nineteenth century in the US. At that time, it was a response from traditional private universities to the expansion of state universities, the land-grant colleges. To face competition from the new universities, the more traditional institutions rallied around a self-supported accreditation agency that should certify their institutional missions. Throughout the twentieth century, the number of accreditation agencies in the US context multiplied. They gained autonomy and carved out their own space in American higher education, certifying all higher education institutions. In the US, accreditation agencies remain private and are supported by fees paid by the higher education institutions themselves. Their focus is to certify the actual implementation of the institution's projects; they ensure that the institution is, in fact, what it claims to be, the fit between the institution's practices and design. Thus, in the US, accreditation directly contributes to the enormous institutional differentiation that characterizes the American system.

This model of accreditation remained limited to the American experience until the 1980s. By the end of that decade, however, the European Union and some individual European countries had their attention drawn to this experience, in the wake of early efforts to reform higher education in the region. The literature associates these reforms with the spreading of New Public Management principles on the continent and also with the debate that accompanied the release of the results of some studies carried out by the EU, which drew attention to what became known as the "European paradox" (Archibugi et al. 1999; Braun and Merrien 1999; De Boer and Goedegebuure 2001; Gornitzka et al. 2007; Olsen 2007). The term "European paradox" refers

to the contradiction between the high quality of European science and the low competitiveness of its technology. It does not matter if this diagnosis was correct. It is important to note that the debate around the so-called European paradox produced a narrative in which the relations between society and university were framed under the dilemma commonly associated with processes of delegation (Kivistö 2007; Lane and Kivistö 2008), which interpreted the university–society relationship in terms of the moral hazard dilemma proposed by the principal–agent theory. This narrative placed special emphasis on the gulf that separates the expectations of national societies and governments from the motivations of the universities. In the new environment, building up accreditation agencies that could certify the fit between the self-image produced by a university and the practices it adopted was a central building block of a new social pact sustaining the universities (Gornitzka et al. 2007).

Thus, the accreditation agencies became aligned with the national policy agenda and their relationship with the universities was affected by the tensions between external interests and a well-knit academic community used to a wide degree of academic autonomy. Despite these tensions, the relationship between accreditation agencies and universities in Europe can be described as cordial. In fact, in many cases, the accreditation agency helps the negotiation of the performance agreements that became the usual mode of financing higher education in Europe (de Boer and Enders 2017).

Later, between the late 1990s and early 2000s, external evaluation initiatives and the model of accreditation agencies also spread throughout Latin America. One relevant push for this dynamic came from the initiatives taken within MERCOSUR,[1] reinforced in the 2000s with the launching of ARCU-SUR, a regional system of accreditation for a limited number of program types leading to specific professions over which the countries have agreed the contents of a minimal curriculum. While ARCU-SUR does contribute to nurturing a culture of evaluation inside national bureaucracies, the real impact of the initiative is small. Besides being elective, ARCU-SUR accreditation offers few benefits to the programs passing through its evaluation, apart from a small number of scholarships supporting mobility of students and academics between accredited programs. Also, all the initiatives for establishing a regional system validating the professional credentials awarded by programs accredited under ARCU-SUR have so far failed.

In some countries this institutional innovation was introduced amid reforms sponsored by international agencies; in others, it was a byproduct of the country's involvement in processes of regional integration. For some, institutional innovation was mostly a symbolic gesture. Either way, the building of an institutional apparatus dedicated to assessing and certifying programs and institutions spread throughout the region. In all experiences, it was added to the institutional framework already in place for regulating and overseeing the content and quality of what was taught

[1]Mercosur (in Spanish), Mercosul (in Portuguese) or Ñemby Ñemuha (in Guarani) is a South American trade bloc established by the Treaty of Asunción in 1991. Its full members are Argentina, Brazil, Paraguay and Uruguay. Venezuela is also a full member but has been suspended since December 1, 2016. Since its foundation, Mercosur's functions have been updated and amended many times; it currently confines itself to a customs union.

in universities. For this reason, in many cases, it ended up curbing innovation and differentiation in the higher education sector (Bernasconi and Celis 2017; Knobel and Bernasconi 2017).

3 Spreading Quality Assurance Policies in Latin America: An Overview

Table 4.1 summarizes the major dynamics around the process of adoption of quality assurance policies in the ten South American countries, identifying convergences and differences. The information comes from the country entries in Springer's *Encyclopedia of International Higher Education Systems and Institutions*, other secondary sources and the countries' official documents (Chávez Irigoyen 2017; Fanelli 2017; Johnson-Toala 2019; Landoni-Couture 2017; Neves 2017; Silva and Enrique 2017;

Table 4.1 Main traits of policy assurance policies in Latin American countries of South America. *Source* Encyclopedia of International Higher Education Systems and Institutions (2017)

Country	Year	Mandatory/elective?	Focus	Main dynamics leading to the adoption of QA policies
Argentina	1995—CONEAU	Mandatory accreditation for post-graduate and undergraduate programs leading to regulated professions	Programs	CONEAU was part of the main project of reform of higher education backed by the World Bank The autonomy enjoyed by public universities limits the impact of government policies
Bolivia	–	Since 1990–2000 there have been some elective moves, mostly organized by the elite private universities. ARCU-SUR (regional initiative for accreditation) operates for a limited number of programs in public universities	–	Strong autonomy prevents government intervention over the traditional public universities Law 070/2010 seeks to infuse the system with a socialist (Bolivarian) orientation. Resisted by traditional public universities A new segment of Indigenous Universities are under community control

(continued)

Table 4.1 (continued)

Country	Year	Mandatory/elective?	Focus	Main dynamics leading to the adoption of QA policies
Brazil	2003—SINAES	Regulation is mandatory both at the institutional and at the program level. No program or institution is authorized to work without formal authorization and approval from the federal government There is a separate system for assessing graduate (master's and doctoral) programs	Institutions and programs	Quality assurance was first adopted at the end of the 1990s, as part of a move to reinforce the role of external evaluation over the private and public sectors. It is based on applying formal formulas to evaluate programs and institutions Reformed in the 2000s as part of a highly elaborated system that allows the federal government to oversee higher education extensively. Strong impact over the large private sector, small impact over the public sector
Chile	1990—CNED 2003—CNA	CNED is in charge of licensing new institutions/evaluating performance and conferring the status of autonomy CNA: accredits autonomous institutions, authorizes and monitors private agencies in charge of accrediting programs at undergraduate and master's level CONICYT oversees doctoral training	Institutions and programs	Coordination is done by market mechanisms; government intervenes with competitive funds and programs While voluntary, accreditation is necessary for access to public funds, including scholarships and student loans Accreditation is based on the principle of institutional autonomy. Institutions are free to define their own mission and institutional purposes

(continued)

Table 4.1 (continued)

Country	Year	Mandatory/elective?	Focus	Main dynamics leading to the adoption of QA policies
Colombia	1995—CNA 2002—SACES CONACES	Elective accreditation. However, it is a pre-requisite for access to some programs for institutional/student support.	Programs	Policies for quality assurance as part of a major reform that regulated university autonomy. Implementation gained force in 2002. It is based on formal formulas applied to all programs
Ecuador	2008—CACES	Mandatory. CACES has authority to close institutions that do not follow directives for improving quality.	Programs and institutions	Policies for quality assurance as part of a major move towards centralization, giving a more pro-active role to central government Implementation produced conflict with public and private universities around the autonomy of the universities
Paraguay	2003—ANEAES	Mandatory, but low level of implementation. Access of some public programs is conditional on being accredited	Programs	The policy of quality assurance is part of a major process of institution building and centralization It responded to a move to control the growth of the private sector. Country's experience with ARCU-SUR was decisive for informing the design of the new system
Peru	2006—SINEACE	Elective accreditation, mandatory licensing	Institutions and programs	The policy is part of an effort to ensure a more proactive role for the Ministry of Education Move from self-evaluation conducted by the National Association of Rectors towards centralization in the hands of the executive

(continued)

Table 4.1 (continued)

Country	Year	Mandatory/elective?	Focus	Main dynamics leading to the adoption of QA policies
Uruguay	–	Many programs take part in the ARCU-SUR (regional initiative for accreditation)	Licensing new programs	There is no quality assurance policy in place. The main public University, Universidad de la República, adopted its own system of evaluation
Venezuela	–	–	–	The conflict between traditional national universities and the government has led to the development of a new layer of HE institutions—territorial and specialized universities—through which the government is trying to implement its goals

Parra-Sandoval 2017; Robledo and Morales 2017; Teixeira et al. 2017; Weise 2017; Zapata and Tejeda 2017).

As we can see, in most countries, quality assurance policies were adopted as part of large initiatives targeting reforms of the countries' higher education. In all cases, the reforms aimed to reinforce the role of the country's executive, mostly the Ministry of Education, as an instance of coordination in higher education, supplanting old arrangements whereby universities were left to internal assessments and challenging the traditional notion of the universities' autonomy. Not surprisingly, also in most countries, these new policies faced strong resistance from public universities' authorities and leaders.

One way of appeasing the opposition was to allow the institutions to decide whether or not to take part in the external assessment procedures. The consequence, however, was that the assessments are applied mostly to the more academically robust part of the countries' higher education system, leaving aside most of the large, demand-driven private sector which is mostly composed of small and very poorly endowed institutions that have mushroomed alongside the public sector in most of Latin America.

"Garage universities," or *universidades patito* are among the nicknames by which this sector is known in the region. These nicknames reflect the contempt and disregard in which these institutions and the quality of education they offer are held by most of society. They may provide access to higher education for many students from poor backgrounds who cannot get access to the most prestigious institutions, but in most

cases, they are only subject to old, bureaucratic licensing procedures before starting to operate. Quality assurance policies, in most countries, do not reach this sector. And even when program accreditation is mandatory, the slow pace of accreditation means that, de facto, the large, demand-driven parts of the countries' higher education remain beyond the reach of the policy.

Brazil, Chile and Ecuador are exceptions to this picture. Brazil applies the most extensive quality assurance procedures in the continent. All bachelor programs are evaluated using information about the senior students' performance in a nationwide examination (ENADE) and about the academic qualifications and type of contract (full time, part time, hourly paid) of the academic staff. These indicators, combined with the information and evaluation provided by the students during the ENADE, are used to produce a course grade. Based on this grade, the course can be subjected to supervising visits organized by the Ministry of Education. From 2007, when all programs were graded for the first time, until the present, the trend has been to diminish the relative weight of the output indicators (ENADE and the student assessment of the course) and increase the relative weight of the data related to the program's inputs (the academic qualifications and conditions of employment). The consequence is that the quality assurance system more closely resembles traditional inspection procedures than modern accreditation procedures that are intended to respect and support the diversity of institutional missions. These input indicators are framed in such a way as to reflect the institutional conditions of the elite public universities, which imposes a strong isomorphic dynamic on the whole system, curbing innovation and making the country's higher education landscape highly conservative (Balbachevsky and Sampaio 2017).

Chile pioneered the development of processes for quality assurance in Latin America and is the most important success story. The national agency for quality assurance (CNA) handles accreditation of institutions approved after the probationary period when they are under the supervision of the National Council of Education (CNED). Accreditation of undergraduate and master's programs is done by private agencies that are authorized and monitored by CNA. While accreditation is facultative, it is mandatory for programs entitled to receive public funds, particularly student loans and fellowships. Since all higher education charges for tuition, accreditation has become almost a universal practice. Also, it is important to note that in this country accreditation follows the principle of institutional autonomy. Institutions are free to define their own mission and the process of accreditation must respect the institution's purposes. In this design, quality assurance procedures feed institutional differentiation and diversity.

In Ecuador, quality assurance has been in place for the last ten years. It was part of a major top-down reform imposed by the government after the election of Rafael Correa as president. The new government adopted a new constitution, followed by an Organic Law of Higher Education, enacted in 2008. The law broke the traditional autonomy of the public universities and imposed top-down decisions requiring them to implement new regulations governing faculty and administration, and to classify themselves as teaching institutions or teaching–research universities. This classification was used for setting up the accreditation procedures. As in other countries,

accreditation is the responsibility of a public agency, CACES, but in Ecuador, CACES can close institutions that do not follow its directives. As in other countries, this policy design reinforces isomorphic dynamics and curbs innovation outside the large public universities.

Despite the limited scope of the quality assurance policies in most countries, accreditation procedures impact Latin American higher education mostly by introducing a culture of self-evaluation associated with permanent efforts to achieve self-improvement. Most important, the entire process of accreditation sustains regional networks of academics interested in the quality of education and exposes programs and departments to a systematic exchange of experiences that contributes to curricular improvements and university planning (Lemaitre 2014).

Finally, it is worth looking at the experience of countries where quality assurance has not been set up. In Uruguay, the need to build a quality assurance system has been on the political agenda since the beginning of the 2000s, but the proposals have never gained enough support. While many course programs at the national university, the Universidad de la República, participate in the regional accreditation regime developed under MERCOSUR (ARCU-SUR program), this experience was not enough to overcome the resistance to a national policy for quality assurance. The university still relies on self-evaluation procedures and the small private sector is contained by strong bureaucratic controls (Landoni 2010).

Bolivia and Venezuela did not develop quality assurance procedures because of their ideological opposition which regards them as part of the neoliberal menu of policies and reforms. The Bolivarian governments have accommodated the demand for access to higher education by building up parallel systems of universities—the Bolivarian Universities in Venezuela, and the Indigenous Universities, under communal control, in Bolivia.

4 Conclusion

This chapter investigated the processes that led to the introduction of quality assurance policies in Latin American higher education through the mechanisms of policy diffusion. Policy models have been disseminated in the region since the 1990s by influential international organizations through reform programs and a well-knit epistemic community of specialists that provided examples for benchmarking in congresses, seminars and official meetings.

In most countries, quality assurance initiatives were part of reforms pushing for a more proactive and leading role for the countries' executive in higher education policies. The introduction of mechanisms for external evaluation reinforced ministerial bureaucracy at the expense of the old mechanisms supporting the traditional autonomy enjoyed by public universities. The way these policies were introduced varied according to local conditions, and they were often grafted onto pre-existing local practices and policies. In most countries, accreditation is limited to the academically best endowed parts of the higher education system. Inside these sectors,

it works as a tool supporting some degree of innovation. However, it has little to say about the huge demand-driven private sector that has grown up in most countries in response to the demand for access to higher education in the region.

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Expanding Access and Improving Equity in Higher Education: The National Systems Perspective

Jorge Balán

Abstract The shift from elite to mass higher education in Latin America has raised a shared concern over the desirable increase in equity brought about by expanded access to distinct types of post-secondary education. A reversal in the trends of economic and social inequality over some 10 to 15 years at the turn of the century lead most countries to support a number of equity policies vis-à-vis higher education. This chapter provides an overview of the conceptual and measurement problems involved in the design of such policies as well as in learning about their results over time. It also reviews different kinds of policies among selected countries in the region: policies promoting further institutional differentiation, those favoring the expansion of publicly supported institutions aiming to serve marginalized sectors, public assistance to students and families to cope with private costs, and affirmative action legislation supporting admission of racial, ethnic or social class groups to higher education institutions or programs. A concluding section briefly discusses the expected consequences of demographic and educational trends, such as a decline in cohort size and increased secondary graduation rates, over the changing higher education policy context.

Keywords Mass higher education · Equity · Affirmative action · Demographic trends in higher education

1 Introduction

As is well known, higher education in Latin America has been transformed during recent decades from an elitist regime serving a small segment of the population in the big cities to a massive one, where the opportunities to continue studies are open

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in principle to all students who have completed secondary education. The most visible aspect of the change is the accelerated growth in absolute student numbers and their relative weight within the corresponding age group. The transition from one regime to the other, however, goes far beyond an accentuated increase in enrollment. In his classic work on transition phases published 40 years ago, recently revised and expanded, Martin Trow defined the elite regime as one aimed at shaping the mentality and character of the ruling classes, while a massive regime seeks the transmission of skills and preparation for a greater range of managerial functions in the fields of technology and economics (Trow 2006), suggesting that transition from one to the other occurs when student enrollment exceeds 15% of the population in the corresponding age range. Along with a wider range of functions, massification entails substantial modifications in student career, curricular content, typical forms of instruction, the number and heterogeneity of institutions of higher education, as well as the governance of national institutions and systems. Student access and selection, although based on a renewed notion of academic merit, are transformed into a massive regime through compensatory programs and institutional and systemic policies aimed at addressing the greater diversity of students and their previous education and expectations, as well as improving equal opportunities to successfully continue their studies.

Paradoxically, massification shifts the political concern for equity from its previous focus, centered on the academic or vocational nature of secondary studies, to equity in access to higher education. The distances between groups and social classes initially become greater with massification: the first to take advantage of the opening of new opportunities for post-secondary study are students from relatively advantaged social sectors, in particular the new urban middle class that aspires to have their children continue their education beyond high school and now faces fewer barriers than before to the satisfaction of that desire.

During the last two or three decades, most governments in Latin America have promoted broader policies for access to higher education, adopting compensatory policies explicitly aimed at achieving greater equity among social sectors—identified either by their location, family income or educational background, gender, ethnic or racial identification—whose educational backwardness results from social barriers or historical discrimination, often organized sectors that seek to improve their representation in privileged positions in the economy and politics and fight for a fairer distribution of public resources invested in education (Flores et al. 2010).

However, while there is broad consensus among families, employers and governments on the need to expand access, the goal of greater equity is not as clear or consensual. It is often erroneously assumed that the expansion of enrollment must necessarily reflect reduced social inequality, benefiting more those who have less. It is also common to think that, if differences persist, it is the exclusive result of the distinction in academic merit: the most qualified enter and advance, regardless of their origin, no matter how much there is a correlation. These statements, however, are confronted with different ideas about the nature of academic merit and its measurement.

Latin American experiences differ little in these areas from those of the rich countries from the end of World War II until the 1970s, the United States and Canada, and shortly thereafter Western Europe, Japan and Australia, although those may anticipate the notion of access to higher education as a universalized right (Clancy and Goastellec 2007; Douglass 2005). The main difference in Latin America has been the relatively greater economic and social inequality in the region, as revealed by the inequitable distribution of family income and cultural assets, particularly formal education, compared to other richer regions and even to East Asian countries with similar per-capita incomes (De Ferranti et al. 2003). Recent studies clearly show the relative delay in the universalization of compulsory schooling, in permanence and graduation rates, and in particular in the conditions that ensure minimum quality standards for all in learning at different levels. They clearly show the negative effects of greater economic inequality and the low quality of public education: the vast majority of children in rural areas and among poor urban sectors tend to enrol without making much progress in the expected learning, with high rates of repetition and abandonment, while children from privileged families benefit from better-quality public and/or private education as well as from the favorable characteristics of the family environment. Something similar happens with the extension of compulsory schooling to the first years of secondary education. One of the factors at play has historically been low public investment in education, as a result of economic backwardness but also of political reluctance to raise the tax burden in order to invest it in financing schooling for lagging sectors of the child population (Engerman et al. 2002; Wegenast 2010). In addition to the low investment in relation to per-capita domestic product, there was a clear bias in Latin America in favor of spending on higher education in relation to basic education, as has been documented by technicians from international organizations (Birdsall 1999; Birdsall et al. 1995) and demonstrated in the historical analysis of public spending on education during the last century (Frankema 2009; Lindert 2010).

But will these trends have changed in the new context of economic and educational policies in the region?

2 The New Context of Access and Equity Policies in Higher Education

Educational inequality, as we all know, is intimately linked to economic and social inequality. Both tended to increase in the second half of the last century in Latin America, especially in the years when the region as a whole was confronted with the strong technological and productive transformations associated with the great expansion of global markets from the 1970s onwards. However, to the surprise of many and for no doubt very complex reasons, these intimately associated trends have been markedly reversed throughout most of the continent since the mid-1990s and during the first decade of the new millennium. Recent studies tell us that the

improvement in income distribution has been quite generalized in the region, affecting countries with both high and low relative inequality, those that grew rapidly as well as others with slower growth or that came out of strong economic crises, benefiting countries governed by political parties and leaders of diverse ideologies and with contrasting social policies (López-Calva and Lustig 2010). The phenomenon is complex and challenging for anyone who is encouraged to offer generalizations. There are, however, some common points that are particularly relevant to our topic today.

The first has to do with changes in the workforce (Cruces et al. 2014). The proportion of adults participating in the labor force (in particular, the number of women working) has greatly increased, the employment of these adults in the formal sector of the economy has tended to increase and in recent years wage differences between different categories of workers' qualifications have decreased, although they continue to be very marked given the strong polarization of previous years. The second has to do with expansion and improvement in the distribution of educational opportunities (Manacorda et al. 2010). The average number of years of study tended to increase more markedly in the lowest quintile than in the highest, in many cases decreasing the absolute difference in years of study between the most and least advantaged sectors. These two trends are clearly linked. Let us consider two examples from the most populous countries in the region.

In Brazil, the decrease in economic inequality resulted mainly from lower inequality in the distribution of labor income per worker. The wage gap between educational levels tended to decrease as a result of the smaller educational differences as well as the drop in individual returns to education. The enormous expansion of educational opportunities since the mid-1990s was the main driver of this change. The country practically doubled the proportion of gross domestic product devoted to educational investment, and we will return to that later, concentrating in particular on compulsory basic education. In addition, there is a massive program of transfers to low-income families conditional on school attendance by children of compulsory school age, known as the "family scholarship" (*bolsa família*).

Something similar happened in Mexico. Income inequality has declined since the mid-1990s, and incomes in the lowest quintile increased twice as much as the top 10% between 1996 and 2006. While until 1994 returns to education were a factor bringing greater inequality, the opposite has occurred in the next ten years as educational capital became better distributed (Esquivel et al. 2010). The decline in the number of lower-educated workers is associated with a relative increase in their wages (and perhaps with increased demand for low-skilled workers). Inequality in the number of years in school clearly decreased between 1994 and 2006, as a result of the increase in educational spending and the program of transfers conditional on the schooling of children (*Progresa/Oportunidades*). The traditional bias in favor of per-student spending on higher education compared to spending on primary education was also reversed, from 12:1 in the 1980s to 6:1 at the beginning of this century, with total education spending, traditionally regressive, tending to be slightly positive today.

What have been the specific differences in access to higher education? Here it will be worth comparing trends in secondary education with those in higher education, since in the medium term the improvement of opportunities in higher education depends to a large extent on changes in access and graduation to the previous level. All the countries in the region for which reliable information is available showed a significant increase in secondary enrollment, in some cases close to or greater than 30 percentage points of difference in two decades. If we look at the change in the distance between income quintiles, we find that in eleven of the sixteen countries included the distance shortened, as is notorious in the case of Mexico, indicating that much of the growth took place in the low- and middle-income quintiles. An analysis by decade shows that this change took place especially in the last decade, since in many cases the distance was still growing in the 1990s. On average, the distance grew by 3 points in that decade and decreased by 8 points in the next.

Equally interesting are the changes in higher education in the same set of countries. In all of them, the rate of participation in higher education grew, sometimes 20 or more percentage points, in the last twenty years (the average for the region is 9 points), but although this increase occurred in the two decades almost equally, the distance between income quintiles also tended to grow much in the 1990s but stabilized in the following decade, with noticeable differences between countries. However, the gap between quintiles despite the growth in enrollment has increased markedly in very different countries, such as Brazil and Uruguay. These results are at first sight surprising, but perhaps a close look at higher education policies from the perspective of equity of access will give us some clues on the subject. Before discussing in more detail four areas of redistributive policies in higher education, it will be convenient to dwell a little on some conceptual and measurement problems of access and equity in higher education.

3 Access and Equity in Higher Education: Concepts and Measurement

Expanding access at a particular educational level is a response to an unsatisfied social demand that motivates institutions to offer programs at that level or the government to regulate them to introduce reforms, or create new institutions or programs facilitating the participation of categories of potential users whose special characteristics make their participation less likely. These characteristics can be very diverse, and include distance from the nearest offerings, the direct or indirect cost of education (fees, books, personal support, opportunity costs), the nature and orientation of the programs and their class schedules, entry requirements (including the bias implicit in evaluations of the candidate's merits), and so on. But in any case, the expansion of access is aimed at increasing educational participation in general or among a certain category of users (poor, handicapped, people who work) who nevertheless meet

certain basic requirements that are not intended to be altered (the ability to follow the courses offered and to benefit from them).

There is an important distinction between access to compulsory education—the age group or the minimum level of education required—where the demand is tied by a double legal obligation (families must ensure that children attend the service and the state is obliged to provide it), and access to education beyond that range, as is the case with higher education, where family obligations disappear and those of the state are substantially modified. Some constitutions ensure the right to education, or even oblige the state to provide it free of charge, at all levels. But this is in fact a contentious issue in education policies that concern public institutions and the regulation of the private market in higher education. Broadening access and participation translates into questions about the allocation of resources to different levels and types of public institutions, direct or indirect subsidies to the private sector and students, and admissions criteria and the degree of selectivity in higher education courses and institutions where demand for candidates exceeds supply.

Participation is often operationally defined as the enrollment rate: what proportion of the population of study age is actually enrolled in a post-secondary course? But there are different ways of conceptualizing participation (Clancy and Goastellec 2007).

The first, perhaps most univocal, is the initial enrollment of high school graduates: what proportion continue their studies within a reasonable period after graduation? For this we need to know the number of new enrollments (and if possible, by age) and the number of new high school graduates.

The second approach takes the evolution of the total number of students enrolled in a given period and divides it by the population in a certain age range. This is a gross enrollment rate. A net rate, no doubt preferable, takes enrollees within the same age range. This range, moreover, varies between countries, but is conventionally accepted for comparative purposes, e.g., enrolled between 18 and 24 years of age on the population of that age (assuming that the vast majority of those enrolled are part of that population and not students coming from abroad).

The third approach emphasizes results, particularly graduation rates: how many students graduate each year as a proportion of all those enrolled a number of years earlier? Unfortunately, administrative data for this purpose are seldom available in the region. Ideally institutions should collect sequential information by cohort, measuring how many students enrolled at the same time do graduate, and when. In practice, we are limited to estimating graduation rates as a proportion of graduates over enrolled students in a given year.

In theory it is necessary to consider these three approaches together. In practice, in Latin America we rarely have reliable administrative information, provided by the institutions themselves, on applications for admission, new and old enrollments, progress in studies, and graduation by income cohort. Governments have sometimes resorted to university censuses, but in recent years the most useful source has been the large-scale household surveys that are conducted periodically in most countries and that include information about schooling, previous studies and grades obtained from members of the household unit.

The literature on equity in education tends to distinguish two different objectives of equity policies. On the one hand, governments recognize—from the origins of compulsory education legislation—the role that formal education plays in the processes of inclusion and effective participation in society, the economy and politics. From this perspective, equity is often identified with the guarantee of a minimum level of quality schooling that individuals must have in order to participate effectively in modern society, whether as citizens, workers or voters. This minimum has increased over time, while the skills, abilities and knowledge that schooling should facilitate have been more clearly defined. On the other hand, governments also consider the problem from the point of view of fairness in the use and distribution of public resources, ensuring in this case that a greater proportion of subsidies are received by those who need them most and whose compulsory education, to be of comparable quality, is notoriously more expensive (e.g., rural students or students from families with little capacity to assist their children with schooling).

In the case of higher education—outside the cycle of compulsory schooling—the inclusive or participatory dimension of equity refers to the pressure to increase the representation of disadvantaged groups (whatever their definition, usually in terms of family income, geographical location, ethnic/racial origin, sometimes clearly identifiable by the population) in higher education and through them in the most privileged positions in the national economy and society. On the other hand, the criterion of improving educational distribution—and hence the distribution of positions of power and prestige—is sometimes upheld in order to resemble the distribution of persons in national society (that is, equal representation by gender, social origin, ethnic or regional group) by offering them equal opportunities. These two criteria, as recently shown by Marginson, sometimes produce different results, since it is easier to increase the relative participation of a certain group or social category than to radically improve the distribution of opportunities, which necessarily means displacing some in favor of others. In other words, while increased participation undoubtedly requires focused additional resources and a change in merit criteria for admission, distributive changes are more clearly a zero-sum game (Marginson 2011; Mountford-Zimdars and Sabbagh 2013).

In practice, again, policies (as well as academic analyses) focus on changes in the level of participation of certain groups identifiable as priorities in the national context. Sometimes the identification criteria overlap widely, others conflict. No doubt the two main dimensions in higher education today are family income and ethnic or racial identity, whereas in the past regional (or rural/urban) location and gender prevailed, since until recently female representation in higher education was very low in most countries.

4 Access Policies with Equity: Recent Areas of Government Action

In this section we will describe selected different forms of recent government action in some Latin American countries whose objectives include, as a priority, the expansion of access and the improvement of equity in higher education.

Some of these areas attack the problem from the point of view of educational provision, particularly by expanding public provision to, among other things, make it more accessible to lower-income sectors and those located in regions where coverage is lower and private provision cannot be expected to expand. We also include here the encouragement of shorter-term or vocationally oriented programs offered in such a way that they can be taken advantage of by working students, and we pay attention to the creation of new institutions, or reforms of others that already existed, to adapt them to the needs of historically neglected groups (such as the indigenous population) or to the demands of the local economy.

Other policies are aimed at subsidizing demand from social sectors that find their access restricted by costs that are high in relation to family income, or through the development of programs that facilitate entry to higher education by traditionally excluded sectors, such as the population of African or indigenous origin in Latin America. Sometimes the two sides come together, as is the case with subsidies aimed at facilitating access for the aforementioned groups.

In a somewhat arbitrary way, then, in the following paragraphs we will consider four preferential areas that address the problem from the perspective of either educational supply or demand: policies of differentiation of institutional supply, and programs and the expansion of the public sector in previously undersupplied areas, on the one hand; and scholarships, and educational credit and affirmative actions, on the other.

4.1 Differentiation Policies in Higher Education and Their Results

Program and institutional differentiation policies have become a priority in the region since the 1980s, often inspired by reform experiences in the United States and Canada (such as that formalized in California in 1960) and in Western Europe where binary systems were popularized under different names. Many countries developed legal frameworks to distinguish between the university sector and another sector, sometimes called tertiary or non-university, in higher education. According to Brunner and Hurtado, the distinction retains the status of most prestigious universities, resulting in a greater degree of autonomy to establish their forms of government and the design of their academic programs, in contrast to institutions that do not enjoy the same privileges. Universities offer longer-term academic programs across a wide range of disciplines, with an emphasis on theoretical training and research work,

supporting specialized institutes and centers, while developing extension programs. In contrast, the non-university sector typically offers vocational or professional programs that, although involving practices, do not necessarily train in research or have the capacity to do so. Another significant difference is in post-graduate training, especially at the highest level of doctorate or post-doctorate, typical of universities. In addition, the non-university sector has more flexible rules for the admission of students (most often open admission without prior examination) as well as in the hiring of professors. Many countries restrict the participation of the private sector, particularly the for-profit sector, in universities, while for-profit private institutions tend to predominate in the tertiary sector (Brunner and Ferrada Hurtado 2011).

Differentiation policies, however, have encountered difficulties of various kinds in implementing these distinctions and using them as a useful tool for regulating access and equity: on the one hand, the strong preference of student demand for the traditional careers offered by the university, and limited enrollment in tertiary programs, particularly within the public sector with low fees; on the other hand, institutions tended to run their explicit mission, particularly universities offering a growing number of short and vocational careers, taking advantage of the greater laxity they have to expand their supply. In fact, much of the non-university institutional expansion took place within the private sector, sometimes exclusively, as in Chile. As we will see later, it is only in the last decade that some countries have had an explicit policy of expanding the public sector in the technological field.

Some recent studies clearly show some of the benefits of the differentiation process for access and equity. García de Fanelli and Jacinto (2010) analyzed the results of recent sample household surveys in five Latin American countries varying in per-capita income levels and higher education enrollment rates, to show differences in student recruitment and graduation. Although enrollment in the university sector predominates in all of them, the survey information allowed the authors to analyze enrollment at the program level. The five countries, like the region as a whole (Espinoza 2013), currently have gender parity in enrollment, with slightly higher rates on average among women. This difference in favor of women is marked in the tertiary sector but not in the university sector. Wide socioeconomic disparities in the student body clearly ifavor the middle- and high-income sectors, but they are much smaller in tertiary programs than in university ones. The authors found that the majority of students enrolled in tertiary programs are the first in their families to have the opportunity to pursue higher education, undoubtedly favored by a more flexible admissions policy. Another important difference is in labor market participation: in all cases there is a high proportion of students working, but this is higher in tertiary than in university programs. Despite this, the graduation rate is higher in these programs, especially among low-income students, while in college programs the graduation rate is low (and time to graduation takes longer) for students of different social backgrounds alike. Unemployment rates are equally low among graduates of the two types of programs, while the wage differences, although favorable to university graduates, are not dramatic and may be thought to be due both to the value of their degrees and to other advantages associated with higher selectivity in the university sector.

In short, tertiary programs attract more students from lower socioeconomic backgrounds, make it possible for students to work while studying, graduate them on time in a greater number of cases, and allow for successful entry into the labor market. The real costs of university studies are undoubtedly much higher than those of tertiaries, although their calculation is difficult since universities do not keep precise accounts of the costs of instruction. Paradoxically, the costs of tuition are more often borne by students and their families in the non-university sector than in the university sector, whereas in many countries the free public offer predominates. Implicitly or explicitly, the policy of differentiation has been linked to stimuli for the expansion of the private sector sustained by the payment of students and their families, in such a way that greater accessibility has not necessarily generated a more equitable system: families with higher incomes continue to benefit, at least in many countries, from the university public offer that operates with higher social costs borne by the public purse.

4.2 Recent Expansion of the Public Sector and Access to Marginalized Sectors

Although the private sector has grown rapidly in recent decades, governments have also expanded their offerings in higher education, although generally at a slower pace, among other reasons because of the limited interest of private offerings in covering areas of dispersed or low-income populations. The creation of new institutions or the consolidation of others into larger scale and capacity institutions has also responded in many cases to the objective of achieving greater program differentiation by creating or expanding national systems of universities or technological institutes in areas previously without educational services at this level. In the last two decades, this growth, at least in some countries, has taken a clear redistributive turn as it has been aimed at increasing the coverage available to lower-income sectors. The strategy for this has been its location, close to families and students with lower incomes. Localization is also, at least in some cases, a form of skilled job creation, with considerable pay and benefits, in the same areas, which is why the redistributive strategy includes privileged social (and political) sectors in remote areas that benefit from federal spending. A bird's eye view of some recent national experiences illustrates the range of strategies and possible impacts of public-sector expansion policy on higher education.

During the last decade, the federal government in Brazil implemented an active policy of expanding the public offer within a national plan of restructuring and expansion of federal universities, founding sixteen new public universities (sometimes through the consolidation of pre-existing institutions) and some 200 university campuses. At the same time, the federal government also supported the creation of hundreds of federal institutes of education, science and technology (i.e., tertiary technological institutes) which, together with the expansion of the field covered by

the Open University of Brazil, tended to consolidate the presence of the public sector in the national non-university segment in areas far from large cities (Ministério da Educação 2011). Some states, particularly São Paulo, have also had an aggressive policy of expanding this public segment. It is worth noting, however, the absence of joint projects (federal and state) although collaboration is greater in the case of the so-called community universities, with strong municipal participation. The restrictions posed by federal labor legislation support the uniformity of teaching statutes and personnel throughout the country, with perverse effects on the public costs of expanding the system to remote and/or underdeveloped regions. Critics have also pointed to the tendency to assimilate technology offerings to those of the academic sector, thereby reducing the degree of real differentiation between segments.

The constitution gives the federal government in Brazil a leadership role in higher education. However, some state (provincial) governments increased their activity in this area following similar guidelines, particularly in the expansion of the technology sector. Such is the case of San Pablo, which in 2001 approved a master plan for the public system aimed at doubling enrollment in the following decade. This plan indicated the creation of a new system of institutions with two-year curricula and vocational orientation. This plan was revised in 2005 to strengthen the public system of state technology colleges composed of local or regional institutions with three-year vocational offerings linked to local development needs. The plan explicitly seeks to preserve the mission of the Paulista university system, which is strongly focused on professional training and research in the sciences and humanities (Pedrosa 2010).

The contrast with the case of Mexico is noteworthy. In this country, the expansion of the public sector, initially within the metropolitan area of Mexico City and major cities in the 1980s and outside those urban areas from the following decade followed alternative models to traditional universities. Unlike Brazil, Mexico prioritized technology offerings, increasingly in collaboration between federal and state governments, occasionally with the participation of municipalities and local private sectors. At present, technological higher education in Mexico is organized in four large sub-systems, with different origins and structures, encompassing around 400 institutions in total. One of them, for example, is led by the Instituto Politécnico Nacional—an autonomous public teaching and research institution based in Mexico City—which offers priority undergraduate programs, while other federal and state sub-systems tend to offer shorter programs. Since 2009, the latter have established coordination mechanisms that facilitate the recognition of degrees awarded, student transfer and mobility between and within institutions, and the possibility of shared quality assessment systems (Ruiz-Larraguivel 2011). In this way, federal government policies have allowed the development of an original model of a decentralized public system with opportunities for collaboration between different levels of government, a system that tends to primarily serve areas and social sectors within the national territory far from the large research universities that are strongly concentrated in Mexico City.

Another original experience in Mexico, although of lesser importance, was the development of the so-called multicultural universities, intended to serve primarily, but not exclusively, the indigenous population concentrated in the poorest states of

the country (Schmelkes 2008). Between 2003 and 2008, seven public institutions and two private institutions were founded within this model with the objective of increasing the participation of the population of indigenous origin in higher education, which at the beginning of the century represented about 1% of the total number of students, to reach a figure that is close to the proportion that that population represents within the nation, that is, about 10%. Unlike traditional public offerings, which undoubtedly also serve part of the student population of indigenous origin, multicultural universities have the additional objective of sustaining and promoting the cultural identity of students and thus functioning as a mechanism for inclusion within the national context.

Finally, it is worth mentioning the Argentine case where, despite the continued predominance of federal public institutions within the university offer and very high enrollment rates in higher education in the Latin American context, the federal government faced a new wave of expansion of public offerings in the first decade of this century. Between 2005 and 2010, eleven universities and university institutes were created, all of them with federal contributions, and 145 non-state higher institutes, significantly expanding the presence of public offerings in different areas of the country through the creation of regional centers, sub-sites, extensions and distance education (Brunner and Ferrada Hurtado 2011). The creation of new national universities was driven by local and provincial governments, including five in the Buenos Aires metropolitan area, despite the high density and diversity of existing public offerings and the absence of a national policy for planning the regional distribution of the offer or the impact of new foundations on the public financing of the higher education system. Although since the 1990s a justification for the creation of new institutions was the need to halt the growth of mega universities, particularly Buenos Aires, which tended to absorb new demands in the urban periphery previously repressed by the restrictive policies of the military government, the context differs greatly, with a stagnation of public university enrollment, deteriorating quality, high dropout rates and the business dynamics of private provision in large cities.

4.3 Assistance with Private Costs: Scholarships and Student Loans

The costs of higher education faced by students and their families in relation to family income are much higher in Latin America than in rich countries. As a result, socio- economic differences in access are more pronounced. Social inequality is increased in part by the expansion of the private sector in countries where public institutions charge considerably lower fees than private institutions, as is the case in Mexico and Colombia, which are required by law to provide services free of charge to students, such as Brazil, Argentina and Uruguay. A recent World Bank study estimated the weight of private costs of higher education as a proportion of household income, taking into account not only average fees but also other costs

of education and student maintenance (Murakami and Blom 2008), discounting the benefits obtainable through scholarships and subsidized credits that existed at that time. The authors concluded that the cost borne by families is a greater obstacle to access in countries with student fees, and in all the countries selected for study this obstacle is considerably larger than in the developed countries. They suggest that scaling up student assistance focused on low socioeconomic sectors is a prerequisite for increasing access and equity within national systems. Institutions have a very limited role in this field in Latin America, despite the proportional growth of those that charge fees to students, particularly those in the private sector. Although almost all have some scholarship program or fee waiver, together they do not make a significant difference to the enrollment of low-income students. Student assistance is, by way of rule, the responsibility of national governments, supplemented in some cases (Brazil, Colombia, Mexico) by provincial governments, sometimes operating in association with the institutions that implement it or that receive students whose fees are subsidized by the government. Although there is a long history of loans—the first federal student loan programs were developed in Colombia in the 1950s—loans for tuition (and occasionally for other educational expenses) remains a conflicted issue that has become more visible in the higher education policy landscape over the past few years (Espinoza 2013; Gómez Campo and Celis Giraldo 2009).

In Chile student attendance plays a more prominent role, mainly because student fees are high and generalized within the entire higher education system, where private financing far surpasses public. Between 1990 and 2010 this country developed a great diversity of scholarship and credit programs subsidized by the federal government, with a strong focus on low- and middle-income sectors, representing a significant proportion of public investment in the sector. Jamil Salmi suggests that student credit in Chile is the most effective subsidy within federal spending to redistribute income in favor of low socioeconomic levels (Salmi 2013). The proportion of students from families at these levels has increased significantly in recent decades, but even so the socioeconomic distribution of university students is clearly biased in favor of those from the higher sectors (Espinoza 2008). The debt that students carry after graduation and upon entering the labor market is, on average, very high in relation to income, a hot topic today's political debates in Chile.

Most countries in the region currently have a variety of student credit programs aimed at assisting low-income students with tuition, but with a few exceptions we know little about their coverage and sustainability (Espinoza 2013). Criticism abounds on the basis of very contradictory readings of the largest and best-known experiences in the region, such as those of Chile and Colombia. Such has been the situation in Mexico following the recent announcement of a US$200 million student loan program available to students at private institutions that charge fees and that, according to critics, have high interest rates and restrict the pool of favored private universities, including some profit-oriented universities operated by international corporations, posing a great risk to students as well as a threat to public institutions with low fees (Lloyd 2012).

Brazil has recently developed an original and ambitious set of federal programs in the region, although there are contradictory reports as to their true scope and

weight within tuition funding. One of them, PROUNI, grants tax subsidies to private institutions that admit low-income students from public secondary schools, offering full or half refund on enrollment (according to income), to students achieving an acceptable pass in the tests at the end of secondary school and fulfilling the family income requirements. Another program gives access to subsidized loans to all low-income students who enroll in private institutions, generally covering only the cost of tuition but not other private expenses. As is often the case, the subsidy is higher in the long run when the inflation rate tends to rise, but this undoubtedly erodes the sustainability of loan programs (Shen and Ziderman 2009).

4.4 Affirmative Actions: Race, Ethnicity, Social Class

This picture would be incomplete without a discussion, albeit a simplified one, of institutional and government programs aimed at facilitating the admission of students on the basis of their ethnic or racial identity (sometimes in combination with their class membership), programs that are often combined with other measures already mentioned (targeted institutions, scholarships and conditional credits). This topic encompasses a great diversity of actions, sometimes called "affirmative" and sometimes known by other names, implemented at all decision levels but rarely in a coordinated manner (Díaz-Romero 2006a, b).

Affirmative action is traditionally understood as a set of anti-discrimination measures aimed at facilitating access to privileged positions for groups that would otherwise be severely under-represented. They are, in short, mechanisms for tackling social exclusion and disaggregating ruling elites (Darity et al. 2011), either through a system of preferential treatment or the application of quotas for identifiable segments of the population of origin. The formulation of these policies always responds to national conditioning factors and meanings that have different historical roots in each case. In Latin America the use of the term is recent and is applied almost exclusively to higher education (although it is also worth mentioning the use of quotas in gender representation in some parliaments).

The most notable recent experience is that of Brazil which, over a period of only two decades, changed from a system of "universal rights" that practically ignored differences of gender, ethnicity, race or social class in access to higher education to another of national policies. This was ratified by the Supreme Court in 2012 when it affirmed the constitutionality of the national law on social quotas that orders federal universities to reserve 50% of their future vacancies for students who graduate from public secondary schools (Lima 2011).

Affirmative action in higher education has also penetrated other countries, including some experiences of the 1980s, such as those of Colombia. In that country, for example, the federal student credit fund, ICETEX, initiated a scholarship program in 1988 to support the admission of indigenous students, followed in 1996 by a similar one for students of African origin, while several public and private institutions established admissions systems to promote the incorporation of students from those

two groups, although rarely with financial assistance or targeted services (León and Holguín 2004). But in Colombia, as in many other countries in the region, affirmative action focused more successfully on socioeconomic categories than on race or ethnicity, except in specific programs associated with some North American foundations (Didou Aupetit and Remedi Allione 2009).

5 Outstanding Issues on the Policy Agenda

The demographic and secondary education changes expected in the next decade offer special opportunities for the development of access and equity policies. On the one hand, new cohorts of high school graduates will be affected by the decline in cohort size. On the other hand, it is to be expected that graduation rates will increase, particularly among students of lower socioeconomic levels, as may already be noted today in some countries. This will result in significant changes in student demand for post-secondary studies and increasing pressure on institutions and governments to develop policies that favor not only the admission of more diverse students but, above all, that focus on their social, cultural and educational characteristics, which differ from those of traditional students, as well as on their career aspirations. The policies required greater coordination of efforts at different levels (program, institution, region, local and national governments), each according to its own responsibilities. They also call for greater articulation between secondary school and the various options open in higher education. The results of these measures can be seen in increased retention and graduation of these students, which tends to be very low in the region.

A particular element of this new equation is financial assistance to students. Beyond the long-standing debate about the advantages and disadvantages of charging fees in the public sector or the responsibilities of the private sector, institutions and governments must take into account the weight of other expenses incurred by families and students and their impact on studies. Living costs, but in particular opportunity costs when students do not work, or their counterpart, the large number of students who do work, have precise and important implications for educational progress and demand the attention of administrators and politicians. For example, the need to expand course schedules to serve working students or to adapt the career structure to students who take a smaller burden of courses has already been established, but little progress has been made in adapting more comprehensively to new student demands, in particular curricular reforms.

Finally, it is worth stressing once again the problem represented by the scarce or sometimes altogether absent articulation between the different institutional offers. Typically, it is impossible for students to transfer between institutions and to recognize studies in different segments. In particular, the lack of articulation between tertiary or technological careers and university careers has negative effects on equity since it limits the progress of students who begin and often successfully complete their studies in the tertiary segment, but to whom opportunities to continue them at higher or specialized levels are closed.

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Privatization of Higher Education in Brazil: Old and New Issues

Helena Sampaio

Abstract The chapter addresses two aspects of the process of commodification and privatization of higher education in Brazil: the emergence of new providers and public funding for students in the private sector. Two peculiarities distinguish this process in Brazil from other countries: a legal framework that has been under construction since the 1960s, which not only allowed the private sector to grow, but, more recently, opened the way for the emergence of a large for-profit sector; and the predominance since the 1970s of private over public enrollments. The hypothesis is that the advance of privatization and commodification of higher education in Brazil is a function of the structural and normative conditions intrinsic to the development of the country, which, in turn, reveal the correlation of forces among different actors participating in the formulation and implementation of higher education policies since the middle of the last century. The study is based on statistical data, official documents and interviews with private providers.

Keywords Higher education · Privatization · Brazil · Public financing · Private providers

A common feature of several national systems of higher education today is the increase in the number of institutions, courses and vacancies to meet the growing number of people aspiring to this level of education. Systems become larger and more complex, but not at the same time or in the same way. In most countries the expansion of higher education enrollment only gained traction at the end of the last century. This occurred thanks to the gradual expansion, at least 50 years ago, of basic education, with the universalization, or near universalization, of primary and later the expansion of secondary education (Altbach 2007). Thus, at the beginning of the twentieth century, worldwide there were only 500,000 university students; by 2000, there were already 100 million, about 20% of the world cohort of young people between 18 and 24 years of age (Clancy et al. 2007).

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The expansion of higher education is a general phenomenon, but is occurring at different paces,[1] and it has local colors: each country responds to the continuous growth of demand for higher education in its own way, according to its specific trajectories and the relationship higher education has had with the state and the market. This demand can be demographic, repressed or a combination of both. The demographic demand, coming from the 18–24 cohort, is expressed in net enrollment rates. The total demand, expressed in gross rates, is composed of this cohort and older people who make up the repressed demand—older people who, motivated by the prospect of social mobility gained from a university degree, or just in search of personal fulfillment, resume their studies and increase the demand for higher education.[2]

In some countries, the expansion of higher education has led to profound changes in provision;[3] in others, there has simply been an increase in the number of places, course programs and institutions. In countries where expansion occurred more recently—between the end of the twentieth and the beginning of the twenty-first century—it took place mostly through an increase in private provision, both in places where enrolment was, until recently, predominantly public and where the private sector was already large.[4]

The expansion of private higher education is a response to a set of factors that are common to several countries, but are handled differently in each context (Brunner and Uribe 2007; Schwartzman 2015). The first factor is a continuous growth of demand exceeding the capacity for public funding; the second, the difficulty for public institutions to respond quickly to market demands, i.e., to train people with specific required professional qualifications. This difficulty opens space for the market to organize itself to meet its needs in specific areas such as administration, paramedics, communication and others. The third factor is associated with the emergence of the "knowledge industry," a new business sector geared to the provision of education

[1]The United States pioneered the massive expansion of higher education, beginning in the middle of the last century. Countries that only later urbanized and industrialized did not begin to feel the pressure until the beginning of the twenty-first century. The styles and models of expansion adopted in each country are related to the different standing of their higher education system in the worldwide rankings of academic excellence.

[2]The growth in repressed demand explains, for instance, the growth in enrollment rates even in countries where distortions in educational flows and the narrowing of secondary education usually slow down the rise in the net rate of access to higher education. For the analysis of this phenomenon in Brazil, see de Andrade (2015) and Corbucci (2014).

[3]Teichler compares the changes in the structure of higher education in some Western industrialized countries from the 1950s, showing how they sought to solve the organizational problems of their respective systems (Teichler 1988). Based on the analysis of the policies and structural changes that took place, the author systematizes the main structural models and patterns found in the different systems since then. For the changes in United States, see Geiger (1985).

[4]Both modalities exist in Latin America. Mexico and Argentina are example of systems that remained mostly public; In Chile, Colombia and Brazil, the private sector, including the religious universities, was always more significant. In all countries the private sector expanded significantly in the twenty-first century (Altbach 1999; Altbach and Levy 2005; Kent and Ramírez 1999; Levy 1986; Levy 1999; Sampaio 2014; Schwartzman et al. 2015).

services. The need to adjust supply to demand is not new, but has become much more complex recently (Hunt et al. 2016).

1 The Expansion of Private Higher Education in Brazil

In the last decade, the number of students in higher education in Brazil has tripled to around eight million. The private sector, which was already dominant, has increased its participation and now accounts for 85% of institutions and 73% of enrollments (INEP 2019a). The hypothesis is that this expansion of privatization and commodification is a function of the structural and normative conditions intrinsic to the development of the country, which, in turn, reveal the correlation of forces among different actors participating in the formulation and implementation of higher education policies since the middle of the last century.

Privatization and commodification are different things, even though they often appear together. Many of the main American universities, such as Harvard, Stanford and Yale, as well as the Brazilian Catholic universities, are legally private and charge tuition fees, but are not guided by the logic of profit in the same way as companies that operate in the educational market, such as Estácio or Kroton in Brazil. Here, I am using the broad concept of privatization adopted by Brunner and Uribe to describe the trend of higher education to be driven by market forces, which is different from place to place (Brunner and Uribe 2007). The way this trend operates varies according to the maturity of the higher education sector, government policies and the strategies adopted by the institutions to respond to market and quasi-market incentives, such as external assessments and performance based public support to students. The processes of privatization range from the creation of markets for higher education to changes in specific aspects of the public/private balance such as the collection of tuition fees, the financing and management of universities and the emergence of private for-profit institutions. Commodification occurs at two levels: that of enrollment, i.e., the proportion of students in the public and private sectors; and that of the resources used to finance institutions, i.e., the proportion of public and private expenditures in the higher education sector.

Two specific characteristics of privatization in Brazil are the *emergence of new providers* and the *public financing of students* enrolled in private institutions. New providers are private for-profit entities working in local, regional and global higher education markets.[5] In this chapter, I show how these new providers—not necessarily

[5]The notion of a global market for higher education relates to the General Agreement on Trade in Services (GATS), set up by the World Trade Organization, which considers education as a service sector and promotes its liberalization. GATS describes educational service or trade (without ever using these terms) in four ways: (a) supply without crossing frontiers—when it does not imply physical change on the part of the consumer or the service provider, such as distance education and e-learning; (b) consumption abroad—when the consumer moves to the country of the service provider where the student will carry out partial or full training; (c) commercial presence—when the service provider establishes commercial facilities in another country (in higher education, it

either new or foreign—are appearing and operating in Brazil. I argue that internal factors have made Brazil a very receptive host for these providers, who have given it specific dynamic characteristics.

Another manifestation of processes of marketization of higher education is the public financing of the clientele. According to Brunner and Uribe (2007), this is part of a mechanism through which the state shifts the financing from institutions—public or semi-public, charging for tuition or not—to students. The effect is to make the institutions compete for students who may be subsidized, instead of competing directly for public support. This has been the case since the reforms of the 1990s in Chile, where a significant part of public and private institutions' resources comes from the students they are able to recruit. In Brazil, public higher education institutions are directly subsidized by the government, but, like the United States, there is a large system of student fellowships and loans for students attending private institutions.

Brazil has two main federal programs that subsidize students attending face-to-face private institutions: the University for All Program (Prouni), which grants tax exemptions to private institutions in exchange for scholarships, and the Student Financing Program (Fies), which provides student loans guaranteed by the government. Since the implementation of these programs in the second half of the 2000s, the state has heavily financed the private sector, reaching about one-third of the students. Before, only non-profit (community based, charitable and religious) institutions could have access to regular public resources through tax exemption (Decree 2306 of 1997). Although there was an educational credit program, its operation was very restricted and its proportion of the system insignificant (Sampaio 2000).

2 The Public/Private Relationship

One of the effects of the first expansion of higher education in Brazil, which began in the late 1960s and continued until 1980, was to establish a relationship of complementarity, rather than parallelism, between the public and private sectors (Geiger

means the presence of campuses and franchises of education companies in other countries); and (d) presence of natural persons—when people go from one country to another to provide a service, which in the case of higher education corresponds to the transit of teachers and researchers. The impact of an international higher education trade regulation is still being discussed and evaluated, and the involvement of the education sector has been slow, albeit growing, with more stakeholder groups debating (and speculating) about possible opportunities, benefits and risks of increased trade liberalization. In this chapter, we deal with the presence of foreign providers in Brazil, working on a commercial basis, and not with the eventual displacement of academics and students. For a detailed analysis of GATS, see Knight (2006).

1986; Sampaio 2000).[6] In those years, in the wake of industrialization and urbanization, the demand for higher education grew and diversified. A larger contingent of young men and women and older people, pressured by the demands of the labor market or in search of personal fulfillment, began to demand higher education, but the supply was still small and insufficient to meet this increased demand, creating a political problem with the surplus applicants who qualified but could not find a place to study. The higher education system needed to grow and modernize, and this was enabled by the legal framework of the 1961 Education Law (*Lei de Diretrizes e Bases da Educação*) and the 1968 university reform legislation. The first recognized the existence of non-university, teaching-only higher education schools, and favored their growth, even if subject to some flexible regulation mechanisms. The 1968 reform moved in the opposite direction, requiring that all higher education institutions should conform to the Humboldtian model of inseparability of teaching, research and extension, which is still in force today as an ideal of higher education for Brazil (Balbachevsky et al. 2019).

In this scenario, while the private sector expanded through the creation of isolated institutions and an increased number of vacancies and courses/careers, the public sector, formed almost exclusively of universities, invested in research structures and post-graduate regulation and support (Sampaio and Klein 1994). It did not take long for the agile private sector, mobilizing its own resources and indifferent to the Humboldtian model, to meet the demand for higher education, and it soon overtook the public sector in number of students, institutions and courses. Between 1960 and 1980, the number of higher education enrollments in Brazil rose from 200,000 to 1.4 million, an increase of about 500%; in the private sector, growth was over 800%.

Figures 1 and 2 illustrate the evolution of enrollments and public and private institutions over the past 40 years. They show, first, the contrasting behavior of the public and private sectors in the 1970s; second, the stagnation throughout the 1980s; and third, the recovery of growth in each sector—the 1990s and the first half of the 2000s for the private, and the second half of the 2000s for the public sector. The stagnation of the 1980s was part of a broader scenario of economic stagnation that occurred in the country after twenty years of military rule, which also limited access and graduation rates in primary and secondary education. It was only at the end of the 1990s that Brazil achieved full enrollment of children in primary education, but its quality remains critical. The stabilization in the growth of private institutions since 2005, while enrollments continued to expand, reflects the rapid process of consolidation of the private sector into large teaching conglomerates.

[6]Geiger uses the notion of parallel sectors to refer to systems in which the public and private sectors differ little on the proportion of enrollments and institutions, academic prestige and sources of funding. Institutions in both sectors tend to perform similar functions and depend on constant public resources for their maintenance. Examples are Chile and Belgium, which have had in common a strong presence of Catholic universities since their origins. In Brazil, until the expansion of the 1970s, the public and private sectors were equivalent in terms of size and prestige. All private institutions were considered philanthropic and were tax exempt. In addition, some Catholic universities, such as that of Rio de Janeiro, had access to public resources for research and post-graduate activities.

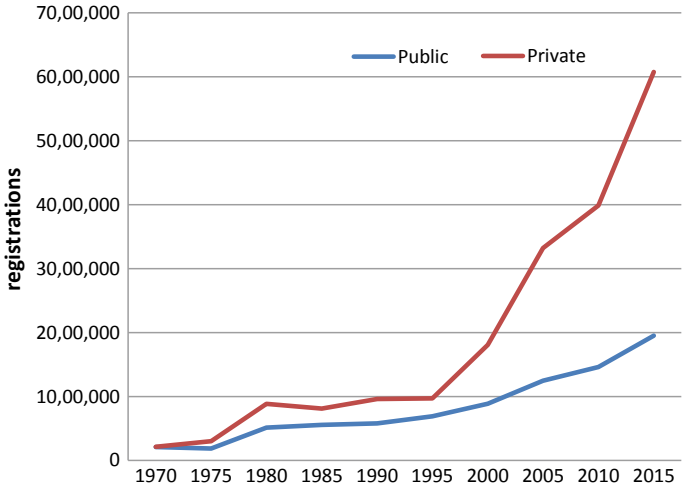

Fig. 1 Higher education enrollments in Brazil, 1970–2015. *Sources* INEP (1998) and INEP, *Sinopses Estatísticas da Educação Superior* for 1975, 2000, 2005, 2010 and 2015 (INEP 2019b)

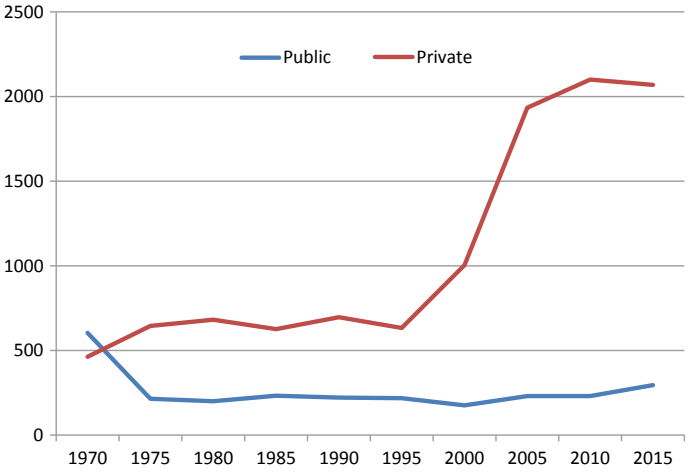

Fig. 2 Number of higher education institutions in Brazil, 1970–2015. *Sources* INEP (1998) and INEP, *Sinopses Estatísticas da Educação Superior* for 1975, 2000, 2005, 2010 and 2015 (INEP 2019b)

The different trajectories in the public and private sectors, derived to a large extent from the legislation, have resulted in profound differences in such matters as funding, cost to the students, academic organization, geographical distribution, access mechanisms, academic recognition, areas of concentration of courses, student profiles, degrees awarded and faculty work regime.

3 The Impact of Recent Legislation: The 1988 Constitution and Federal Decree 2306 of 1997

The 1988 Constitution enhanced the principle of university autonomy, which meant, among other things, that the universities did not need prior authorization from the then Federal Council of Education to create, eliminate or relocate course programs and increase or reduce offerings in their headquarters. One requirement for a private institution to become a university was that it must offer a variety of professional and post-graduate course programs. In 1997, a presidential decree established that "university centers," institutions providing undergraduate education in various careers, could be granted the same autonomy to create courses and admit students as the universities, without being required to do research and post-graduate education. This led many private institutions to seek university status, in a process of business consolidation through mergers and acquisitions. In 1980, there were 20 private universities and nineteen university centers; in 1990, 40 and 74; and in 2000, 86 and 134. To attract more students, the private institutions increased their offerings in less developed regions—northern, north-east and mid-west states—and in smaller towns in the more saturated south-east and southern states.

They also expanded by offering course programs in new careers, by breaking down some of the existing specialized sub-fields, at BA level and increasingly in vocational, shorter careers ("technological" in Brazilian terminology). Examples include international commerce, gastronomy, commercial management, logistics and marketing in administration, and product design, interior design, digital games and computer networks in technological areas. By 2015, enrollment in vocational education in the private sector was 22.2%, against only 7.4% in the public sector (INEP 2019b).

In 1997, in a watershed legal provision, Presidential Decree 2306 allowed private higher education institutions to become for profit if they wished, a move that continues to raise a great deal of controversy (Sampaio 2014). Until then, all private institutions were considered non-profit and enjoyed tax exemption, even if, in practice, many of them had profit objectives, obtained through subterfuges such as high salaries for top executives and payments for real estate, equipment and services provided by the maintaining institutions. It was expected that under the new legislation the government would apply stricter certification criteria to the non-profit status of philanthropic, community-based and religious institutions, which would retain the benefits of tax exemption and be able to receive subsidies in specific cases, leaving other institutions subject to the normal commercial legal regime. Holders of profit-making entities agree that by turning higher education institutions into commodities that could be bought or sold, the decree allowed them to grow exponentially. By 2017, of 2,448 higher education institutions, 88% had become private and, of these, about half were for profit. In fact, many of the individual private institutions that appear in the higher education census are owned by the same controlling company (or "maintainer"), meaning that ownership is much more concentrated than it seems.

4 Expansion and Distribution of Careers

The expansion of private higher education in the 1970s in Brazil included a few careers, such as education and the applied social sciences including pedagogy, administration, accountancy and law. Twenty years later, health and social welfare was added, with the creation of careers such as music therapy, occupational therapy and psychomotricity in addition to those derived from the fragmentation of established careers in administration and social communication. Table 1 gives the distribution of enrollments by field according to UNESCO's international classification and institutional ownership.

Table 1 Enrollments in higher education by field and institutional ownership, Brazil, 2017

	Federal (%)	State (%)	Municipal (%)	Private, for profit (%)	Private, not for profit (%)	Total (%)	Enrollments
Arts, humanities and education	30.8	40.0	14.1	19.3	15.0	21.5	1,813,851
Social sciences, journalism and information	6.7	4.4	6.2	4.4	6.4	5.3	445,704
Business, administration and law	11.9	16.8	32.9	37.0	35.1	31.0	2,609,486
Natural sciences, mathematics and statistics	5.9	2.6	0.3	0.3	0.7	1.4	119,821
Computer sciences and information and communication technologies	5.1	5.7	2.8	3.6	3.6	4.0	333,997
Engineering, production and construction	19.0	15.7	12.6	11.6	14.8	13.9	1,170,673
Agriculture, forestry, fisheries and veterinary science	7.2	4.6	5.4	1.6	2.9	3.1	259,399
Health and wellbeing	11.8	9.1	25.0	19.9	20.1	17.9	1,505,856
Services	1.6	1.1	0.7	2.3	1.4	1.9	158,283
Total %	15.4	7.8	0.8	50.4	25.6	100.0	8,417,070
Enrollments	1,299,165	652,478	66,593	4,241,249	2,157,585	8,417,070	

Source INEP, Censo da Educação Superior, 2018

Table 1 shows that the private, for-profit sector absorbs about 50% of the total enrollment, with a strong emphasis on education, business administration and health. Compared with the private sector, public institutions give more emphasis to the arts and humanities, while the private sector gives more emphasis to business and health. Federal and state universities, both public, are similar, except that state universities give more emphasis to education. Almost 80% of enrollments in natural sciences, mathematics and statistics, and 47% in agricultural sciences, are in federal and state universities (not shown in Table 1). These fields, perhaps because they are too expensive to provide, remain niches for public institutions; otherwise, the distributions according to ownership are not so different.

5 New Providers and Operations

Since the first half of the 2000s, the processes of acquisition and/or merger of private institutions have become increasingly frequent in Brazil, involving large national and international groups and billionaire individuals. These operators are known as "new providers"—corporate universities, educational corporations and private profit-oriented institutions (Brunner and Uribe 2007) that act outside the traditions of public service that are typical of traditional universities. This commercial orientation became legal in 1997, although profits were made in private higher education before this through subterfuges such as renting real estate, or paying high salaries or relatives. There is a legal but highly confusing distinction between the maintainer and the higher education institution, which allows them to have the same owner but buy and sell services to each other, helping the transfer of resources. Strictly speaking, it is the maintainer, not the higher education institution, which can be for profit or not, and the same maintainer can own several higher education institutions (Fernandes 2007).

Interviews conducted around 2010 with owners in the higher education market allow more detail of their operations to be seen. A private university has various assets, including buildings and equipment, the prestige of its name, and its portfolio of students; it also has liabilities related to faculty staff costs, administrative and financial commitments. Each of them is considered separately in the transactions. In the example of Anhembi-Morumbi, a private university bought by international company Laureate, one of its attractions was its privileged location in downtown São Paulo city.[7]

Commercial transactions between private profit-making institutions are quite complex and involve many agents: national and foreign financial institutions, market "scouts," educational corporations, market research and marketing agencies, and specialized consulting firms for private higher education, in addition to a range of professionals such as lawyers (in various specialties), managers and market analysts, among others. Table 2 shows the volume and characteristics of commercial transactions involving private for-profit entities between 2007 and 2013.

[7] Interview by the author in 2011 with Gabriel Rodrigues, founder of Anhembi-Morumbi University.

Table 2 Number and type of commercial operations in the period 2007–13

Year	Number of mergers and acquisitions	Between Brazilian companies	Foreign company buys Brazilian companies	Brazilian company buys foreign companies	Brazilian company buys foreign shares from Brazilian company
2007	19	–	–	–	–
2008	53	–	–	–	–
2009	12	8	3	0	1
2010	20	15	5	0	0
2011	27	25	1	1	0
2012	19	12	7	0	0
2013[a]	7	3	3	0	1

[a]Refers to the first quarter
Source Carvalho (2013)

Up to the beginning of 2013, there were 157 commercial transactions, between acquisitions and mergers. Of these, there is information for 85; most involve only national capital and the largest buyers are the Anhanguera and Kroton groups. The total number of acquisitions and mergers carried out by these two groups, currently merged, corresponds to about a third of the total, and involved institutions present in 60 Brazilian cities (Table 3). The result was that, in 2014, fifteen companies, or maintainers, controlled 36% of the higher education market and 27% of the total

Table 3 Main providers and transactions, 2007–13

Buying institution	Number of HEIs acquired	Number of cities involved
Anhanguera Educacional	32	32
Kroton	19	28
Estácio	18	15
SEB	13	12
Laureate	10	4
Civita (Abril Educação)	6	5
UNIESP	4	4
UNIBR	4	1
Devry	2	2
Grupo Campos de Andrade	2	2

Source Carvalho (2013)

revenues. Ten years ago, the 20 largest groups held only 14% of the market (Hoper Educação 2014; Sampaio 2014).

In our interviews, apart from the obvious interest in "making a lot of money," we identified two main reasons for owners to decide to sell their institutions: doubts about their ability to survive in a more competitive environment, and the eventual difficulty of family succession in the business. These two motivations often appear together. There is a general feeling among the maintainers interviewed that the higher education market became more competitive after 1997. Many of these owners still belong to the first or second generation of educators, and it is from this perspective that they see the difficulties of the market and complain about the rampant competition that has taken place in private higher education. In the words of Edson Franco, a well-known member of the old guard, there is today a "competition between brothers" (interview in April 2011).

Private institutions often start as family businesses. As they grow, with more students, faculty, employees, teaching modalities and locations, they have to deal with complex issues related to taxes, assessment procedures and modern accounting systems that require professional management, and this can be obtained when ownership or control is transferred to a larger institution. Professional management brings tools that increase the ability to compete and adapt to the demands of new environments, reduce costs and increase earnings. Without personal and family constraints, it is easier to trim the administrative and teaching staff, close inefficient and less profitable courses, adjust class sizes and standardize the teaching materials. The managers of the large groups that work in higher education have never been teachers, have not founded schools or had personal links with education; most of them are administrators and economists, preferably from the financial sector.

The second reason given by owners for selling their institutions is related to problems of family succession. Many institutions started as family endeavors in the 1960s and 1970s, and the new legislation allowing them to become for profit coincided with a period of generational change. It is not unusual for the founders to find that their heirs are not prepared or willing to take their places.

Finally, it was clear from the interviews that, although the owners tended to say that the process of mergers and acquisitions was positive and necessary, it was always a difficult decision, with many cases of regret, disagreements among partners over the sales of their holdings and the breakdown of decades-old friendships.

One unexpected effect of the concentration was an increase in the number of students enrolled in small and medium-sized institutions (64% of all institutions have up to 1,000 students) and an increase in enrollments in regions where the private sector did not have a significant presence in the past. The reason is that the large conglomerates can own and manage many small institutions in distant regions using standardized teaching and distance-learning technologies, reducing costs that are then transferred to the students in the form of lower tuition fees (Corbucci 2014; Sampaio 2011).

6 Public Financing of the Clientele

The financing of students, rather than their institutions, has been used in Chile and in other countries to stimulate institutions to compete for them (Brunner and Uribe 2007). In Brazil, however, there were other motivations and consequences. Public universities remained tuition free, and the student loans and fellowships for the private sector were intended to broaden access, particularly for students from lower socioeconomic backgrounds. The government also created a special program for the expansion of federal universities, called Reuni, to create new campuses and more course offerings, and to increase enrollments. To promote diversity, 50% of the places in federal universities were set aside for students from public schools, Afro-descendants and those from indigenous groups. However, because of the smaller size and higher costs of public institutions, it was easier to subsidize access to the much larger private sector.

The two main programs of student support are University for All (*Universidade para Todos*), or Prouni, created by Law 11096 of January 13, 2005, and the Student Financing Program (*Programa de Financiamento do Ensino Superior*), or Fies, created by Law 10260 of June 12, 2001 and its subsequent modifications.

Prouni operates by granting scholarships to students enrolled in face-to-face undergraduate courses at private institutions. Recipients must not have a tertiary education degree and the per-capita monthly family income must be below one-and-a-half times the minimum wage (about 300 euros a month) for a full scholarship, and up to three times the minimum wage for a partial scholarship of 25 or 50%. They need also to have achieved a minimum score of 450 points in the National Exam for Secondary Education (ENEM) and have completed secondary education in a public school. There are also quotas within Prouni for racial minorities and persons with physical handicaps. Each institution should award ten scholarships for every 107 paying students, until the sum of benefits reaches the equivalent of 8.5% of the annual income of the academic period. In exchange, the institution benefits from tax exemptions. Because of the tax exemption, and the low marginal cost of adding more students, Prouni is extremely attractive for private institutions, particularly those for profit.

Figure 3 shows that the number of Prouni scholarships grew continuously over ten years, with a significant increase in the number of full scholarships in 2014. In 2016, however, the total number of scholarships fell and by 2017 we see a trend towards a balance between the number of partial and full scholarships.

Fies is a student loan program for low-income students enrolled in private institutions. Depending on their income and other factors, the student receives a loan for the full or partial amount of their tuition, as set by the institution. Repayment starts typically 18 months after graduation, depending on the amount of the debt, the graduate's income and other factors. Fies is administered by a government-owned bank, Caixa Econômica Federal. Prouni and Fies have similar designs in terms of their target population, benefiting private non-profit institutions. In both cases, the

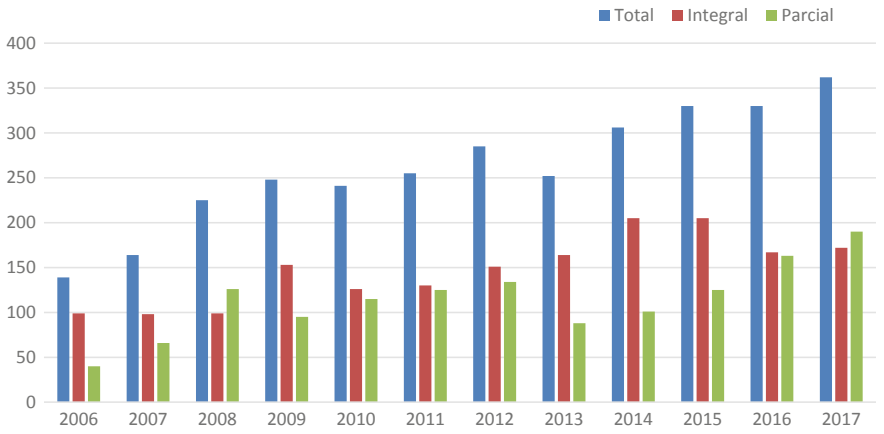

Fig. 3 Growth in the number of Prouni scholarships (in thousands), Brazil, 2006–17. *Source* Prepared by the author based on data from Sindata/Semesp, 2018 (SEMESP 2018)

institution needs to achieve a minimum score in the federal system for assessment of higher education (SINAES).

As shown in Fig. 4, the number of loan contracts grew continuously between 2011 and 2014 to peak at 864% in 2014, the year in which then President Dilma Rousseff was re-elected. However, since this huge growth, successive changes in the program's operating rules have led to a drastic reduction in the number of contracts signed. The recent changes include a rise in interest rates, the requirement for students to obtain at least 450 points in the ENEM and more strict loan guarantees.

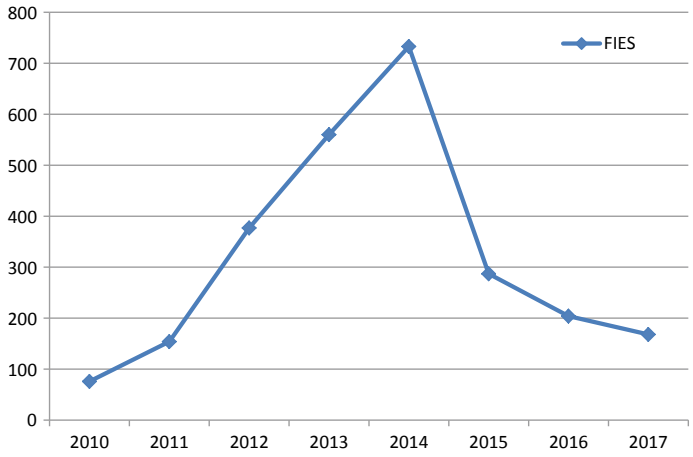

Fig. 4 Number of student loan contracts signed under Fies (in thousands), Brazil, 2010–17. *Source* Prepared by the author based on data from Sindata/Semesp, 2018 (SEMESP 2018)

Thanks to Prouni and Fies, private higher education continued to expand at the expense of the federal government during a period of stabilization of demand caused by stagnation in the number of students coming out of secondary schools and other factors (Andrade 2015; Corbucci 2014). In other words, the process of privatization and commodification of Brazilian higher education was due not to the expansion of private investments, but to public subsidies, creating a worrying situation in which the private sector is highly dependent on the state for its existence and commercial success.

7 The Public and the Private: Near and Far

The differences between public and private higher education, until very recently perceived as startling, have tended to become more nuanced. Two factors have contributed to this phenomenon: first, the pressure of market demand for higher education; second, the last two decades' policies of increasing access and equity. Table 4 shows this approximation in the following dimensions: financing, cost to students, geographic distribution of institutions, access mechanisms, student profile and distribution of enrollments by area of knowledge.

Nevertheless, differences between the public and private, for-profit and non-profit sectors persist. Research, post-graduate courses, full-time faculty and better evaluated course programs tend to occur mostly in federal and state universities, but the internal heterogeneity that characterizes each of the sectors prevents the establishment of rigid demarcations. Regarding research and the offer of post-graduate programs, there is a continuum between "more present" (public sector), "present in some niches" (private non-profit) and "almost non-existent" (private for profit). The academic qualifications of the teaching staff are similar in the public and non-profit sector, but most faculty in public universities have full-time contracts, while those in the private sector have part-time contracts or are hourly paid employees. Regarding quality, about 80% of the course programs in the public sector have a rank of 3 or more in the five-point scale adopted by the Ministry of Education, while the largest number of courses ranked 2 or lower are concentrated in the private sector. At the same time, most of the highly qualified courses in management and economics are in a few private, non-profit institutions.

8 Conclusions

Although the processes of commercialization and privatization of higher education are common to several countries, their characteristics vary according to the domestic situation. In this text I have shown how these processes occur in Brazil. Presidential Decree 2306/97, which legalized for-profit higher education, did not represent the starting point of the commercialization of higher education induced by international

Table 4 Differences and approximations between the public and private sectors of higher education in Brazil

	Public sector	Private, non-profit	Private for profit
Financing	Public. Eventually private. Resources for research projects in specific areas	Mixed. Private financing: payment of fees and tuition fees by students. Public funding: tax exemption (Prouni scholarships) and Fies (student loans)	Mixed. Private financing: payment of fees and tuition fees by students. Public funding: tax exemption (Prouni scholarships) and Fies (student loans)
Access	Entrance exam/ENEM + affirmative action programs (ethnic/racial and social quotas). Degree of selectivity varies according to the institution and the course/career	Entrance exam/ENEM + affirmative action programs (ethnic/racial and social quotas). Degree of selectivity varies according to the institution and the course/career	Entrance exam/ENEM + affirmative action programs (ethnic/racial and social quotas). Degree of selectivity varies according to the institution and the course/career
Cost to the student	Free	Paid, but fellowships and subsidized loans available	Paid, but fellowships and subsidized loans available
Courses and careers	Greater coverage in all areas of knowledge.	Greater coverage in all areas.	Concentration in courses in social professions
Geographical distribution	Present in all states	Concentrated in more developed regions and in medium and large urban centers	Tendency to geographic dispersion. Greater growth in the mid-west, north-east and northern regions

factors, as has often been suggested. There were local reasons for the decree: an extensive established private sector that already included for profits in disguise to a significant extent, with a strong lobby to defend their interests; and a growing demand for higher education that the public institutions were not able to meet. Alternatives to expand public higher education by increasing the number of places, offering evening courses, introducing new teaching modalities, such as distance learning, vocational courses, and so on, have historically faced resistance from much of the academic community in public universities. The argument for opposing the changes was that they threatened the quality of the universities, bound by the principle of inseparability of teaching, research and extension. This resistance contributed to the passing to the private sector, in different periods, of the leading role in responding to the demand. Between 2008 and 2012, with the implementation of the Reuni expansion program

for federal public university resources, the number of enrollments in this segment has doubled, but at a high cost, and it still does not exceed 15% of enrollments.

The 1997 decree distinguished between for-profit and non-profit institutions, and brought the non-profits closer to the public sector, maintaining their tax exemptions and exercising greater control over them; at the same time, it pushed for-profit entities into the market, legalizing profits and charging taxes. The decree explaining this separation seemed, at the time, to contemplate the diverse interests within the private sector.

It was not a coincidence that the adoption of public funding for students enrolled in private for-profit higher education institutions took place at the same time as the large private sector in the country was being organized on a single front: the *Forum das Entidades Representativas do Ensino Superior Privado* (Forum of Entities Representing Private Higher Education). Created in 2009, the Forum brings together various associations representing diverse and often irreconcilable interests. In a document presented at a public hearing at the National Congress, they presented their views of the policies required to reach the goals of enrollment in higher education set by the 2014 National Plan of Education: more public investments and diversification of funding sources (Forum das Entidades Representativas do Ensino Superior Particular 2013). The target was to reach 50% of gross and 33% of net enrollment in higher education by 2024, with at least 40% of the new enrollments in the public sector. By 2017, the gross rate was 34.6%, of which 8.9% in the public sector (INEP).

These high targets justified the strong partnership established by successive governments of the Workers' Party, extending to the for-profit entities the same benefits as those of the non-profits, through student loans and tax exemption. Public support for private higher education is not a Brazilian invention; but it is surprising that, in Brazil, these initiatives have been adopted by governments that have always presented themselves as severe critics of the processes of commodification and privatization of higher education.

These policies changed in 2016, when President Dilma Rousseff was impeached amid a deep economic and fiscal crisis. One of the main goals of the new government of Michel Temer was to cut costs, and this led to a drastic reduction in the size and scope of the student loan program, whose costs and expectations of default were escalating out of control. These cuts and restrictions affected the private sector very strongly, which responded by expanding distance education and transferring students from face to face to this modality. In 2019, in his first months in office, newly elected President Jair Bolsonaro announced a 30% cut in the current expenditure of federal universities. These cuts were later reinstated, but, at the end of the year, a general freeze on new contracts was introduced. Both measures reinforce the long-standing and intense process of commodification and privatization of higher education in Brazil.

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Return Scientific Mobility and the Internationalization of Research Capacities in Latin America

Sylvie Didou Aupetit

Abstract The chapter examines the return of scientists to their countries of origin in Latin America resulting from active policies introduced by countries affected by massive emigration of their highly qualified personnel. Data on highly skilled emigration of Latin Americans is presented, focusing on assessments of the relevance of return programs. The most obvious policies in this regard have been those of repatriation, re-linkage and recruitment programs for foreign academics. Examples from Mexico are used to examine how this return, whether induced by government policies or based on personal decisions, affects the consolidation of local disciplinary areas and the establishment of globalized knowledge exchange networks.

Keywords Return migration · International academics · Brain drain · Repatriation programs · Scientific diasporas

1 Introduction

Pioneering studies on the international migration of professionals from Latin America date back to the late 1960s, both for the region as a whole and for Argentina and Colombia (Eusse Hoyos 1981; Houssay 1966; Oteiza 1970). At the end of the 1990s, two research lines appeared, on brain drain and on international student mobility and the asymmetric circulation of skills. Faced with negative flows of highly qualified personnel, many governments in the region implemented programs to reverse international mobility, organize the diaspora and recruit international scientists. These programs involve government authorities, regional blocs and international agencies as well as higher education and science institutions in the countries of origin and destination. The literature on the subject is, however, heterogeneous. Much of it is journalistic, sensationalist rather than informative, and limited to individual experiences. As a research subject, professional mobility attracts the attention of specialists

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in disciplines such as demography and, to a lesser extent, economics, political science and sociology. Although most specialists are interested in quantifying migration flow, some do it from a public policy perspective, looking at the operation of government programs in countries that send or receive the migrants (Luchilo 2010). Since the intellectual tradition in demography privileges the study of outgoing rather than incoming migrations (IOM 2009), the return of scientists to their places of origin arouses less interest than their departure.[1] Some contributions deal with counter-flow scientific migration programs for Mexico (Didou and Villalobos 2013), Argentina (Luchilo and Stubrin 2013) and Peru (Piscoya 2013), and their impact on knowledge management policies. Others analyze the signing by Latin American countries of the Hague Convention on the apostille of diplomas, bilateral or macro-regional agreements on the recognition of foreign qualifications or teacher training (Pedroza et al. 2018) and the ongoing adoption of the new UNESCO Regional Convention on the Recognition of Studies, Degrees and Diplomas in Higher Education in Latin America and the Caribbean (1974), known as the Buenos Aires Convention (Skjerven and Schwitters 2019).

In this chapter, we are interested in programs that deal with the return of emigrating citizens and the attraction of foreigners for their incorporation into academic markets in Latin America. We describe the scope of reverse mobility programs and recruitment of international scientists in the region. We point out ways of improving knowledge of return migration and some results from articles and empirical research carried out in Mexico.

2 Brain Drain and Emigration of Scientists in Latin America

The works, mainly on demography, published in the last 20 years and the information compiled by data banks of international organizations (Migration Panorama by the International Organization for Migration, International Migration Outlook by OECD) and regional programs (*Programa de Investigación sobre Migración Internacional en Latinoamérica-IMILA*) show that information about Latin American emigrant professionals is dispersed. The criteria for identifying the "scientist" category are not homogeneous, in terms of years of schooling, ages, occupations and time spent abroad. This is confirmed by revisions done in Spain and the United States (Fiori and Koolhaas 2012).

Nevertheless, experts agree that the regional rate of highly skilled emigration from Latin America has increased since the 1990s (Docquier and Marfouk 2004; Docquier

[1] "Returned migration is a relatively new area that has no standard meaning in national or international policies or law. Different types of return have been proposed to describe the level of development of countries linked to migration and return, time spent in the country of origin, the intention of migrants to the effective outcome or the sociological environment of the returnee" (IOM 2009, p. 276).

and Rapoport 2012; Dumont and Lemaître 2005; Ozden and Schiff 2006; Pellegrino and Vigorito 2009). It grew from 10.1% in 1990 to 11.3% in 2007 and reached 15% in Central America (except Costa Rica) and the Caribbean. By destination, high percentages of such migration go to the United States as a country and to the whole OECD area as a block (Lozano-Ascencio and Gandini 2009).

Despite this increase, in the United States, the percentage of Latin Americans with studies corresponding to higher vocational level or above among the foreign-born population remain below the average. They also vary according to country of origin. Between 2005 and 2007, of the 1,192,746 Latin Americans with higher education over the age of 25, with jobs and resident status in the US, 68% had bachelor's degrees, 20.4% master's degrees and 11.4% doctorates. Colombia, with 15%, Chile with 16.2%, Uruguay with 24.1%, Argentina with 24.5% and Paraguay (44.6%) exceed the regional average of doctorate holders over total human resources with thirteen or more years of schooling (Lozano-Ascencio and Gandini 2012, pp. 13–15). In 2007, 136,306 salaried Latin Americans 25 years of age or older employed in the United States had a doctorate: 38.08% of them obtained it in the United States on average. At the extremes are the Caribbean countries with 50.8%, on the positive side and, on the negative side, the Andean countries with 24.5% (Lozano-Ascencio and Gandini 2011).

Less detailed but more recent figures confirm the heterogeneity of highly skilled migration to the United States, by nationality of origin. In 2016, among South Americans, the percentage of total US migrants aged 25 and over with a bachelor's degree or more in relation to the total reference group was 32.3%. Among the Caribbean countries, it reaches 20.4%, among Central Americans, 9.2%, and among Mexicans, it remains at a low percentage, 6.2% (Krogstad and Radford 2018).

The relative proportion of postgraduates who stay in their country compared with those who leave also varies according to school, socio-economic and political factors, including among others: the existence of established national post-graduate systems; government policies to provide scholarships abroad; national and international accreditation of programs; discipline-related training traditions; and language facilities for international mobility. Factors leading to emigration include work opportunities abroad, living conditions and the pre-existence of host family networks. Other factors leading to emigration include political instability and the upsurge of populism on the left or right, which may target students and their institutions, and the reduction of public support for science and higher education (Nicaragua, Brazil, Mexico).

Different combinations of these factors explain the differences in the age at which professionals migrate. 45.5% of Caribbeans with higher education, 41% of Central Americans, including Mexicans, and 25% of South Americans left their home countries before the age of eighteen, attending primary, secondary and/or preparatory school in the United States (Esteban 2011), probably due to family migration. These percentages suggest the need to revise the predominant discourses on the loss of "educational investment" made by the countries of origin. They show that it is important to focus recruitment, bonding and repatriation programs on groups that are in a personal and cultural position to return or re-link. These subgroups are less extensive than the diaspora, defined in broad terms as anyone belong to an ethnic group or

nationality, or all doctoral students of a given nationality who study abroad and do not return. Those more prone to return are, by age, students who come to a foreign country to complete university studies and maintain their main socio-affective or professional networks in their countries of origin. Professionally, they are made up of postdoctoral candidates who cannot find stable employment either in their country of origin or of destination (Ramirez García 2016), workers in the education sector, or students fleeing political or economic crises (Venezuela, El Salvador, Honduras). In contrast, migrants who left young for family reunification are less likely to return. This is demonstrated by interviews with young illegals (Mexican or Central American) enrolled in the Deferred Action for Childhood Arrivals (DACA) program, which since 2012 has been seeking to improve their opportunities to stay in the United States (Torre-Cantalapiedra 2017). But to say that 179,000 South Americans, 170,000 Caribbean and 145,000 Central Americans work as scientists and engineers in that country, of which 93,000 are Mexicans, 64,000 Cubans, 54,000 Argentines and 36,000 Colombians, only gives an order of magnitude of absolute emigration. The concrete bases of re-linking and/or repatriation are actually much smaller, and the better working conditions for scientists in developed countries, compared with those in Latin America, ensure that mass repatriation of Latin American scientists living abroad is very unlikely.

The attractiveness of policies for the return and recruitment of international researchers depends on their ability to provide professional stability and decent salaries, in national and international terms, to those willing to come back. The duration of the stay in the country where the holders of foreign post-graduate degrees obtained their diploma, migration policies (mainly immigration quotas and conditions for obtaining work visas by nationality), and accessible positions (precarious or definitive) also determine return decisions.

From time to time, Argentina, Uruguay, Colombia or Mexico look at the figures of their programs and identify the host institutions of the returnees. Consultants from the Economic Commission for Latin America and the Caribbean (ECLAC) call the results "lukewarm" and point out that, to get better results, it would be necessary to align the programs to the expectations of those interested in scientific collaboration with their country of origin, by means of inverse mobility or knowledge transfer schemes.

Data on Latin American migrants with doctorates are outdated, since they are from the early 1990s, and incomplete. Still, their analysis helps to identify some issues that have yet to be incorporated into the design of science policies. The first, which follows the analytical approach to the brain drain proposed by UNESCO, is the estimation of the financial cost of pre-university and, probably, university education, which could be charged respectively to the countries of origin and destination on the one hand, and to families or governments on the other, depending on whether the emigrant has studied in public or private education institutions.[2] A second, normative

[2]UNESCO warns that a significant proportion of highly qualified migrants have been trained in private institutions of higher education, so the calculations on the waste of public investments in the education of migrants in their countries of origin should be reviewed at least in countries that,

topic, concerns procedures for recognition and validation of degrees obtained abroad. The UNESCO International Institute for Higher Education in Latin America and the Caribbean (IESALC) has drawn attention to the significance of the issue in the region, but concrete progress varies according to the existence of bilateral agreements. For instance, degrees granted by Mercosur countries are automatically recognized in Brazil, but just for research and teaching purposes. Mexico has bilateral agreements for automatic recognition of qualifications with Argentina, Chile, China, Colombia, Ecuador, Paraguay and Spain. Nicaragua validates professional degrees issued by other countries in South America. Paraguay and Uruguay recognize degrees issued by other Mercosur countries or registered according to the Hague Convention. Besides the differences in criteria and products, the time it takes to get a degree recognized in other countries varies from 15 days in Peru, when registered according to the Hague Convention, to 14 to 16 months in Argentina (Pedroza et al. 2018).

A third issue is the systematic compilation of national legislation on, in particular, the recertification of professional skills. A fourth is the comparative documentation of the contributions of international academics to the consolidation of endogenous capacities in scientific systems in the region. The last is the opening of new lines of research, regional in scope, to establish the empirical determinants of the international circulation of scientists in the region, based on the characteristics of Latin American PhDs abroad and in their countries of origin.[3] The professional nomenclature related to research posts[4] and the profiles of the in situ internationalization of science versus those consolidated in countries with high proportions of foreign scientists in strategic fields (engineering, university teaching or health) are mainly topics of academic interest.[5]

A comparison between the degrees of internationalization of different professions in foreign and Latin American countries would contribute to improving national regulatory standards or provisions on the free transit of professionals contained in trade agreements and/or educational agreements such as Mercosur, and to alleviating the tensions produced in the universities of Latin America and the Caribbean by the

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like most of those in Latin America, have expanded their coverage by strengthening the private provision of educational services. http://www.unesco.org/new/en/social-and-human-sciences/themes/international-migration/projects/skilled-migration-and-brain-drain/.

[3] Aibo and Ordaz Diaz (2011) estimate that 20,218 Mexican PhD holders live in the United States, compared with a similar group of 80,000 people in Mexico, 73,000 of whom were born in the country.

[4] "Indeed, the use of the term "researcher", if it provides a general category of analysis, conceals a heterogeneity of professional situations. This heterogeneity does not allow us to add either the mobility of doctors, post-doctors and incumbent researchers or that which takes place in research organisations and within private companies" (Harfi and Mathieu 2006 p. 12).

[5] "According to US census data, as recently as 2007, highly skilled "legal" immigrants had become essential in many key economic sectors, constituting fully 44% of all medical scientists, 37% of all physical scientists, 34% of all computer software engineers, 31% of all economists, 30% of all computer engineers, and 27% of all physicians and surgeons. With citizen members of the "baby boom" generation entering retirement in ever-increasing numbers, demographers predict that pressure to recruit highly educated and highly skilled immigrants will continue" (Gutiérrez and Almaguer 2016, p. 108).

recruitment of international PhDs. Indirectly, it would help with the measurement and monitoring of the growing number of applications for revalidation of degrees.

3 Return, Invitation and Re-linking Programs in Latin America

These programs were driven by international agencies in their initial stages. In 1974, the International Organization for Migration (IOM) launched a talent return program for Latin America (Esteban 2011, p. 113). In 1986, the United Nations Development Programme financed the Basic Sciences Development Programme, through an agreement with the Ministry of Education and Culture and the University of the Republic in Uruguay, to repatriate and organize the collaboration of Uruguayans living abroad. The World Bank has co-financed the Program to Support Science in Mexico (PACIME) for foreign scientists since 1991, and UNESCO has been supplying courses for Venezuelan talent abroad since 1995. The Inter-American Development Bank grants loans to Argentina for the Root Plan for the repatriation of scientists in 2003 and is currently doing the same in Peru.

Thanks to their own funds, donations or international co-financing, most countries in the region now administer repatriation programs. Many organize temporary return events for members of their diasporas. Others enact migration incentive laws: Peru did so in 2004 to encourage the return of professionals living abroad (Ponce and Quispe 2012).

Several countries in the region have achieved interesting results. Argentina (Bayle 2015), Brazil (Schwartzman and Paiva 2016) and Mexico (Didou 2017) have rethought their reverse mobility policies from co-development or transnationalism perspectives. With a vision of migration as a polycentric, circulatory, temporary phenomenon subject to diverse patterns of geographical displacement (Beltrame 2007, p. 10), they are seeking to recruit foreign scientists and involve "definite" emigrants in (occasional or recurrent) cooperation activities, invoking a principle of mutual benefit in strategic development projects. For this, they set up diaspora organization programs and temporary invitation or recruitment of foreign scientists, parallel to return programs. They have shifted from a policy to compensate for brain drain that emphasizes its negative externalities to a proactive approach that encourages a relative and beneficial brain gain (Beine et al. 2008). They promote transnational epistemic networks and permanent knowledge transfer chains (Faist 2008) supported by information and communication technologies. Countries that have traditionally been lax in their demands for the return and qualification of their trainees abroad have tightened up their controls on obtaining the diploma and the obligation to return.

Despite its obvious relevance in Latin America there are no reliable estimates of the number of foreign or national academics, graduates of institutions in other countries, who are working in national and foreign systems of higher education and science. However, a growing number of questions are raised by the scope of diaspora

repatriation, attraction and organization programs, including costs and benefits, and the contribution of these programs to the introduction of innovative lines of research in the host universities of returned or foreign academics. Some studies show, in fact, that the settlement patterns of "returnees" and the distribution of their workloads in teaching, administration and research are out of line with their training profiles (Balbachevsky and Marques 2009 on Brazil). It has similarly been suggested that the effectiveness of the Patrimonial Chairs program in Mexico and Prometheus program in Ecuador decreases if the receiving institutions do not put institutional programs in place to provide resources for returnees' scientific careers (Pedone and Izquierdo 2018).

Despite the limited reach of these programs, they work both as a demonstration of possibilities and by achieving some effective reversal of outgoing mobility. The number of returned "re-linked" scientists in the diasporas is growing in Latin America, but their rate of increase is lower than the number of highly skilled migrants going abroad. The Network of Mexican Talents Abroad, coordinated by the Institute of Mexicans Abroad (IME) in collaboration with the National Council for Science and Technology (CONACYT) and the United States-Mexico Foundation for Science (FUMEC) included 231 Mexicans in 2009. In 2019, the Network, renamed Global MX Network, registered 3,000 members in its 36 chapters located in eighteen countries.[6] This increase in migrants abroad is not reflected in a parallel increase in returnees: thus, the number of Mexican researchers residing abroad accepted by the National System of Researchers (NSR), meaning that they return to the country for short or long stays, is almost stable: in 2010, the NSR accepted 236 beneficiaries and in 2017, 262.[7]

Regarding the choice of partners to implement programs of cyclical return or scientific reconnection between researchers inside and outside the country, governments and science management agencies cooperate with other public administration bodies, private associations, international foundations and local immigrant organizations. For Latin America, those covered by these associations are a minority, compared with other nationals abroad. In the United States, they account for 8.89% of all Colombians, 14.12% of Dominicans and 0.70% of Mexicans (Portes 2011, pp. 8–9). They are regarded as organizational and linking devices, alternatively underused or questioned, having been selected as counterparts without explicit criteria or evaluation of their representativeness, which opens the way to suspicions of clientelism (Agunias 2009).

In general, investments in repatriation and attraction programs seek to respond to individual demand. They are not usually governed by public policy priorities on areas, lines of research or establishments to be supported. In Mexico, starting in 2014, CONACYT has tried to connect the institutional needs and profiles of recent graduates. Its Young Researchers Chairs Program centralizes candidates' resumes and institutional applications to link collective requirements to individual competencies. However, their contributions to the internationalization of research, to the

[6] https://consulmex.sre.gob.mx/santaana/index.php/red-global-mx.

[7] http://conacyt.gob.mx/SNI/2009/SNI-mexicanos-en-el-extranjero-2009.pdf.

capitalization of the advantages acquired by PhD holders trained abroad and to the interactions, substitutive or not, between returns and outflows of competencies have not been assessed (Ramirez García 2016).

Thus, the return of highly qualified personnel is an issue to be further explored in Latin America, preferably in comparative frameworks on a national scale, because of its relevance in understanding the dynamics of the scientific field. Systematic observation and follow-ups would make it possible to identify innovative programs, useful for activating discipline internationalization practices, and to scale up the number of international publications and scientific cooperation networks, intensifying mobility and the transfer of knowledge and improving the degrees of internationalization of academics.

4 Visibility and Contributions of Foreigners to the Mexican Scientific Community: A Case Study

As in all of Latin America, in Mexico, there is a lack of research on incoming mobility related to sabbaticals, postdocs (i.e., of a temporary type) or hiring for a definitive professional incorporation. These issues have yet to be included in a national research agenda that would close the information gap and reveal the international positioning strategies of higher education institutions.

Nevertheless, due to its tradition of political solidarity, Mexico has received significant contingents of intellectual migrants (Castaños 2011). In the 1930s and 1940s it opened its doors to Republicans fleeing from civil war in Spain and from refugee camps in France; in the 1960s and 1970s, the country welcomed political exiles from Peru, Brazil, Chile, Argentina and Uruguay. These Latin Americans are today the oldest group of foreign researchers belonging to the NSR, so their importance is diminishing as they approach retirement.

In a second and more programmed phase of attraction between 1991 and 1997, CONACYT's Patrimonial Chairs II program stands out. It attracted almost 700 scientists, many from former Eastern Europe and Russia, out of a total of 6,278 NSR members (Izquierdo 2011). Although the estimate should be modified according to how many settle permanently in the country,[8] it represents the first attempt to strategically consolidate research groups with international profiles in public institutions interested in reinforcing research, especially in the arts, mathematics and hard sciences. It enhances the status of these establishments in a national scientific environment that measures the quality of institutions according to the percentages of international PhD holders and activities carried out (publications, attendance at international congresses, and so on).

[8] "In the period 1991–1997, CONACYT (1999) reported that, of the 689 foreign scientists who obtained a CPE [Patrimonial Chair of Excellence], Level II, 218 ended up settling permanently in Mexico and estimated that 90 of them joined the National University" (Izquierdo 2008).

From the year 2000, in a third phase, support for scientists willing to return depends on their individual situation and is based on an analysis of the professional and social advantages resulting from labor insertion in a foreign scientific system of medium prestige. Arriving scientists may maintain some of their professional relationships in their countries of origin, due to the multiplication of programs supporting bilateral cooperation in Mexico, which may eventually mitigate the psychologically negative impact of migration.

The data on the incorporation of foreign scientists refer to 2009 because, since 2011, the NSR no longer reports the countries of birth, highest school grade and citizenship of its members, due to a restrictive interpretation of data protection legislation (Oliva and Didou 2019). Recent studies therefore do not provide any indicators with respect to international scientists (Rodríguez 2016). In 2009, 12.9% of the 15,654 members of the NSR were born abroad (Didou and Gérard 2010) and about 10% of foreigners older than 25 living in the country held a doctoral degree (INEGI 2010). They are present, in decreasing order, in the humanities and behavioral sciences, mathematical physics, earth sciences and social sciences. Few of them have lived in places other than their country of origin and Mexico, although this pattern is changing among the younger generation. A third of the foreigners, mostly political exiles from the 1970s, obtained their degrees in Mexico, but the others completed their doctorates in Europe or the United States. However, if we measure the degree of internationalization of the NSR not only by the number of foreign scientists but also by that of Mexican academics who graduated abroad, the figure is 36% of members, showing the historical importance of CONACYT's foreign scholarship policy.

In 2019, 19,529 of the 28,632 scientists in NSR reported their institutional affiliation; only 724 locate it abroad.[9] They are likely to be scientists who commute periodically between Mexico and other countries, suggesting that the arrival of foreign academics is associated with diasporic returns, whose dynamics deserves to be studied.

Interviews carried out in 2013–14 with 116 foreign researchers permanently based in Mexico allow us to see other qualitative aspects of scientific immigration, such as the strategies they adopt to become well known and the roles of international academics as promoters of innovative lines of inquiry and participants in international networks. The career paths vary according to chronological, disciplinary and institutional factors. For the recently arrived, there is more variation in places of origin, with a still small number of persons coming from China, the Maghreb and India. Their professional insertion takes longer, and is more competitive and complicated. To make it easier, they move from Mexico City to other states and are willing to put up with precarious working conditions before getting a satisfactory job with a stable income and working conditions. They express interest in maintaining an academic interaction with their countries of origin, depending on individual (circumstances of departure, family or individual situation and time of life) and institutional factors (regulations related to affiliation and full-time contracts, assessment of international activities, teaching loads, support for international mobility and networks). They

[9] www.conacyt.gob.mx/images/SNI/Vigentes_Enero_2019.xlsx.

admit they would be interested in returning to their original places in the country of origin, if they could (Gongora 2018; Jung 2019).

The researchers interviewed consider that their role as intermediaries between scientific groups in the countries of origin and of insertion depends on maintaining a relationship with their thesis director (for the youngest), on the knowledge of exchange opportunities with the country of origin, on their inclusion in associations of graduates and specialists, and on their ability to lead networks. They believe that their main contribution to Mexico is not bringing knowledge that did not exist in the country, but bringing new ways of producing it, based on different disciplinary and professional traditions. In more technical areas, they believe that international mobility is linked with their knowledge of equipment that the country lacks.

However, integration into the local professional environment may be difficult. Some feel they are in a delicate position because their own behavior differs from that of their local peers, which may give rise to jealousies. They believe that making an effort to develop strong intercultural communication and negotiation skills and the acquisition of another language makes it easier for them to take part in multinational networks and teams. To improve their integration in their discipline, they combine interacting at the same time with close and distant colleagues.

Professionally, international academics socialize by joining scientific teams interested in attracting recognized foreigners or recent graduates. They are hired because of their disciplinary specialization or specific techniques that enable them to open up innovative lines of research. Their main contributions to the national scientific field include the articulation of international networks between countries of origin and arrival, and third countries, the establishment of research nuclei and supporting their doctoral students to spend time abroad.

Policy decisions announced or implemented since 2019, however, are affecting the research community and this process of international opening. They include the drafting of an Austerity Law that provides for the abolition of performance bonuses and premiums, the withdrawal of major medical expenses insurance from researchers in public research centers and similar institutions, CONACYT's delay in channeling authorized resources to various programs and basic science projects approved in 2018, and the reduction of public universities' budgets. The government discourse in favor of a "nationalist science" raises concerns about the pay and professionalization of scientists in the coming years. If these trends are confirmed, a reduction in international scientific migration to Mexico and an increase in departures abroad or the non-return of national scientists, mainly among the youngest, can be expected.

5 Conclusions

The circulation of scientific flows depends on the interest of scientific communities and institutions and on government programs to support the academic profession and its internationalization. The incoming mobility of researchers results from the interaction of individual decisions, political or economic conjunctures, and attraction

programs (Didou and Villalobos 2013). Each combination implies distinct types of linkage with the country of origin, which can lead to various kinds of professional and scientific arrangements.

Return, re-linking and international recruitment programs allow institutions that benefit from them to improve their performance in fields that lie between the local and the global. They have a positive impact on the exchange of people and the joint production of knowledge. In favorable circumstances, they encourage intergenerational mobility of young researchers or doctoral students.

Perceiving this, many Latin American countries are complementing their traditional policies of sending students abroad with policies to attract international academics. For this, several mechanisms of international cooperation are being created. Examples are chairs supported by multilateral organizations (UNESCO), higher education institutions (Sciences Po-Poitiers in France and the College of Mexico) or associations (CONAHEC Chair), and joint degree programs provided by institutions in different countries. It will be important to see if these mechanisms are supported by research communities that already have experience in the integration of multinational research groups and whether they expand the scientific circuits involved in internationalization.

However, the publication of opinions critical of the benefits of internationalization, whether in academic (Brandenburg and De Wit 2011; Knight 2011) or political terms (Redden 2019 for Brazil), and the recent reconfiguration of scientific mobility to and from Latin America brought about by economic and political crises, raise questions about the future evolution of outgoing and incoming migration of highly qualified human resources, both from South–South (for instance, the Venezuela–Peru corridor) and South–North perspectives (Mexico–United States).

It is therefore necessary to reactivate the debate, moving from rhetorical arguments about the benefits of internationalization to a systematic and comparative analysis of the patterns of international mobility and the promising practices of networked scientific research. This is urgent in contexts where political authorities linked to governments of different political persuasions express their skepticism about the benefits of internationalization and, in general, question the contributions of science to their national development projects.

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Technological Innovation and the "Third Mission" of Universities

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Abstract This chapter presents a historical perspective on the interaction between universities and industry that has developed since the beginnings of the industrial revolution. The main objective is to connect the historical analysis to current views of university–industry interaction, to indicate the relative positions of Brazil and a few other countries in Latin America, both historic and current, in terms of industrialization and higher education development, and how their universities and industry interact. We show how the model of industrialization adopted by Brazil since 1930 has had a negative impact on the country's ability to develop technological innovation and on the development of its higher education system, and conclude with an analysis of the potential role of universities as innovation becomes even more relevant, and as the service sector fully absorbs and develops the potential of the digital revolution.

Keywords Innovation · Higher education · Third mission of higher education · Industrialization · Digital revolution

1 Introduction

The three missions usually attributed to universities are instruction or teaching, research and extension activities. The order in which they are usually stated has some historical origins, as universities started in the eleventh century as basically instruction-oriented institutions, then developed research activities during the Enlightenment and industrial revolution periods, finally engaging the surrounding communities and providing continuing education, services and knowledge transfer to industry over the last century. In recent decades, there has been a growing literature on how higher education impacts technological advances and how to measure such impact (OECD 2007; Jongbloed et al. 2008; Puukka and Marmolejo 2008; E3M Project 2012; Kenney and Mowery 2014). Other studies have sought to develop general and case studies of the impacts on industrial innovation of groups of universities,

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regionally or nationally, or the more general effects of higher education on industrial development (Lester 2005; Laredo 2007; Brentani et al. 2011).

Every study on how industrialization has developed since 1800 includes a section dedicated to higher education, usually related to its role as source of scientific knowledge and as centers for the education and training of engineers and scientists. More recently, universities have been seen as places where young people start developing entrepreneurial skills, or as irradiating hubs for "technological parks." Their place in contemporary societies is continually expanding and becoming more diversified.

In this chapter, we will develop a historical perspective on how the interaction between universities and industry has developed since the beginnings of the industrial revolution, including some discussion of the key public policy initiatives that were important for such development in relevant countries, especially the United States which, as we will see, was where the forces of industrialization were more clearly connected to the development of universities, producing the most important input for scientific-based innovation and new knowledge in all its forms. The main objectives of the chapter are to connect our historical analysis to the current views of university–industry interaction, and to identify where a number of countries, in particular Brazil and others in neighboring Latin America, stood along the way, and where they currently stand in terms of industrialization and higher education development, and also how their universities and industry interact.

A few basic questions about the relationships between universities and industry will be used to organize the ideas presented here. Some that arise frequently in the debate about university–industry interaction have already been answered in various ways by specialists, but we will revisit them from our historical perspective; others have been developed alongside the text of this chapter.

First, two general questions concerning the three missions of universities:

1. How essential is academic research to technological innovation?
2. How important is the education provided by universities for the development of ST&I activities?

Focusing on university activities directly related to knowledge transfer and the impact on technology innovation:

3. How relevant is intellectual property development by universities to the transfer of knowledge to industry?
4. What other forms of university–industry interaction are taking shape as technology becomes so ingrained in everyday life?

The next two questions deal with the historical relationship between higher education development and industrialization, which will be central to country-specific analysis:

5. How does the degree of industrialization of a country impact the development of higher education and in which forms?
6. What are the consequences for industrial innovation and university–industry interaction of the way industrialization occurs in a country?

Finally, two questions about the future of countries that, like Brazil and its neighbors, seem to be still lagging behind the more technologically innovative economies, despite already having developed reasonable research-capable university systems:

7. How can an emerging economy like that of Brazil escape from its current low-innovation industrial model and become a competitive and innovative global player?
8. Can universities help such a movement?

The last two questions are posed more as a challenge to our audience than in anticipation of being able to provide a detailed response. We do not even claim to respond to the first six questions above in a complete or even in a satisfactory way. But we hope that our discussion will motivate other researchers and, especially, students to take the analysis developed in this chapter forward, expand and eventually criticize it, since it forms the basic text for a class on higher education in the Latin American context.

The first section reviews concepts that may be unfamiliar to higher education specialists, including ST&I activities, the current state of knowledge about the structure of university–industry relations, and how national ST&I systems have been analyzed and studied. The next two sections describe how universities became increasingly relevant to technological innovation, as the industrial revolution gradually incorporated scientific knowledge into their products and processes and, eventually, governments realized how important science was to national strategic interests and economic development. We have chosen two historical turning points in that process: first, the period between 1860 and 1920, known as the second phase of the industrial revolution, when industry intensified the use of science for innovative purposes; and second, the period between the end of WWII (1945) and 1970, marked by the Cold War and communications and space technology, and culminating with the Moon landing. This period of accelerated industrialization in Brazil coincides with the first phase of intensive expansion of HE in the country (which extends to 1980), and marks the end of the economic expansion the country enjoyed in the post-WWII era. We then move to the current period, starting in the early 1990s, and present detailed evidence of how Brazil has performed in higher education and industry interactions compared to a group of countries. We end with a summary of our main findings, as we try to answer the questions posed above in both general and specifically Brazilian contexts.

2 Universities, Industry and ST&I Systems: Concepts and Models of Analysis

2.1 Basic Concepts: Science and Technology, Research and Development, Innovation

Research may be characterized as the activity involving the discovery and creation of new knowledge based on established systematic methods, allowing for testing and verification of claims and results. It may occur in various fields and subjects, in all areas (exact, natural and social sciences). *Science*, or *scientific knowledge*, is the body of knowledge developed under scientific research.

Research may be considered *basic* or *fundamental* when its principal purpose is to understand natural and social phenomena from a conceptual and theoretical perspective, developing general models and hypotheses to be tested empirically. It is of an *applied* nature when there is a practical purpose from the start of the project. Of course, there is no clear-cut boundary between those two types of research. Some areas of knowledge are by their nature closer to applications, for example, the biochemistry of vaccines, while others, like the physics of the origins of the universe, have a deep theoretical and abstract character.

Despite the difficulty of establishing the boundaries between basic and applied research, there is an economic criterion that helps analysts of ST&I systems to detect which is which: is the research in question supported mostly by government or by business? As Vannevar Bush wrote almost 75 years ago (Bush 1945), most basic research will never be supported by businesses and industry, so governments must do it for the benefit of business itself and of society as a whole. Thus, as research performed by universities tends to be mostly of a basic nature, they are funded mostly by governments, and this is true in all countries, whether more or less liberal in economic terms. One could argue that if universities tried to do research dedicated to applied problems, then businesses would fund it. But then who would do the basic research required for many innovative activities in industry? Industry itself? Or maybe research institutes? We will discuss this point further when presenting Bush's arguments (see Sect. 4.1), and relate it to the very nature of a university, which is first and foremost a center of learning—thus, research performed at universities must further the interest of education—and we think there are good arguments in favor of the view that it is basic research that best fits that role.

Next, *technology* is related to knowledge, tools, equipment, techniques, methods and processes used in the production of goods of all types, from foodstuffs to airplanes. And most technology is a result of the activity of developing new products and processes. *Innovation* may be seen as the final result of all these activities put together for a specific end. Lester (2005, p. 6), reporting on regional impacts of universities on technological innovation, speaks of strengthening the local "capabilities for innovation," which he defines as "the ability to conceive, develop, and/or produce new products and services, to deploy new production processes, and to improve on those

that already exist." Next we discuss the possible roles of universities in technological innovation and interactions with industry.

2.2 *The Roles of Universities and Industry and Their Interaction*

As most basic science is developed at universities (and research institutes), we start by identifying the numerous formal mechanisms of industry–science interaction, ranging from government policies to the appropriation of knowledge for innovation purposes (Fig. 1). Governments' role includes establishing "framework conditions" conducive to the development of scientific and innovative activities, such as policies related to education, the labor market, public procurements, the economy, urban and regional planning, research funding, innovation legislation, and so on. These are very important and may well be the most relevant for distinguishing between ST&I systems of different countries.

At intermediary level, there are institutions, organizations directly related to innovative activities, like joint labs, spin-offs and different ways of interaction between science and the scientific community and industry, like licensing, contracts, researchers' mobility, co-publications, conferences, the flow of graduates and informal interactions.

Finally, the third block of Fig. 1 shows outputs and products of that interaction, including scientific output, patents, infra-technologies and prototypes, with their degrees of knowledge appropriation and degrees of codification.

An OECD report (2002, p. 22) observes that, despite the relevance of these formal mechanisms of industry–science interaction, as they may be acted upon by the actors

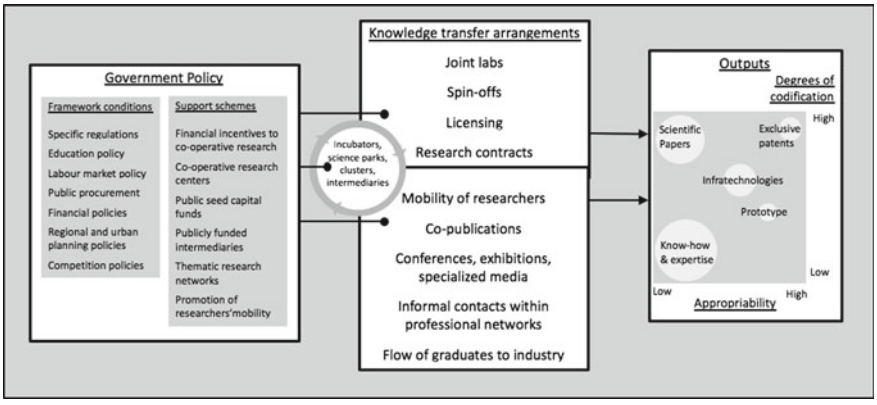

Fig. 1 Formal mechanisms of industry–science relationship (ISR). *Source* Adapted from OECD (2002), p. 23

involved (government, industry and universities), "the bulk of industry-science relations take place through informal and indirect channels and also through unrecorded direct channels in countries where regulatory framework has been fairly restrictive in the past."

This last comment is, in some sense, true in the case of Brazil, since it is only in this century that legislation has allowed for more open interactions between universities and businesses, especially regarding how faculty collaborates with industry. Even after these changes, the academic community, especially in public universities, where research is more developed in Brazil, has been relatively slow to embrace a more active role in collaborations. It is in industry, however, where the demand for science for innovation should be initiated, and where technological innovation actually happens.

It is clear where universities would have an impact using the model in Fig. 1, especially regarding the middle block. The modes of interaction are also listed in a study by Agrawal and Henderson (2002) and by Lester (2005). The graph in Fig. 2 shows how MIT faculty who have developed patents rank the main ways universities interact with industry.

This figure shows that MIT patent holders do not regard the levels of patent development and licensing by universities as important indicators for evaluating the level of university–industry interactions, as analysts and even government policy agents suggest. In fact, the results in the graph imply that the first two missions of universities, education/instruction and research, are at least as relevant as collaborations, consulting and other typical "third mission" activities. Similar results, of the primacy of consulting, scientific publications and recruitment of graduates, and the lesser role of patents and licensing in university–industry interactions may be found in other studies (Cohen et al. 2002; D'Este and Patel 2007). Kenney and Mowery (2014) also argue in favor of a broader perspective for the role of universities in technological

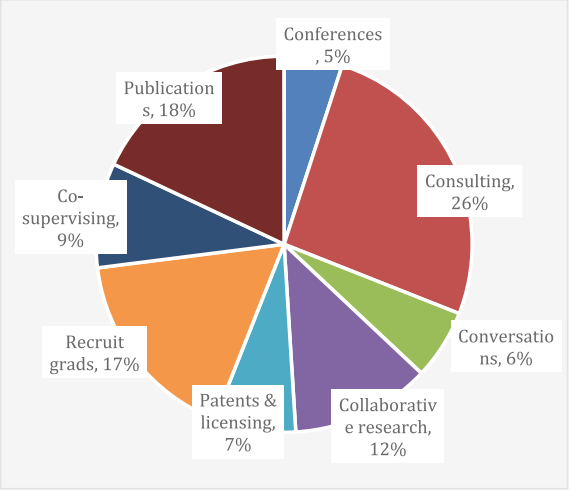

Fig. 2 Perceptions by MIT faculty patent holders of relative importance of alternative channels of knowledge transfer from university to industry. *Source* Lester (2005), from Agrawal and Henderson (2002)

innovation, in their introduction to a series of studies on the impacts of the various *campi* of the University of California on technological innovation in the state. They observe that, despite the recent growth of patent granting and licensing by universities, the studies "indicate that a great deal of economically valuable technology transfer takes place outside the administrative channels created by most U.S. universities for technology licensing." Moreover, they also note movement in the other direction, as "a number of important cases in this book highlight the movement of technology, people, resources, and knowledge from industry to university."

They observe, citing studies by Narin et al. (1997) and Hicks et al. (2001), that there are

> a number of reasons for the recent policy focus on research universities. Considerable evidence suggests that the dependence of technological innovation on advances in science and engineering research has increased in recent decades, a considerable change from the "trial-and-error" character of innovation in the late nineteenth and early twentieth centuries. Universities also play a unique role in both research and training, and their ability to expose graduates to the frontiers of scientific research provides a powerful mechanism for the transfer of knowledge and technology.

We end this subsection with a brief discussion of the basic findings from the executive summary of Lester's report on the regional impact of universities on technological innovation (Lester 2005), which we quote in full (emphasis is ours).

> The evidence shows that universities contribute to local innovation processes in a variety of ways. *At present the major focus is on technology transfer.* Many universities are seeking to exploit their laboratory discoveries by patenting and licensing intellectual property to local firms. *But often this is not the most important contribution.* In addition to their own discoveries, *universities can help to attract new human, knowledge, and financial resources from elsewhere. They can help to adapt knowledge originating elsewhere to local conditions.* They can help to integrate previously separate areas of technological activity. *They can help to unlock and redirect knowledge that is already present in the region but not being put to productive use.*
>
> *Very often the university's most important contribution is education*. Another important indirect role is to serve as a public space for ongoing local conversations about the future direction of technologies and markets. *The importance of the public space role of the university and its contribution to local innovation performance is often underestimated.*
>
> A key finding is that the *university role in local innovation processes depends on what kind of industrial transformation is occurring in the local economy.* New industry formation, industry transplantation, industry diversification, and industry upgrading are each associated with a different pattern of technology take-up and with a different set of university contributions. (Lester 2005, p. 3)

These three paragraphs summarize all major aspects of the role universities play from a local perspective, and when all references to "local" and "regional" are removed, also from a much broader one in contemporary society. The second paragraph mentions contributions universities make to the public debate on the future impact of technologies on local (and, we add, global) communities. This is even more urgent today, when information technology (IT) is providing not only new modes of social and technological interactions between people, organizations and government, but

also challenges introduced by the use of artificial intelligence for surveillance by governments everywhere, with both positive (more public safety) and negative impacts (possible uses for social control). Universities certainly have an important role in debating these issues, as they are the source of most of the science used and of most of the people involved in developing such new technologies. This "space of public debate" aspect of universities is closely related to the current revival of discussion about higher education and the "common good" (Marginson 2014), which is especially relevant for emerging economies, where resources tend to be scarce and there is a need for enlightened policy choices (as an example, see the chapter in Ashwin and Case (2018) on South Africa).

The last paragraph in the above quote suggests that a major factor in university–industry interaction is how industry is integrated within the local community where the university is located. We add that, again, this is relevant also in a national and global context: universities may develop all sorts of knowledge which can be used in technological applications, but unless there is a sufficiently developed industrial sector with innovative enterprises which would demand and apply that knowledge for innovative purposes, it will remain locked inside a restricted environment. What distinguishes vibrant national ST&I systems from ineffective ones is that the former include industry that sees the need to innovate to survive and compete, especially in the larger global arena. Universities can only do so much. As we will see later in the chapter, a competitive industrial sector is required for technological innovation, and its existence would further push for a research-intensive university system. This will become clear when we discuss how the US HE system developed after 1860, as science-based industrialization was taking hold, first in Europe, then across the (North) Atlantic, as well as the current development of HE in South Korea and China. We will also see that Brazil, like other Latin American countries, did not develop an industrial base then and, in fact, has not yet achieved a mature, innovative, competitive industrial sector, with significant (negative) consequences for university–industry interaction.

2.3 Science, Technology and Innovation Systems in National Contexts

We now discuss briefly the concept of an innovation system or ST&I system in a national context. According to Freeman and Soete (2008), the idea of national S&T systems is already present in the work of Friedrich List (List 1904) analyzing the roles of education and science at the beginning of the second phase of the industrial revolution in Germany, when science was becoming central to industry, especially in chemical processes and, later, in the applications of electricity (and magnetism) by Siemens and others, which had been established on solid scientific ground by Ampère, Gauss, Faraday, Maxwell and others (Forbes and Mahon 2014).

List observed that classical economists (Adam Smith, among them) had ignored the role science and technology played in economic development. He wrote:

> Rare are the industrial establishments that do not relate in some form to Physics, Mechanics, Chemistry, Mathematics, to Design Arts etc. No progress, no new discovery or invention may be accomplished in these sciences which are not capable of induce change or improvements in hundreds of enterprises or processes. (Freeman and Soete 2008, p. 505)

According to Freeman and Soete, these arguments played an important role in how Germany developed its systems of universal basic education and of research institutes and universities. List was the first economist to propose a systematic role for public policy on the development of new technologies by industry in national contexts—what is today usually referred to as "industrial policy." In this sense government has played a systematic role in both Germany and France since the beginnings of the industrial revolution. Japan, and more recently South Korea and China, also fit that model. The United Kingdom and the United States have tended to see a more restricted role for government in promoting industrial innovation, concentrating on supporting basic science, on establishing stable institutional frameworks and on government procurements to industry, and letting markets attend to industrial innovation. These models seem to have worked well for both the four original industrial powers and the three newcomers, leaders in the development of science and technological innovation, with neither model able to claim superiority over the other in terms of results (although this is always a favorite topic of political debate regarding ST&I systems).

As the concept of (national) systems of innovation eventually became accepted as a way to describe and understand how nations organize the various ST&I actors (see again Fig. 1), scholars sought to analyze such systems—Freeman and Soete (2008) for the case of the United States, and Albuquerque, Cario & Suzigan (2017) for the Brazilian context. According to these authors, and the analysis of Fig. 1, an innovation system can be described as based on the development of:

(a) universities which are highly capable of educating people in all fields, of producing high-quality research, and which are open to interactions with industry;
(b) industrial enterprises which are highly motivated and able to innovate in their field;
(c) institutions dedicated to help the interaction between universities/research institutes and industries, such as joint laboratories, innovation offices in universities, etc. (second block in Fig. 1);
(d) a regulatory framework which makes innovation possible; and
(e) appropriate financing mechanisms of R&D activities, both public and private.

How does a country develop an innovation system? We will now discuss the extent to which the level of development of a national ST&I system depends on its previous path.

Albuquerque, Cario & Suzigan (2017) observe that in the case of Brazil, the late development of all these aspects (including the establishment of universities)

explains, at least in part, the relatively low level of innovation by Brazilian industries and may be seen as relevant to the current (relatively weak) state of the Brazilian ST&I system. Some countries that started from even lower levels of ST&I activity by industry and from underdeveloped university systems have recently achieved impressive results, for example South Korea since the 1970s, more recently, China, and even more recently, India.

Despite efforts by Brazil to industrialize, at least since the end of WWII (and to develop a capable system of research universities), most of its industries still show very low levels of innovative capacity, due to a lack of market incentives, Brazil having been one of the most protectionist economies in the world. Between WWII and 1980, Brazil and many other Latin American countries adopted the import-substitution model of industrialization (Cardoso and Falleto 1979). But while other countries, such as South Korea and China, developed active economies producing manufactured goods with increasing levels of imported technology and were able to participate in the development of global value chains (Marcolin and Squicciarini 2017), Brazil remained trapped, condemned forever to be a provider of raw commodities and believing that "internal markets" would suffice for the economic development of its industrial sector. Even during the recent commodities trade boom of the 2000s this remained the case, as revenues from exports were directed to finance consumption, and not to provide savings for investments. As a consequence, while many emerging economies began expanding their transformation industry sector in the 1990s and linking it to global value chains, Brazil's transformation industry was (and still is) contracting, as we will see later in the chapter.

Lester (2005, p. 3) observes that "the university role in local innovation processes depends on what kind of industrial transformation is occurring in the local economy." If industry is shrinking in a country, not participating in the development or production of innovative products, how can one hope for a strong knowledge transfer link between university and businesses?

In view of the above discussion, we add to the list of criteria for the development of an effective ST&I system, the existence of:

(f) an economic environment which makes innovation not only relevant, but vital for businesses to survive and compete, not only at the national but also at the international level.

Rather than concentrating on government incentives, such as the fiscal waiver policies very common in Brazil, or on institutional aspects of the system, it may be more effective to develop market incentives for innovation, so that industry and other economic sectors will not only be interested in innovation, but will see it as essential for their existence. An example in Brazil is the privatization of the state-run aircraft company, Embraer, in the mid-1990s. Many thought it would not be able to compete internationally, but with initial government support, it eventually succeeded and is now one of the major international players in the sector (Montoro and Migon 2009). Brazilian agriculture, a sector that thrived in the international arena, is another success story that also involved much innovation.

In discussing development of a nation's ST&I systems, we need to identify important policy turning points in its institutional and economic development. Path-dependency limitations, especially those from the remote past (in Brazil's case, the colonial past) are not relevant. In the next section, we focus on turning points in higher education developments in the United States, and show how they relate to important phases of industrialization involving high levels of scientific knowledge. We also consider the relevance of Brazil's industrialization choices during the twentieth century to its present situation.

3 The Birth of the Research University, the Second Industrial Revolution and the First Wave of Expansion of Higher Education

The first phase of the industrial revolution, from 1750 to 1850, was characterized by the introduction of basic mechanization and the large industrial plant, and the growth of an organized financial system. Also relevant were the intensive use of coal for production of energy, the introduction of the steam engine and, in later years, of railroads. But the new science, the result of the scientific revolution of the two previous centuries, was mostly absent from these innovations which came from the inventive genius of a few people, most with only practical training. This would change drastically in the decades after 1850, which would also impact higher education, as science entered industrial innovation via the recently developed ideas of electromagnetism and new chemical processes (Landes 2003; Freeman and Soete 2008; Forbes and Mahon 2014).

While the United Kingdom, especially England, was the center of the first phase of the industrial revolution,[1] the second phase saw a change of guard, first to Germany and then to the United States. Germany, even before unification (1871), had been developing a broader educational system, from basic to higher education. Before the nineteenth century, northern Europe, including large areas that later became Germany, had already developed a system of technical schools (some of which would later become the Colleges of Applied Sciences, *Fachhochschulen*), as well as a large number of universities (Ridder-Symoens 2003). In contrast, England had only two institutions, and the situation had changed little by the end of the nineteenth century.

Weber (1958) argued that most industry leaders and technical workers in 1800s continental Europe, all with higher levels of education, were Protestant. He associated the "Protestant ethic" with Europe's (and Germany's) development of capitalism during the eighteenth and nineteenth centuries. He also observed that by the end of the nineteenth century, Protestants in Baden region mostly attended more "practically

[1] The decisive factors explaining why England was the starter of industrialization are still debated; they range from education to institutions to politics to economics to demography to geography. The historiography of this period has been updated frequently; see, for example, Allen (2009).

oriented" secondary schools (*Realgymnasien*, *Oberrealschulen* and *Realschulen*), which linked them to industrial development and the "spirit of capitalism" of the era.

With the advent of the eighteenth-century Enlightenment in Germany (Prussia), and especially in the early 1800s, there were calls for the development of a new type of university, which would embrace the developments of the scientific revolution and include research as one of its main activities. The main force behind those efforts was Wilhelm von Humboldt, whose proposal for research universities influenced the establishment of the University of Berlin (now Humboldt University) in 1810. Humboldt presented a model for a university fully autonomous in terms of academic orientation, emphasizing the role of research. He was very explicit:

> The State should not treat its universities as either gymnasiums or specialized schools or serve itself from their academia (faculty) for technical or scientific consultation. In general, …, it should not ask from them anything that is of its immediate and direct interest, but nurture the conviction that, fulfilling their objectives, universities will also satisfy its (State's) own, from a more elevated viewpoint, from which much more may be comprehended, allowing for the summoning of forces and leveraging which would be wholly different from those the State would be able to put in motion.

The model Humboldt proposed would eventually spread to much of Europe and, eventually, to the US where, after the Civil War, various private institutions were started, most notably Johns Hopkins University in 1876. It is interesting to contrast Humboldt's vision with that of Daniel Gilman, founder and first president of Johns Hopkins, expressed in his inaugural speech:

> What are we aiming at? An enduring foundation; a slow development; first local, then regional, then national influence; the most liberal promotion of all useful knowledge; the special provision of such departments as are elsewhere neglected in the country; a generous affiliation with all other institutions, avoiding interferences, and engaging in no rivalry; the encouragement of research; the promotion of young men; and the advancement of individual scholars, who by their excellence will advance the sciences they pursue, and the society where they dwell. (Gilman 1876)[2]

Gilman proposes a different university that must look for promotion of "useful knowledge," but confers on individual scholars the role of advancing the sciences which will eventually benefit the "society where they dwell." The state is not mentioned—government was not seen as a major actor in the endeavor, unlike in Germany or France. Benefiting society as a whole, and individuals through education, was the watchword from which support for higher education, be it from private or government sources, would get its legitimacy (Douglass 2007).

The founding of Johns Hopkins, like that of MIT (1861) and Cornell (1865) earlier, and of Stanford (1885) and Chicago (1890) later, all part of a new wave of "modern" private scientific-oriented institutions, was only part of the story. In 1862, amid the

[2]Gilman's speech is much more than a program for the new university being founded. It contains a long section describing a full system of education and discusses Germany's secondary school system, applied science colleges (which he calls polytechnics) and universities, as well as many other types of institutions. It is clear from his speech that mid-nineteenth-century American scholars already had a broad view of what would eventually become the country's higher education system, with different types of institutions and different missions.

Civil War,[3] the US Congress had passed the Morrill Act (the Land Grand Act), under which the Union would grant land to states to be used to support the establishment of colleges primarily dedicated to "agriculture and the mechanic arts."[4] In the following decades, further legislation promoted the development of the new system, including support for agriculture stations, at a time when the US was not only industrializing fast but was also becoming the main agricultural power in the world (APLU 2012).

Even though most of the new institutions founded under the Land Grant Act were not, at least initially, dedicated to research, they formed the basis of a large state system of institutions which, as Marginson (2014) claims, started the era of mass higher education in the world. This system expanded after WWII to absorb the war veterans and receive most of the new money made available by the federal government for research (see below and also Thelin 2011).

The expansion of higher education following the Morrill Act was closely connected with the industrialization then under way in the United States, and with the development of engineering education. Mann, in his 1918 Carnegie Foundation report on engineering education in the US, observes that, until 1850, a "high degree of engineering ability was required to accomplish this industrial revolution," but adds:

> Among the civil engineers who took part were a number who had the advantage of scientific training either at Rensselaer or at West Point. But in the long list of mechanical engineers who built the locomotives, the steam engines, the machine tools, and the farm machinery, it is difficult to find a single one who had any special school training for the work. As science developed and machinery became more and more complex, the need of special training for the mechanical engineer became more pressing. Hence the period from 1820 to 1870 may be said to have indicated the value of special training for the civil engineer, and to have defined the need for trained mechanical engineers for industrial production. (Mann 2018, p. 5)

New York's Rensselaer Polytechnic Institute and West Point were, until the foundation of the MIT in 1861, the only two schools in the US dedicated to engineering. At the time of Mann's report, there were more than 120 institutions where engineering was considered one of the main fields, most of them land-grant institutions. The US was already graduating more engineers than any other country in the world, including Germany, with more than 30,000 students enrolled in engineering programs. Not only did the Land Grant Act help create mass higher education, it also helped create engineering education as we know it today.[5] Today, over 75% of all engineers graduating from US HEIs have studied in the more than 100 land-grant colleges and

[3]The Morrill Act's approval benefitted from the fact that, due to the Civil War, representatives of the Democratic South, who were mostly tied to traditional landowners and against public support for any type of education, especially using federal resources, were not attending sessions (APLU 2012). Morrill was a senator from Vermont who had been trying to pass the bill since the 1840s. Lincoln was a Republican and supported Morrill and the new legislation. Accordingly, a provision of the law barred any state in a "condition of rebellion or insurrection against the government of the United States" from benefitting from the grant.

[4]Its name made this explicit: "An Act donating Public Lands to the several States and Territories which may provide Colleges for the Benefit of Agriculture and the Mechanic Arts.".

[5]MIT was also very influential, especially regarding engineering programs' curricula, as Mann points out in his report. It is interesting to observe that, despite being a private institution, MIT was

universities, which currently enroll over 3.5 million undergraduate students, 1.1 million graduate students and attract two-thirds of all federal research funding (APLU 2012; Brantley 2012). Research, as we will see later, became prominent in the system after WWII.

It is instructive to compare the early development of engineering education in the US with that in Brazil. In 1860, when there were two engineering-dedicated institutions in the US, in Brazil there was one, the Imperial Academia Militar, which was established in 1808 and followed the model of the École Polytechnique in Paris. In 1874, its civil engineering branch was separated and formed the Escola Politécnica in Rio de Janeiro, today part of the Federal University of Rio de Janeiro, and the Instituto Militar, nowadays the Military Institute of Engineering, also in Rio. At about the same time, Brazil's ruler, Dom Pedro II, commissioned a French mining engineer to develop a School of Mines in Ouro Preto, in the heart of the original gold mining region in the state of Minas Gerais. These foundations were followed, after Brazil became a Republic in 1889, by the Escola Politécnica in São Paulo (1893), now part of the University of São Paulo, the School of Engineering in Porto Alegre (1896), now part of the Federal University of Rio Grande do Sul, and the Mackenzie Institute, founded by American immigrants in São Paulo in the same year with a curriculum based on the US model. Thus, in 1900, there were only six schools dedicated to engineering in Brazil (and no university, with all institutions basically dedicated to a single field). Between 1900 and 1940, only a few other schools of engineering were founded, so that, by that year, Brazil's engineering education was restricted to about ten institutions (Schwartzman 2015). We will return to engineering education in Brazil in the last section.

But the low level of development of HE in Brazil well into the twentieth century was not restricted to engineering education. At the end of the imperial period, in 1889, Brazil had only seven HEIs, two each in law and medical education and three in engineering (Cunha 1980). At least there had been some progress since 1808, the year the Portuguese court fled to Rio de Janeiro from invading French troops, when there had been none! At that time, there were various large universities spread along the Spanish colonies in the Americas, but Portugal did not allow colonies to develop universities (Cunha 1980; Schwartzman 2015). In 1800, there were already 38 colleges in the US, increasing to 381 by 1860, just before the Land Grant Act (Snyder 1993, Table 27). By 1880 the number had more than doubled to 811 institutions, and by 1900, there were 1,000 HEIs (Table 23). In that year, 238,000 thousand students were enrolled, and 27,000 bachelor's degrees and 382 doctorates were awarded.

Only in the 1930s did Brazil start to develop research-oriented universities, the first being the University of São Paulo (USP) which remains the country's leading research university. USP has been from the start a public university, fully funded by the State of São Paulo. Most of the state institutions founded during the first half

chosen by Massachusetts to receive land-grant benefits in the state, as the law did not require that colleges that benefitted from the grant had to be state run or funded. Public land-grant institutions were essential for providing the large numbers of engineers and other scientists required by industry for projects and to work in their new R&D laboratories.

of the twentieth century later became federal institutions. Until the 1980s, only São Paulo maintained a strong state system. This contrasts with the US, which never developed a national system of public universities.

Schwartzman (2015) and Motoyama and Ferri (1979) point to the founding of USP in 1934 as a turning point for scientific research in the country. Brazil's HE system remained relatively small until the end of WWII, with academic research and graduate education in their infancy. In 1945, 27,000 students were enrolled in Brazil (Cunha 1980), while in the fall of the same year, US HEIs were enrolling 1.68 million students (Snyder 1993, Table 24).

How did Brazil come to be left behind by such a wide margin in higher education in general, and engineering education in particular, during the nineteenth century and a good part of the twentieth? The slow beginnings are only part of the story. Industrialization and the economic development it brought, especially in the period after 1850, as science became increasingly tied to industrial innovation, played an important role in pushing countries to develop their higher (and secondary) education systems.

With the US entering a period of intensive industrialization after the Civil War, there was considerable pressure first on Congress to pass the Land Grant Act, then on states to develop their systems—even though politically, policies in areas such as food production, basic education, public health, sanitation and urban issues may have seemed more urgent. The benefits of industrialization were still hard to see for most people. The fact that Congress, federal and state governments used scarce resources for the development of higher education amid the ravages of the Civil War, with the mandate to develop "mechanics and agriculture," is one of the small political and historical miracles that happen so rarely. Its impact on the US as a world leader in science, technology and innovation was huge.

Even in 1930, Brazil was still an agricultural economy dependent on a few crops, such as coffee, as it had depended on sugarcane during the colonial period (Fausto 1970). Industry was limited to textiles and food products. In São Paulo, the country's most industrialized state, there were only four metallurgical companies in 1925, producing a total of 12,700 tons of steel. Belgium, a small player in Europe, was already producing over 100,000 tons in 1879, while the UK, the largest producer in the world, had an output of more than a million tons that year.

In 1920, agriculture's share of total employment (6.38 million) was still eight times higher than that of industry (789,000), and agriculture accounted for two-thirds of all employment. Not till the 1980s did industrial employment (all subsectors) surpass that of agriculture (IBGE 1990). In the United Kingdom, the number of people employed in industry exceeded those in agriculture before 1850, and in Europe as a whole by 1890 (Crafts 1988).

Industrialization had a huge impact on the economic development of the US and of most European nations. According to data collected by the Maddison Project (2019), in 1800, Brazil's GDP/capita was equivalent to 56% of that of the US ($1,123 to $1,980). By 1920, that ratio had been reduced to 18%, with the US figure $8,845

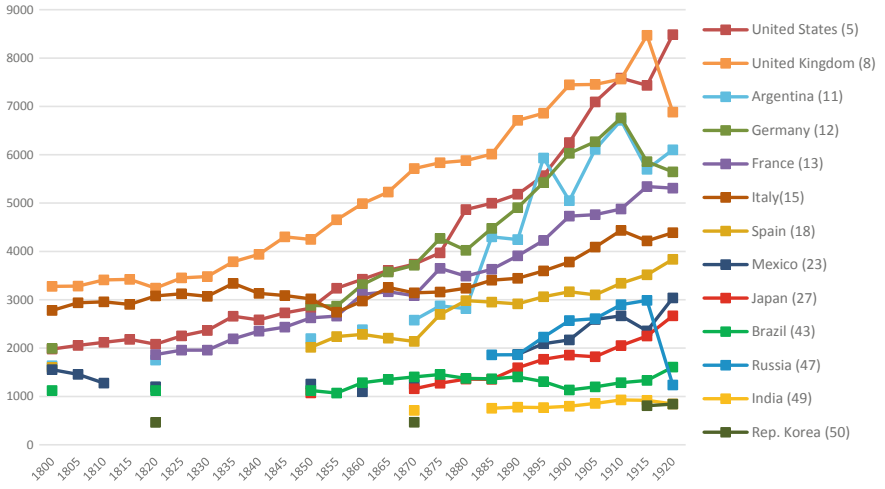

Fig. 3 GDP per capita, Brazil and comparison group of countries, 1800–1920. *Notes* PPP$ International Dollars 2011. Number in parenthesis in legend is rank in 1920 among 50 countries with data available. *Source* Maddison Project (2019)

and Brazil's, $1,608. Figure 3 includes data for Brazil and a comparison group of countries.[6]

Argentina, ranked 11th on GDP/capita in 1920 and still a relatively rich country by the end of WWII, would eventually be left behind as its insertion in the world economy still depended basically on agricultural products. Mexico had a relatively good position due to the early development of its oil industry, but, again, it did not participate in the industrial revolution actively. As Stearns (2012, p. 102) puts it,

> The simple fact was that the goods exported to the West (by LA countries) – agricultural and mineral products almost exclusively – were not as valuable as the manufactured products that the West exported. The terms of trade favored the West. Furthermore, Western capitalists controlled many operations directly. They ran the shipping and most of the international trading companies. With their greater capital resources, they bought many mines and estates directly.

He then mentions the origins of the international debts and economic dependency of LA countries:

> Local governments and businesses, seeking to develop their export opportunities and in some cases sincerely hoping to generate more diversified economies, frequently went into debt. … The solution was to borrow from eager, capital-rich banks in western Europe and the United States; the result was a growing indebtedness that made additional investment

[6]The group of countries includes the US and the most developed larger European countries by 1920, as well as Argentina and Mexico in Latin America, India, Russia, and the Republic of Korea (later S. Korea). China does not have data available for 1920 in the tables. Its GDP/capita for 1930 ($807) would be lower than that of Korea in 1920. We will follow the development of these countries, and of a few others which we deem relevant for analysis of later periods, in economic terms and regarding their scientific and innovation outputs.

> more difficult and that invited Western interference, including military threats on occasion, in basic economic policy. … Latin America became a classic area of economic dependence, importing manufactured products and luxury goods from the West while trying desperately to stay afloat with low-cost exports.

While this perhaps simplistic argument is open to dispute, the end results Stearns mentions coincide precisely with observations for LA as a whole at the beginning of the twentieth century and even for later periods (see the analysis by Cardoso and Faletto 1979). The structural economic dependency on developed economies established at the end of the nineteenth and beginning of the twentieth centuries in practically all LA countries exacted a heavy price on their development which some of them have only recently started to overcome.

A comparison of Brazil with Japan shows that, despite Japan's relatively low GDP/capita in 1920, it had been developing a strong industrial sector, including an extensive railroad system, ship building, aircraft, machinery, weapons and even a high-quality optical industry (Stearns 2012). Although much of this was destroyed during WWII, post-war recovery was incredibly fast. Accumulated scientific knowledge and innovative industrial capability may stop functioning during a catastrophic event but, given a chance, will eventually flourish—a lesson for all nations.

In 1930, agriculture and animal food production still accounted for 30% of the country's GDP, almost twice the participation of industry, 16% of the total output (all industrial sectors). Industrialization started with political changes after 1930, with reforms promoted by Vargas finally bringing Brazil into the twentieth century (Fausto 1970). By 1944, industry finally overtook agriculture in the composition of the country's GDP,[7] a stage which the industrialized nations had already reached in the 1800s. In 1945, Brazil's GDP/capita was $2,320, less than 15% that of the US ($15,992), and still about one-third that of Argentina ($7,652) (Maddison Project 2019). Nevertheless, Brazil's nascent industry was to transform every aspect of the country after WWII.

Perhaps the small miracle we associated with the passing of the Morrill Act in the US was not actually a miracle at all. There was an already relatively large higher education system in place, and a few bright minds, with sufficient conviction and awareness about the direction things were turning to in the mid-1800s. Maybe it is more surprising that a country like Brazil, with a large territory and other resources, and historical links to Europe, would have so dramatically missed what was happening in Europe and North America. Yet the fact that the economy's participation in international trade was still based on agricultural commodities in the twentieth century, and the consequent limitations on the country's ability to invest in industrial development, is an important piece of the apparent historical puzzle.

[7] Author's estimates based on Haddad (1975) and IBGE (1990).

4 Higher Education, Science and Technology in the Post-WWII Era (1945–70)

4.1 The Increasing Role of Government

The technological advances from R&D carried out during WWII and the advantage they gave the Allies changed government's view of science's role in relation to strategic national interests dramatically. The success of the Manhattan Project, developed under military supervision, which produced nuclear artifacts in less than two years from its inception, building on scientific knowledge that had been worked out in universities in the US and Europe, including Germany, during the 1930s, was the most visible of the various technological advances made during the war years, which also included the development of penicillin, radar, information technology (the breaking of German codes by Turing and his group), initial semiconductor technology and many others.

In July 1945, the month before the first atom bomb was dropped on Hiroshima and Nagasaki, Vannevar Bush[8] wrote a report for President Truman (requested by Roosevelt at the end of 1944[9]), entitled *"*Science, the Endless Frontier.*"* Bush was then Director of the US Office of Scientific Research and Development, the agency created by Roosevelt in 1940[10] to coordinate scientific research for military purposes. A central theme in his report was that government should be the main supporter of basic research, especially in universities. He observed that with

> some notable exceptions, most research in industry and Government involves application of existing scientific knowledge to practical problems. It is only the colleges, universities, and a few research institutes that devote most of their research efforts to expanding the frontiers of knowledge. (Bush 1945, p. 6)

In the section "The importance of basic research," he discusses not only the purpose, but the very nature, of basic research, implying the need for government support (emphasis is ours):

---

[8]Bush was an extremely accomplished research-oriented electronic engineer and entrepreneur, trained at MIT, where he had also taught. He was one of the founders of Raytheon, to this day a leading high-tech company in air-traffic control systems, missiles, radar and surveillance technology, satellite sensors, semiconductors and many other technologies. It was the main contractor to develop radar instruments during WWII. Using the technology, Raytheon developed the commercial microwave oven, launched in 1947.

[9]Roosevelt's letter of Nov. 17, 1944 to Bush ended with the following very interesting remark: "New frontiers of the mind are before us, and if they are pioneered with the same vision, boldness, and drive with which we have waged this war we can create a fuller and more fruitful employment and a fuller and more fruitful life." Bush's text may be seen as quite a literal expansion and response to Roosevelt's call.

[10]Bush's first proposal for such an agency in 1940 was approved by Roosevelt approved, resulting in the establishment of the National Defense Research Committee (NDRC), composed of various important scientists, including Compton and Loomis, who were researching radar technology, and Lawrence, who would later be an important Manhattan Project scientist. The Office was established in June 1942 and assumed the duties of the NDRC.

> *Basic research is performed without thought of practical ends. It results in general knowledge and an understanding of nature and its laws.* This general knowledge provides the means of answering a large number of important practical problems, though it may not give a complete specific answer to any one of them. The function of applied research is to provide such complete answers. *The scientist doing basic research may not be at all interested in the practical applications of his work, yet the further progress of industrial development would eventually stagnate if basic scientific research were long neglected.*
>
> One of the peculiarities of basic science is the variety of paths which lead to productive advance. Many of the most important discoveries have come as a result of experiments undertaken with very different purposes in mind. *Statistically it is certain that important and highly useful discoveries will result from some fraction of the undertakings in basic science; but the results of any one particular investigation cannot be predicted with accuracy.*
>
> *Basic research leads to new knowledge. It provides scientific capital. It creates the fund from which the practical applications of knowledge must be drawn.* New products and new processes do not appear full-grown. They are founded on new principles and new conceptions, which in turn are painstakingly developed by research in the purest realms of science. (pp. 18–19)

Arguing that Europe will not be able to maintain its pre-war scientific activity level, Bush explains why government must support basic science (emphasis is ours):

> New impetus must be given to research in our country. *Such impetus can come promptly only from the Government. Expenditures for research in the colleges, universities, and research institutes will otherwise not be able to meet the additional demands of increased public need for research.*
>
> Further, we cannot expect industry adequately to fill the gap. *Industry will fully rise to the challenge of applying new knowledge to new products. The commercial incentive can be relied upon for that. But basic research is essentially noncommercial in nature. It will not receive the attention it requires if left to industry.*
>
> For many years the Government has wisely supported research in the agricultural colleges and the benefits have been great. *The time has come when such support should be extended to other fields. (p. 22)*

Bush also envisioned the need for a government agency dedicated to funding such research, after observing that there is no such organization yet (emphasis is ours).

> Therefore I recommend that a new agency for these purposes be established. Such *an agency should be composed of persons of broad interest and experience, having an understanding of the peculiarities of scientific research and scientific education.* It should have stability of funds so that long-range programs may be undertaken. *It should recognize that freedom of inquiry must be preserved and should leave internal control of policy, personnel, and the method and scope of research to the institutions in which it is carried on.* (*p. 9)*

That agency would be the National Science Foundation (NSF), founded in 1950,[11] the model for research funding agencies developed throughout the world in the following decades, including the National Scientific Research Council (CNPq) in Brazil, established in 1951.

[11] There was a long debate in the US Congress from 1945 until the end of 1949 about the governance structure and focus (including applied research) of the new agency. The final structure and mission would follow, essentially, Bush's vision of academic leadership and criteria for support, with a focus on basic science.

Table 1 US R&D expenditure by source of funds, 1953–83 (US$ billion of 1977)

Year	Federal	Business	Total	Federal (%)
1953	4.6	4.1	8.7	54
1958	10.2	5.9	16.2	63
1963	15.6	8.1	23.8	66
1968	18.1	11.7	29.8	61
1973	15.5	13.5	29.1	54
1978	15.8	16.1	32.0	50
1983	18.6	21.9	40.5	46

Source Mowery and Rosenberg (1989)

Bush was well aware of how government had increased R&D support during the war and worried that government and Congress would not maintain it at the same level. Federal expenditure on R&D had risen from US$83.2 million in 1940 to US$1.314 billion in 1945. The growth was not restricted to direct military applications; expenditure on the development of weapons and military vehicles (tanks, ships and airplanes) totaled US$423 million in 1945 (Mowery and Rosenberg 1989). Many other areas received direct federal money, including developments in medicines, new materials (synthetic rubber), communications, even the start of semiconductor technology, with federal support given to Shockley at the Bell Labs during the war to develop the first solid-state diode, used in radar applications. The transistor was first tested in 1947, also at the Bell Labs.

Bush's defense of the importance of government support for basic research, coming from someone deeply involved in developing technology in many areas, who had been in charge of the war effort on science and technology, had an enormous impact on US ST&I policy, with reverberations all over the world. By 1953, government was spending US$4.6 billion (in 1977 dollars), which went up to US$18.1 billion in 1968, as Table 1 shows.

We can see that private expenditure eventually caught up and surpassed the public, which remains the case to this day. But, at least until 1970, federal money was the main source for R&D in the US. The main items behind the early faster growth of federal money were the space program and defense research.

Support for basic research, as Bush had proposed, was mostly directed to universities, both public and private (MIT, CalTech, Stanford and others have absorbed large amounts of federal funds since then), but the main players were ultimately the most developed state university systems. At the same time, the GI Bill,[12] the Servicemen's Readjustment Act, which supported war veterans as they completed their education, changed the landscape of US undergraduate higher education. Enacted in June 1944, this was a turning point in the development of higher education in the US. In 1930, after steady growth of the public system, the participation of the public

[12]GI is the abbreviation for galvanized iron, term that was associated with the infantry soldiers of the US Army.

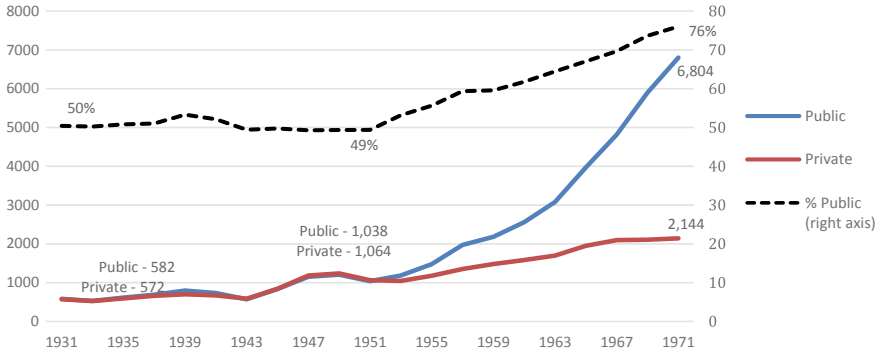

Fig. 4 Enrollments in higher education in the US (thousands, left axis), by sector, and participation of the public sector (%, right axis). *Source* Snyder (1993)

sector, which had been only 20% in 1990 (Goldin and Katz 2009, p. 278), was about 50%, a level that it maintained until 1950 (Snyder 1993, Table 24). In 1961, 62% of all students were enrolled in public institutions; participation exceeded 75% in 1971 and has been maintained at that level since. More than 2 million veterans went to college with support from the GI Bill amounting, in the decade after WWII, to US$48 billion (dollars of 2000) (Thelin 2011, p. 263) (Fig. 4).

One of the state systems that benefited most from the GI Bill and also from new federal research finds was the University of California (UC), one of the original land-grant institutions. In 1940, the system enrolled about 23,000 students, increasing to 33,000 in 1950 and to 38,000 in 1960. In recognition of the relevance of the university for the state, a Master Plan developed under the leadership of Clark Kerr, president of the university system, included a goal of 100,000 students enrolled by 1985. Undergraduate enrollments duly reached 73,000 in 1970, 94,000 in 1980 and 108,000 in 1985 (Douglass 2007; University of California Office of the President 2020).

Graduate education, with strong support from the newly founded NSF, also expanded quickly in the UC system, reaching 27,000 students enrolled in 1985. Today, the system, comprised of ten *campi*, is possibly the best public research-oriented, HE system in the world. It has had an enormous impact on the technological advances developed in California, not only in Silicon Valley, but also in agriculture, aviation, pharmaceuticals, and many others (Kenney and Mowery 2014).

Thelin (2011, p. 261) comments that the rise of higher education after WWII and its growing role in research should not be regarded as something planned from the start, as a direct result of "public policies" developed by government. He argues that various interests and groups participated and contributed to that process, most without a clear vision of the desired goals and objectives (Thelin 2011, p. 262). Mowery and Rosenberg (1989) observe that during

> most of the pre-1940 period, basic research in the U.S. was clearly second rate in comparison to those in European countries like Germany, United Kingdom and France, despite the

> fact that Physics research was already attaining world class status between the wars. The fundamental transformation in the structure of the U.S. R&D system brought by WWII changed the status of science in the country, which turned from follower to uncontested leader.

Along with the development of research in universities, the post-war period was also one of fast growth for graduate education, which benefited from the scholarship program supported by the NSF. In 1950–51, 7,337 PhD degrees were awarded by US universities, about twice as many as a decade before. That number then more than quadrupled, to 32,107 in 1970–71 (Snyder 1993, Table 28).

Albuquerque, Cario & Suzigan (2017), citing Rosenberg (2000), list five characteristics that distinguish the US HE system from those of other developed nations:

(a) capacity to respond to economic demands;
(b) high levels of decentralization;
(c) competition for funds;
(d) scope and coverage, related to high levels of diversification; and
(e) unique synthesis of research and education at undergraduate and graduate levels.

These characteristics, already fully in place by 1970, can be traced to the three turning points already mentioned:

(1) The founding of a group of private, research-intensive institutions, starting in 1861 with MIT, then Cornell, Johns Hopkins, Stanford, Chicago, CalTech and others, which influenced the colonial colleges, like Harvard, Yale, Columbia, Princeton and others, to follow an updated Humboldtian research-oriented model.
(2) The establishment of (state) public institutions in the wake of the Land Grant Act of 1962, and further legislation, like that establishing the agricultural stations; some of these institutions, like UC Berkeley, were already developing research of a high order before WWII, but not at the level of the best European institutions.
(3) The GI Bill and the creation of the NSF (1950), which, through federal support, expanded and qualified the state public systems.

In his 1945 report, Bush proposes that government should be the main supporter of basic research, while also mentioning industry's role in that support.

> In providing government support, however, we must endeavor to preserve as far as possible the private support of research both in industry and in the colleges, universities, and research institutes. These private sources should continue to carry their share of the financial burden. (Bush 1945, p. 22)

Mowery and Rosenberg (1989) observe that, in 1953, about 11% of academic research was funded by businesses, but that participation quickly fell to 5.5% by 1960, then to less than 3% by 1978. During the 1990s it increased to 7%, a level it has maintained since (Brito Cruz 2014). It is frequently claimed that Brazil's universities are not interested in private support of research, or that they do not offer industries opportunities and projects that it can support. In fact the most research-intensive universities

show a similar level of support from industry for research to those in the US, at about 5% of the total funding for academic research (Brito Cruz 2019).

4.2 *Brazil's Industrialization and the First Wave of Expansion of Higher Education*

Between 1945 and the early 1960s, the number of students enrolled doubled to 100,000. A subsequent period of fast growth brought the number to 1.4 million in 1980, a 14-fold increase in less than two decades, as shown in Fig. 5.

A comparison with data for the US (Snyder 1993) shows that the high level of expansion in the immediate post-war years that occurred in the US system did not apply to the Brazilian case. Only after the mid-1960s is there relevant expansion of Brazilian HE. Another important difference is that in Brazil, the private sector, which was smaller than the public one until 1970, expanded faster and became dominant, a situation that endures to this day. After the military seized power in 1964, a series of liberal reforms which included the higher education system facilitated the expansion of the private sector, although the public sector was also rapidly expanding. Demand was also expanding, as secondary education was also growing fast and Brazil was said to be in a period of "economic miracle." In fact, from 1965 to 1980, the Brazilian economy grew at a yearly rate of 8.5%, one of the highest in the world. GDP/capita rose from $2,320 in 1945, to $10,687, now more than a third that of the US ($29,613) and 74% of that of Argentina ($14,414), which had started to fall behind (Maddison Project 2019). In comparison, all Latin American countries, including Brazil, had a yearly GDP growth rate of 5.4% between 1947 and 1980. South Korea's GDP/capita

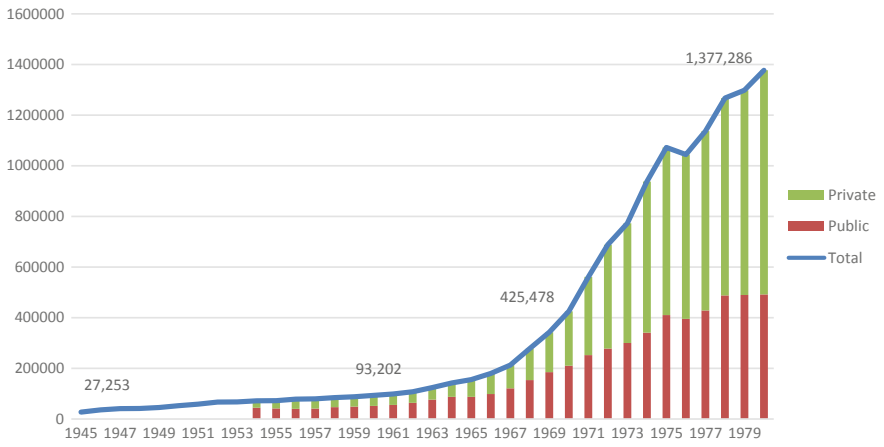

Fig. 5 Undergraduate enrollment figures, total and by sector, Brazil, 1945–80. *Sources* Cunha (1980), Levy (1986), INEP/MEC

growth rate had been similar, and its GDP/capita was a little over half that of Brazil ($5,674) in 1980. However, it was about to start an even faster period of growth, as Brazil's economy entered a long period of stagnation.

Industry's expansion was a major part of the story, as in 1980, the transformation industry sector reached 31% of GDP, and industry as a whole, including construction, mineral extraction and other sectors, accounted for 40%. Industrialization had become the motto of all post-WWII administrations in Brazil. Agriculture's contribution to GDP had dropped to 10%, and services were reaching 50%. Brazil appeared to have become a modern industrial economy, and many hoped that it would be able to escape the "middle-income trap" that seemed to hold back all countries that reached that level of economic development. This was not the case, as we will see, but the level of industrialization that Brazil had attained in 1980 was certainly part of the explanation for the fast expansion of higher education in the previous two decades.

The development of higher education between 1960 and 1980 was not restricted to undergraduate education. In 1951, two federal agencies, one dedicated to supporting research, the National Council of Scientific Research (CNPq), and the second to supporting graduate education, the National Coordination for the Development of Academic Personnel (CAPES), were founded. Their activities started at very low levels, as there were not many researchers or graduate programs in the country. In fact, when, in 1965, Brazil's Federal Council of Education established regulations for graduate programs, there were 37 such programs in the country, 26 at master's and eleven at doctorate level (Balbachevsky 2004). In 1970 there were 70, and by 1980, over 250 doctoral programs (and more than 700 at master's level), with almost 40,000 students enrolled (Schwartzman 2014, pp. 287–9). CNPq and CAPES also supported a growing number of graduate students in the US, France, the UK and Germany.

Meanwhile, scientific research had also started to develop. In 1980, 1,615 scientific publications,[13] or 0.36% of the world output of over 455,000 publications, included authors working in Brazil. Of those publications, 19% had co-authors from other countries, an indication of the international insertion of the Brazilian academic community. Argentina remained ahead of Brazil, with 1,046 publications for a much smaller population. South Korea had only 141 publications attributed to its researchers. We will present detailed data on scientific output after 1980 in the next section.

The founding by the Brazilian Air Force of the Centro Técnico Aeroespacial (1947–50), a mixed research, technological and higher education center dedicated to aircraft and aerospace education, research and development and based on a report by MIT aeronautics engineer Robert Smith, had an important impact on the future of the Brazilian aircraft industry. It included an engineering school, the Technological Institute of Technology (ITA), modeled on MIT, whose graduates founded Brazilian aircraft company Embraer in 1968. Two research institutes, the Brazilian Center for Physics Research (CBPF), founded in 1949, and the Pure and Applied Mathematics

[13] Articles, Proceedings Papers and Reviews listed in the Web of Science database. InCites/Clarivate, download 2019/09 (Fapesp license).

Institute (IMPA), founded in 1952, would play major roles in developing Brazilian science.[14]

In the early 1960s, COPPE, the graduate school of the Polytechnic School of the Federal University of Rio de Janeiro, was founded, soon becoming the country's top graduate school for engineering. The Brazilian Agricultural Research Corporation (EMBRAPA), a federal company, was founded in 1973, eventually becoming a major source of innovation in all areas of agribusiness, including the development of grain adapted to tropical regions, which made it possible for Brazil to become a world leader in production of food products.

All these science/business success stories involve economic activities related not to the development and production of manufactured goods oriented to mass markets, but rather to commodities (agriculture, oil and gas) and the aircraft industry, which, despite involving high-tech innovation, in fact produces intermediary goods for transport, part of the service economy. Thus, despite the push for industrialization in Brazil during the post-WWII period, most of the new technology was brought to Brazil by foreign companies under import substitution. This is a recurrent theme in Brazil's (and Latin America's) economic history.

In São Paulo, two new state universities were founded, the State University of Campinas (Unicamp), in 1966, and the State University of São Paulo (Unesp), in 1976. Both would eventually become important research institutions, making São Paulo the national leader in research and graduate education. The state also established a research funding agency in 1962, the São Paulo Research Foundation (Fapesp), to help develop graduate education and research.

The National Technological Fund (FNT) was established in 1964 under the auspices of the National Economic Development Bank (BNDE). From 1968, administered by federal agency FINEP, it became the National Fund for Scientific and Technological Development (FNDCT), and was an important source of funds for industrial R&D in the next decades (for more on this see Pedrosa and Queiroz 2014). It is interesting to observe that, despite the tension between academia and the military rulers of the country during the 1970s, somehow there was some sort of "convergence" of interests, as many saw, in the strong state-oriented model of development that the military adopted, exactly what many left-oriented economists and scientists had been asking for the country since the end of WWII (Schwartzman 2015, p. 279).

The Minister of Planning for much of the 1970s, João Paulo dos Reis Veloso, had an important role in planning for the scientific and technological development of the country (Suzigan and Villela 1997). Despite the tension between academia and the military regime, many left-oriented economists and scientists saw a convergence of interests in the strong state-oriented model of development (Schwartzman 2014, p. 279).

Nevertheless, the import-substitution model adopted since the end of WWII by successive administrations implied an extremely protected economic environment for Brazilian industry, with high tariffs and restrictions on industrial imports, and

[14] IMPA, especially, has developed into a major international research institute, from which Arthur Ávila, the first Brazilian Fields' medalist (2014), graduated and where he works.

the country was ill prepared for the foreign debt crisis that hit many LA countries. Brazilian policies had focused on the development of internal markets, with the term *nacional-desenvolventismo* adopted by civil and military administrations since 1950 to describe their chosen economic model. Cardoso and Falleto (1979) observe that the dependent nature of LA economies in relation to the developed nations limited their industrialization compared to alternatives, such as Japan, whose model was based on exports of consumer goods, sacrificing internal consumption in favor of savings to be invested in the recovery. South Korea and China more recently would follow the same path, demonstrating clearly that a country cannot depend exclusively on using foreign savings to develop chosen industrial subsectors and to increase internal consumption for long periods of time, as Brazil did between 1950 and 1980. By 1984, the import-substitution model had more or less collapsed, as the foreign investments that had fueled decades of growth were suddenly cut, and Brazil (and Mexico) defaulted on their foreign debt after the sudden rise of interest rates that followed the international oil crisis in 1979. There was no time for a controlled transition to a more open economy. Inflation soared and Brazil's economy faced a period of stagnation that lasted a full decade. In 1995, Brazil's GDP/capita, which had reached $10,687 in 1980, was still only $10,905. Figure 6 shows GDP/capita figures for the same countries as in Fig. 3, adding South Africa and removing Russia.

We can see how following a period of growth until 1980, the three largest LA economies, Argentina, Brazil and Mexico, suddenly stagnated, while South Korea, which was still far below them in 1980, increased its growth rate and was already ahead by 1995, with a GDP/capita about 70% higher than that of Brazil. China and India had not yet started their fast growth period. South Africa had slow growth from 1945 to 1980, then fell to a level just below that of Brazil in 1995.

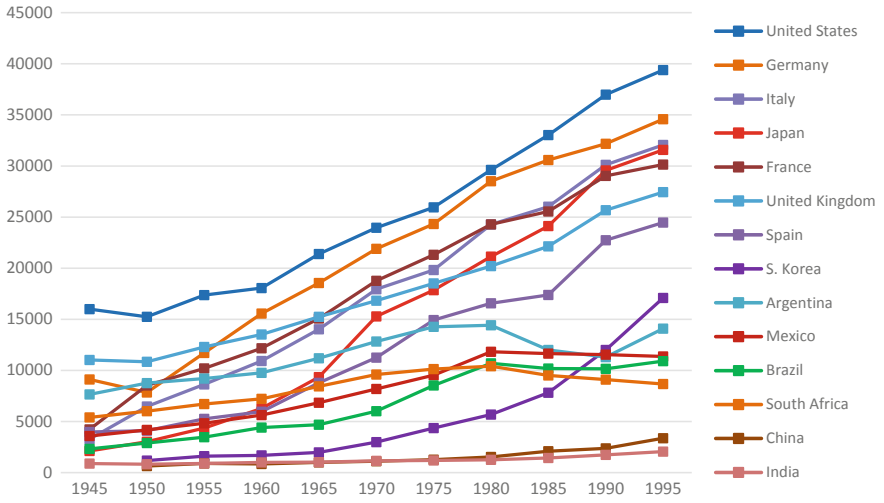

Fig. 6 GDP/capita, selected countries, 1945–95. *Source* Maddison Project (2019)

The stagnation in the economy had its counterpart in higher education, with the number of undergraduate enrollments expanding only from 1.4 to 1.8 million between 1980 and 1995. As GDP/capita decreased between 1980 and 1985, so did enrollment in the private sector, showing how the economic environment directly impacts the population's ability to pursue higher education in the absence of strong public subsidies, as was then the case.

5 Recent Trends in Development of Higher Education, Industry and Their Interactions

In 1995, the newly elected Brazilian administration of sociologist F.H. Cardoso finally began to control inflation and start a process of economic normalization of the country. Cardoso continued the previous administration's policies of greater openness to foreign trade and the privatization of many areas and companies (such as Embraer). The previous fifteen years of stagnation, however, had reduced Brazil's ability to compete internationally, as globalization was taking hold and Asia was starting on its high-tech industrial development path.

5.1 Economic and Industrial Development

Brazil would never recover the industrial dynamism of the post-WWII era. The recent surge in economic growth is based on the rise of commodity prices, especially the important exports of grain, meat and iron ore. Figures 7 and 8 explore economic development since 1990 for our group of countries.

Figure 7 updates the GDP/capita growth for our group of comparison countries from 1990 to 2015, with Chile, Colombia and the Russian Federation added.

The first obvious development is how South Korea has moved quickly from the group of emerging economies, which included Brazil, its LA neighbors, South Africa and Russia, to the leading pack, overtaking Spain and Italy. If this trend is maintained, South Korea appears on the verge of overtaking Japan, the UK and France in (real) GDP/capita. China has caught up with some LA countries and is on course to overtake them soon. Chile shows the highest rate of growth in the period among LA countries and already leads that group of nations. Brazil finally shows some growth between 2005 and 2015. Leading nations, in particular Spain, Italy, Japan and France, have slowed their growth rate. To better evaluate the long-term GDP/capita growth rate of this group of nations, we split the period from 1945 to 2015 into four sub-periods and present the data in Table 2.

In the two decades since 1995, Brazil has actually recovered some of the economic dynamism it had lost between 1980 and 1995, but not to the levels that China, India and South Korea had been enjoying since at least 1980. South Korea shows the

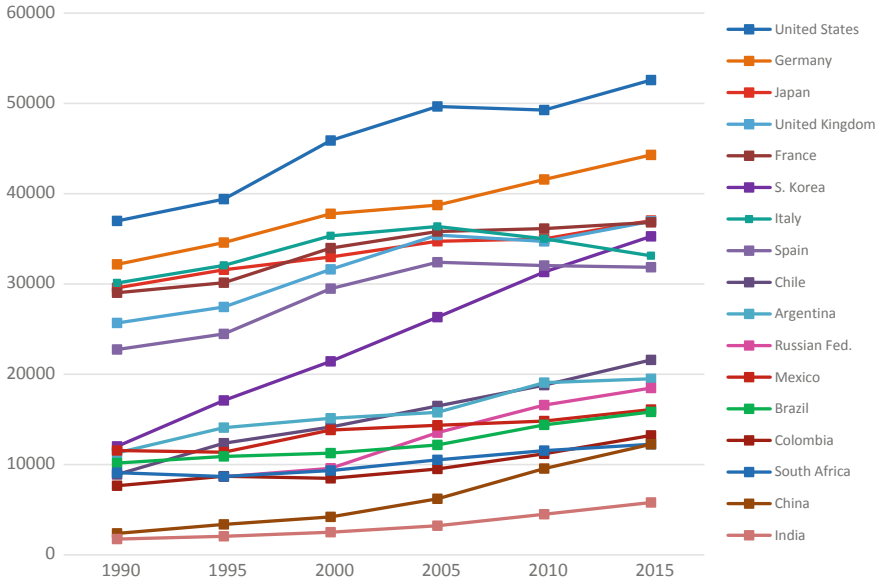

Fig. 7 GDP/capita, selected countries, 1990–2015. *Source* Maddison Project (2019)

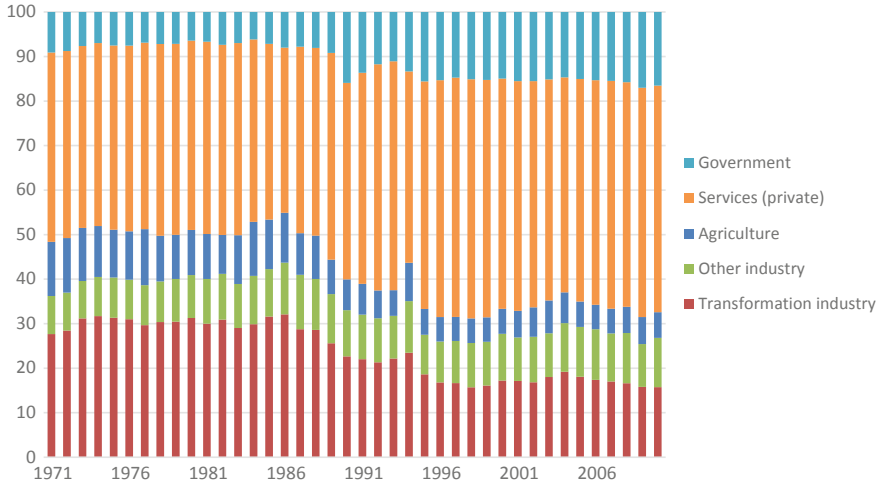

Fig. 8 GDP (Value-added GDP, which includes only production output, leaving out taxes.) by sector participation, 1971–2010. *Source* IPEA/ME (http://repositorio.ipea.gov.br/bitstream/11058/3529/9/cc12_serieshistoricas.xls. Accessed 4 Oct 2019)

Table 2 GDP/capita growth rate (PPP$ International Dollars 2011), selected countries, 1945–60, 1960–80, 1980–95, 1995–2015, 1945–2015, in descending order of value for 1995–2015

	1945–1960[a]	1960–1980	1980–1995	1995–2015	1945–2015[a]
China[a]	2,84	4,09	5,36	6,67	4,65
India	0,84	1,48	3,37	5,32	2,72
Russian Fed.	–	–	–	3,87	–
S. Korea[a]	3,68	8,41	7,63	3,69	5,37
Chile	1,34	1,92	3,05	2,83	2,16
Brazil	4,37	6,09	0,13	1,88	2,78
Mexico	3,05	5,08	-0,27	1,76	2,17
South Africa	1,94	2,48	-1,21	1,74	1,17
Argentina	1,64	2,63	-0,15	1,64	1,35
United Kingdom	1,36	2,72	2,06	1,50	1,74
United States	0,81	3,35	1,92	1,46	1,72
Spain	2,74	7,06	2,63	1,33	3,02
Germany	3,63	4,12	1,29	1,25	2,28
France	7,29	4,72	1,45	1,01	3,14
Japan	7,51	8,43	2,71	0,80	4,17
Italy	8,35	5,47	1,87	0,16	3,36

Source Maddison Project (2019)
[a]Data for China and S. Korea start in 1950

highest yearly GDP/capita growth rate for the entire period under analysis. Chile alone among LA countries has also shown a steady level of growth since 1980. Following the collapse of the Soviet Union in the early 1990s, Russia first had a drop in GDP/capita (not shown), but has recovered since and is steadily moving forward. All the highly industrialized countries show significant drops in economic performance since 1980, but more so since 1995, presenting yearly GDP/capita growth of at most 1.5%. Japan and Italy have rates below 1.0%.

But the economic recovery that Brazil recently enjoyed ended very abruptly. Between 2014 and 2016, after two years of recession, Brazilian GDP/capita fell by 9%,[15] probably the largest short-period GDP/capita drop in Brazilian history. But even during the growth years up to 2014, the share of industry in the country's economy, especially that of the transformation sector, had been falling ever since it reached 32% in 1986, the highest level in the country's history (Fig. 8).

[15]World Bank data show slightly different numbers, but the accumulated drop in GDP/capita between 2014 and 2016, the period of the recession, is similar for both datasets, at about 9%. The Maddison data set shows a slight increase in GDP/capita between 2014 and 2015, whereas the WB's shows smaller drops in both years.

Since 2010 the situation has deteriorated further. By mid-2019, transformation industry's participation in the country's (value-added) GDP has reduced further to 12%.[16]

5.2 *Higher Education and Basic Scientific Research*

The slowdown in economic growth in the old industrial economies after the 1980s and especially since the year 2000 has in many cases reduced public support for higher education, a situation that worsened, especially in the US and Britain, after the economic crisis of 2008. Institutions like the University of California, the jewel in the crown of the US public HE system, suffered from severe cuts in state support, described by one commentator as the "end of a dream" (Marginson 2016). Although California has started on a plan to recover levels of investments in the state's HE system, it will probably never again be able to invest almost 20% of its budget in HE, as it did during the golden years after WWII. In the UK, government has abandoned the policy of free tuition but still provides a higher level of public support for HE than the average for OECD (1.4% compared to 1.2% of GDP). Brazil spends a bit more, relatively, at 1.4% of its GDP,[17] but as its GDP is much lower than that of the industrialized nations, the amount invested is much less in absolute terms.

Brazil's HE has shown spectacular growth since 1995 to reach over 8 million students enrolled in undergraduate programs in 2017, which in terms of the population is higher than countries like China and India, but lower than South Korea, Chile and most industrialized nations (Fig. 9).

The recent surge of growth in HE in Brazil has not coincided with any industrialization advances. Part of the growth was spurred by the increasing numbers of high-school graduates, at least up to the mid-2000s, then by the growing economy, after 2005, as many older people returned to education to improve their chances of getting higher-paying jobs (returns to HE in Brazil are among the highest in the world).

As South Korea became a leader in electronic consumer goods, as well as in the automotive, shipbuilding and capital goods industries, higher education played an increasing role in economic and industrial development. The number of students increased rapidly from 1980 and new institutions were founded, including PosTech and KAIST, among the top innovative young HEIs and the top 100 in the world.[18] Moreover, Korea had achieved universal basic education in just a few decades, with 94% of adults born after 1970 having a secondary degree and, of those, over 50%

[16] IBGE—ftp://ftp.ibge.gov.br/Contas_Nacionais/Contas_Nacionais_Trimestrais/Tabelas_Completas/ (accessed October 4, 2019).

[17] OECD, Main Science and Technology Indicators, accessed October 3, 2019.

[18] https://www.topuniversities.com/university-rankings-articles/top-50-under-50-next-50-under-50/qs-top-50-under-50-2020, https://www.timeshighereducation.com/world-university-rankings/2019/young-university-rankings.

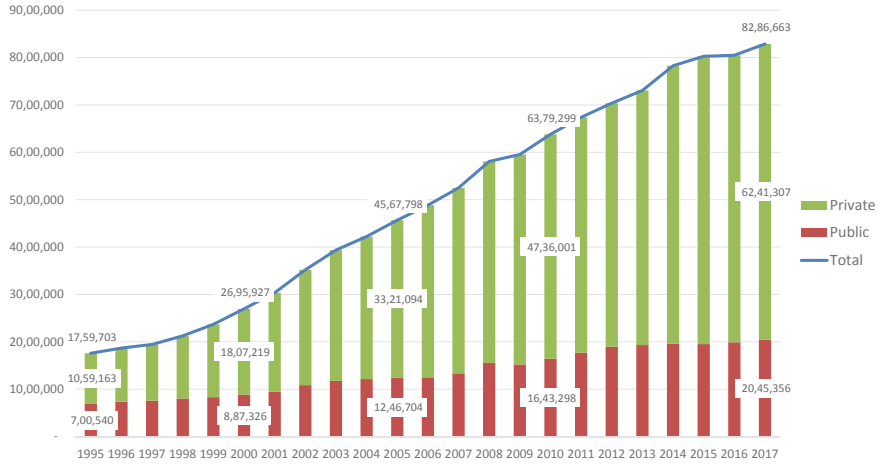

Fig. 9 Enrollment in undergraduate programs, Brazil, 1995–2017. *Source* INEP (1995–2017)

attending a tertiary institution (Park 2007). Brazil has not yet succeeded in achieving such levels of educational attainment (although Chile has).

The number of doctorates awarded by Brazilian HEIs remains strongly related to the development of academic research (Fig. 10).

South Korea has similar numbers to Brazil in graduate education, but for a population four times smaller. China has shown faster rates of growth in graduate education. In 1990, about 2,000 doctorates were awarded by Chinese HEIs, rising to 11,000 in

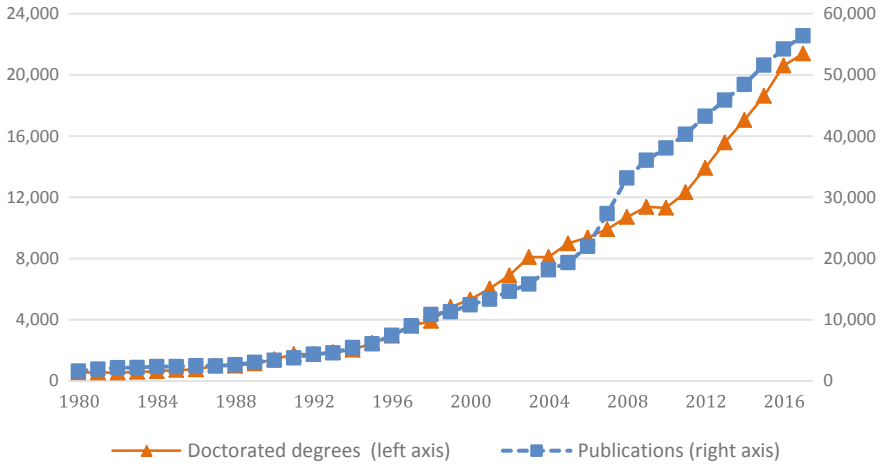

Fig. 10 Doctorates awarded and scientific publications (Articles, Proceeding Papers and Reviews, as indexed by Web of Science/Clarivate. Access in 2019/07.), Brazil, 1980–2017. *Sources* CAPES/MEC, Web of Science/Clarivate

the year 2000. The number has recently exceeded 60,000, above the number of PhDs awarded by US HEIs.[19]

The number of scientific publications that include Brazilian researchers among their authors has grown very fast during the last three decades, above the world's average, as Brazil's share of the total world's output went from 0.35% in 1980 to 2.6% in 2017. Table 3 shows, for our updated group of comparison countries (now including also Poland and Portugal), the number of publications per 1 million population, and the indicator InCites/Clarivate uses for measuring the impact of publications, based on the number of citations a publication receives from other similar publications. The table also includes the annual average number of publications for the last period.

The data show that, among Latin American countries, Brazil and Chile evolved similarly in terms of number of publications per capita, but Chile's values are about twice those of Brazil. Argentina's and Mexico's output grew by a smaller factor, about half the rate of growth of the other two countries, and Colombia faster, but from a very small starting value. Among the other BRICS, China increased its output per capita by a factor of almost 30, the highest among all countries listed, while the Russian Federation showed the lowest. South Africa and India performed slightly below Brazil's rate of growth. Portugal and South Korea showed fast rates of growth; their per capita volume of scientific publications is equivalent to that of traditionally developed countries.

On the citation impact indicator, Brazil, India and the Russian Federation with numbers between 0.80 and 0.90, similar to Mexico, are below the world's average. China, Argentina and South Korea have figures around the world average, with South Africa, Chile and Colombia above the world average in the last period considered. Portugal, France, Italy, Poland and Spain are above the OECD average. At nearly 0.90, Japan's is the lowest among all highly industrialized countries.[20]

5.3 University–Industry Interaction and Innovation Outputs

Table 3 contains general scientific publication data, a good indicator of academic research output and the development of a country's research universities.[21] An important aspect of university–industry interaction is how much of this body of literature derives from collaborative research. In a recent paper, Brito Cruz (2019) shows that in this respect Brazilian research-intensive universities perform similarly to their US counterparts, and that interaction has been expanding very fast in the last two

[19] Source: pages of Ministries of Education of China and S. Korea, NSF for the US.

[20] A possible reason for the relatively low impact of Japan's and South Korea's publications, which seems at odds with their economic, educational and innovation status, is that many publications are in the national language (as is the case for LA countries). Once one restricts the database to English-language publications, the numbers rise significantly.

[21] In all countries, universities are responsible for about 90% of scientific publications (source: Web of Science/InCitesClarivate, author's search). This is what one would expect from our discussion regarding universities' role in ST&I in the previous sections.

Table 3 Number of scientific publications per 1 million population and Category Normalized Citation Impact (Indicator uses the average number of citations received by publications (with authors of a given region/country) and normalizes it by subject area, type of publication, year and world average (which becomes 1.00)), 3-year averages, 1995–97 and 2015–17. Ordered by documents per 1 million population for 2015–17. World and OECD totals, Brazil and comparison countries. BRICS countries in boldface

	Documents		Documents per 1 million population		Category Normalized Citation Impact	
Region/Country	1995–1997	2015–2017	1995–1997	2015–2017	1995–1997	2015–2017
World totals	**885,207**	**2,126,852**	**153**	**284**	**1.00**	**1.00**
OECD totals	**737,263**	**1,409,927**	**655**	**1100**	**1.13**	**1.13**
Switzerland	13,490	37,960	1909	4536	1.43	1.71
Sweden	15,141	34,312	1713	3457	1.21	1.50
Australia	21,700	78,592	1186	3247	1.10	1.42
Netherlands	20,137	48,715	1296	2860	1.31	1.64
United Kingdom	73,564	155,026	1265	2363	1.19	1.45
Canada	38,782	84,885	1310	2350	1.22	1.36
Portugal	2,444	20,068	243	1943	0.91	1.20
Germany	67,066	139,174	819	1692	1.03	1.35
United States	300,907	505,256	1117	1564	1.41	1.36
Spain	19,262	72,380	483	1556	0.93	1.24
Italy	31,854	88,280	560	1456	0.95	1.35
France	50,201	95,513	840	1430	1.01	1.26
South Korea	8,978	67,552	197	1318	0.69	0.98
Poland	9,216	37,370	239	984	0.62	1.05
Japan	71,483	100,065	568	788	0.85	0.93
Chile	1,603	10,305	110	566	0.80	1.17
Russian Fed.	***30,166***	***53,715***	***204***	***372***	***0.39***	***0.83***
South Africa	***3,992***	***17,319***	***95***	***308***	***0.74***	***1.16***
China	***17,934***	***400,808***	***15***	***291***	***0.51***	***0.99***
Brazil	***7,501***	***54,133***	***46***	***263***	***0.73***	***0.89***
Argentina	3,355	10,815	95	248	0.73	0.99
Mexico	3,895	17,931	42	145	0.70	0.87
Colombia	416	6,405	11	133	1.03	1.13
India	***16,331***	***96,892***	***17***	***73***	***0.52***	***0.82***

Sources InCites/Clarivate and World Bank, author's elaboration

decades, having reached about 2.6% of all research including universities' researchers as authors (his Fig. 5.4). Brazil's collaboration intensity for 2015–17 was 2.4%, above China's (1.5%), similar to those of Spain and the EU-28, and a little lower than those of Italy (2.6%) and the US (2.8%). The leaders in Cruz's sample were South Korea

(3.9%), Germany (4.3%) and France (4.4%). These results show again that Brazilian universities' level of scientific collaboration with industry is similar to those of emerging and industrialized economies, and not as far behind as one might expect from other innovation indicators, such as patent filing by industry and others (see below). Brito Cruz (2019, Fig. 5.2) also shows that the levels of private support for research at USP and Unicamp, public research-intensive HEIs in Brazil, are very similar to those of their US counterparts, and actually higher than that of most public US institutions, including some of the most prestigious ones.

A third important aspect analyzed by Cruz is patenting by universities.[22] He shows (Table 5.4), that the number of patents filed per 100 faculty members of research-intensive universities in Brazil is typically smaller than those for their US counterparts. There are a few exceptions, such as CalTech (118), MIT (45), Stanford (13), Harvard (13) and University of California (6.0). Unicamp has 3.2 patents filed per 100 faculty members, the same as Boston and above Massachusetts (2.3), which is just above the Federal University of Paraná (2.2).

Structural differences between (public) HE systems in Brazil and the US, however, inflate the number of full-time faculty in Brazil, reducing its per-faculty ST&I indicators. Public universities in Brazil usually do not hire associates and TAs, who undertake some instruction in the US, even at the research-oriented institutions. In Brazil, regular ladder-rank full-time faculty typically mostly teach rather than performing any sort of research other than at a very low level. This can be seen from the student–faculty ratio of public universities in Brazil, counting only full-time ladder-rank faculty, which, in 2017, was 14.4 for undergraduate students (INEP 1995–2017) and 16.9 including graduate students (CAPES 2020). Public universities in the US tend to have much higher student–faculty ratios. For example, even counting all faculty, the University of California system-wide student–faculty ratio was 21.7 in 2017–18. If only ladder-rank faculty are counted, the number is 28.4, about twice that of Brazilian public HEIs. Thus, when computing any indicator which has the number of faculty members in the denominator, the values for Brazilian universities will tend to be lower than for US universities.

In Brazil, the universities have become the leading organizations filing patents in the national office in recent years (Table 4).

The data show that universities have increasingly participated in the development of new patents in Brazil, and the share of invention patents, excluding individual inventors, has risen from 7% of the total patents filed by residents in 2000 to over 30% in 2012, and to even higher levels since. In Europe, according to data from the European Patent Office, this participation is less than 6%, similar to what it was in Brazil before 2000.

Table 5 shows the number of patents issued to Brazil and the comparison group of countries by the US Patent and Trademark Office for four years covering the period since 1990.

The data in Table 5 show how first South Korea, then China and more recently India have caught up to the industrialized nations in absolute numbers. Taking population

[22] Patent production in Brazil, including the role of universities, will be discussed below.

Table 4 Leading organizations by number of invention patents filed by residents, 2000–05, 2013–17, 2017

Rank	2000–2005		2013–2017		2017	
1	Petrobrás	53	Whirlpool	67	UNICAMP	77
2	UNICAMP	46	University of São Paulo	62	Fed U Campina Grande	70
3	Semeato	26	UNICAMP	62	Fed U of Minas Gerais	69
4	Arno	25	Fed U Minas Gerais	59	Fed U Paraíba	66
5	Multibrás	23	Fed U Paraná	47	U São Paulo	53
6	SP Research Foundation	20	Petrobrás	40	Fed U Ceará	50
7	Vale	18	Fed U Ceará	37	CNH Industrial	35
8	Fed U Minas Gerais	16	CPQd	31	Fed U R. G. Sul	34
9	Embraco	14	Fed U R. G. do Sul	30	Cath U Paraná	31
10	Jacto	12	Fed U Paraíba	28	Fed U Paraná	
11	Dana Industrial	11	Fed U Pelotas	26	Fed U R. G. Norte	30
12	Fed U Rio de Janeiro		Fed U Bahia	25	Fed U Pernambuco	26
13	Nat Council of Sc. Research	10	Fed U Rio G. do Norte	24	Fed U MG Sul	
14	Embrapa		Vale S/A	21	Four federal universities tied	25
15	University of São Paulo	9	Fed U Pernambuco			

Source INPI/ME

into account, China and India would still be behind the industrialized countries, but South Korea would have surpassed Japan, at 431 to 393 patents per 1 million population. On the other hand, Brazil and the other emerging economies are still far behind, despite consistent progress in the three decades covered by the data, as the yearly rates of growth indicate. But that small success is tarnished by the fact that most of the patents granted to Brazilian residents are not to Brazilian nationals, as most are being developed by foreign companies with subsidiaries in Brazil.

A comparison of data in Tables 5 and 3 shows that the world of technological innovation is much more unequal than that of scientific research. For example, Germany's scientific output in recent years is 2.6 times that of Brazil, but for patents, it is 39 times greater. Further, although the gap is smaller in relative terms in the period considered (that factor was twice as large in 2008), it is so large in absolute terms that the reality of technological innovation for frontrunners is as different from those in the lower ranks as if they were living in different centuries (which, in some senses, they are).

Table 5 Patents issued by the USPTO, 1999, 1998, 2008, 2018, total, to US residents and to residents of comparison group of countries

Country of residence	1990	1998	2008	2018	Yearly % growth 1990–2018	Total 2018[b] (%)
Total	**96.727**	**154.579**	**182.556**	**339.534**	**6,5**	**–**
United States	51.526	85.783	91.843	161.970	5,9	47,7
Total issued to residents of other countries	**45.201**	**68.796**	**90.713**	**177.564**	**7,1**	**52,3**
Japan	20.170	30.490	35.847	50.020	4,6	28,2
South Korea	236	3.052	8.410	22.059	25,5	12,4
Germany[a]	7.765	9.304	9.794	17.433	4,1	9,82
China	***45***	***87***	1.684	***16.318***	***34,3***	***9,19***
United kingdom	2.947	3.548	3.882	7.552	4,8	4,25
Canada	261	3.302	4.052	7.226	18,1	4,07
France	3.032	3.823	3.683	6.988	4,3	3,94
India	***18***	***80***	650	***4.249***	***31,4***	***2,39***
Italy	1.460	1.754	1.890	3.248	4,1	1,83
Netherlands	1.049	1.282	1.670	3.217	5,8	1,81
Sweden	840	1.258	1.249	3.165	6,9	1,78
Switzerland	1.342	1.339	1.340	2.893	3,9	1,63
Australia	534	754	1.485	1.965	6,7	1,11
Spain	147	285	386	964	9,9	0,54
Russian Fed.[a]	***162***	***181***	186	***536***	***6,2***	***0,30***
Brazil	***38***	***79***	131	***442***	***13,1***	***0,25***
Mexico	30	83	78	385	13,6	0,22
Poland	13	16	64	291	16,8	0,16
South Africa	***121***	***126***	11	***190***	***2,3***	***0,11***
Portugal	9	9	30	110	13,3	0,06
Argentina	15	41	46	83	8,9	0,05
Chile	3	16	19	58	16,0	0,03
Colombia	6	22	9	44	10,5	0,02

Source USPTO/USA (https://www.uspto.gov/about-us/performance-and-planning/uspto-annual-reports. Accessed 4 Oct 2019)

[a]Data for Germany and the Russian Federation for 1990 include those of the Democratic Republic of Germany and of the USSR, respectively

[b]Percentages for countries other than the US are over total issued to residents of foreign countries

5.4 *Engineering Education and Employment: An Update*

We now return to engineering education and employment in Brazil. After the stagnation of the 1980s and early 1990s, engineering education has enjoyed significant expansion in the last two decades. From 1995 to 2017, the number of engineering (B.Sc.) degrees awarded jumped from 16,000 to 112,000, almost twice the growth rate for the rest of the system. In 2017, the number of students enrolled in undergraduate engineering programs had reached 1 million, or 12.5% of the total student population. These numbers are at least as high as for the United States, higher than for France, Germany, the UK, Japan and South Korea, and below only China and India. Doctorates in engineering reached 2,000 per year in 2017, almost four times the number in 1998 (525).

A more relevant comparison with other countries would require us to analyze the quality of the education, especially the undergraduate degrees. Results from the National System of HE Evaluation indicate that a large proportion of those graduating in engineering would not satisfy qualification requirements to function in a modern industrialized economy (Maciente et al. 2015; Kloot and Pedrosa 2018).

Regarding employment of engineers, Maciente et al. (2015) observe that only about 23% of the graduating engineering class of 2011 (42,000 students) were formally employed as engineers by the end of the next year. The total number of formally employed engineers in Brazil, which had risen from 155,000 in 2005 to 267,000 in 2015, fell during the last recession and was 231,000 in 2017 (Fig. 11).

This graph shows that employment in the transformation industry sector has followed the general trend of engineering employment as a whole, representing 27–28% of total engineering employment throughout the period considered. Education—mostly higher education—where most of the PhD holders are employed, is the only

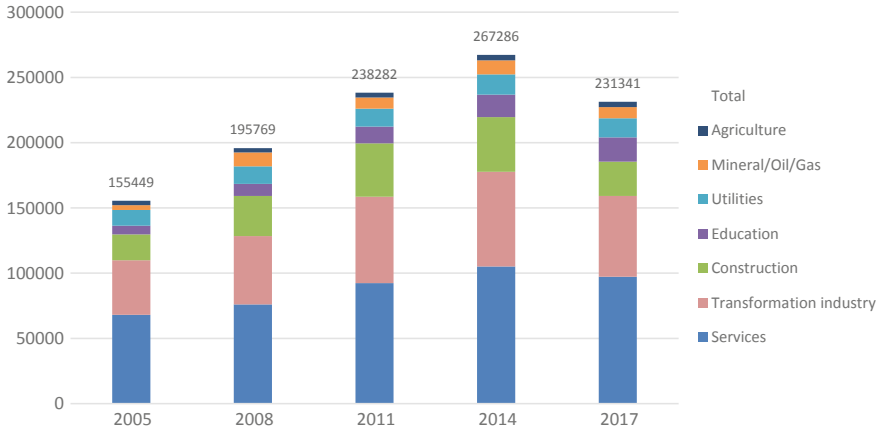

Fig. 11 Formal employment in engineering by economic activity sector, Brazil, 2005, 2008, 2011, 2014, 2017. *Source* RAIS (2005–2017)

Table 6 PhD holders employed in engineering, by activity of employee and sector of employer, 2017

	Private enterprises	Public enterprises	Government	Non-profit	Other	Total
Academic	214	0	2,465	1,330	0	**4,009**
Agric/Agron Eng.	100	1,401	158	36	10	**1,705**
Civil Eng.	92	72	138	11	0	**313**
Elect/Mech/Chem Eng.	201	418	73	23	2	**717**
Researcher (Eng.)	117	13	216	207	1	**554**
Other	133	47	63	11	2	**256**
Total	**857**	**1,951**	**3,113**	**1,618**	**15**	**7,554**

Source RAIS (2005–17)

sector showing growth in absolute numbers as well as in participation, moving from 6,700 to 18,500 people employed, and from 4.3 to 8.0% participation level between 2005 and 2017, which follows from the general expansion of HE in the period.

Of the 7,554 PhD engineers employed in 2017, 4,009 (53%) worked in higher education, 1,705 (23%) as agronomic and agricultural engineers, showing the importance of innovation for the agricultural sector in Brazil,[23] and 554 (7%) in research (Table 6). The table also shows that academics in engineering were employed mostly (62%) by public HEIs, then by non-profits (33%), with only a small proportion (5.3%) employed by private (for-profit) HEIs, which is closely related to research and graduate education weightings for those HE sectors.

Only 717 (9.4%) worked as electrical, mechanical and chemical engineers, showing how low the level of highly trained engineers employed by the transformation industry in Brazil is. Most of them (58%) were employed by public enterprises, which includes the large the state-run oil and gas company, Petrobrás, and another 10% by government directly (in non-academic posts). Only 201, or 28%, were employed by strictly private companies, confirming the low level of interest by the transformation industry in classical industrial R&D activities.

Formal employment figures in Brazil should be interpreted with caution, as employers may not update the education status of employees as they progress and many Brazilians, especially in technology services and technologically innovative SMEs, work as individual entrepreneurs. Although almost 25,000 PhDs were awarded between 1998 and 2017 in Brazil (CAPES 2020), less than one-third of them were formally employed according to the Ministry of Labor and Jobs statistics

[23] As data in Table 6 indicate, most of the PhD holders working as agriculture and agronomic engineers are employed by public enterprises, actually, most by Embrapa, the federal company dedicated to agriculture R&D, which has been the main innovative force behind Brazil's success in the sector.

for 2017. We believe the majority of those unaccounted for are heads of small businesses and are probably involved in innovative activities, as the number of start-ups has grown significantly in Brazil in the last decade (Brito Cruz 2019).

However, most PhD engineers that are missing from formal employment data are certainly not working for traditional transformation-sector companies, which provide regular returns to the government's annual labor statistical survey (RAIS/MTE), which confirms our general findings about the low level of results regarding innovative R&D activities by the sector.

For an international comparison of levels in manufacturing employment depending on foreign trade, Fig. 4, p. 13, in OECD (2017) shows a distribution of economies in various groups of countries according to the percentage of jobs ultimately sustained by foreign demand. For example, Brazil's (15%) is lowest percentage of the G20 countries, with South Korea's the highest at 55% and the average of all countries 36%. If the analysis is restricted to non-OECD G20 countries, which include Argentina, Brazil, China, India, Indonesia, the Russian Federation, Saudi Arabia and South Africa, again Brazil's is the lowest level (also 15%), and South Africa's the highest at 40%, with the average at 28%. Brazil's economic model thus puts it at the bottom of the largest economies in terms of its integration in world trade in manufactured goods.

A final note about Brazil's private-sector R&D activities: the intensity of R&D expenditure by businesses in Brazil is about 0.5% of GDP, similar to that of various industrialized countries like Spain, Italy and Canada (Fig. 12). The figure also shows that Brazil's R&D expenditure level is much higher than that of other Latin American countries, including Argentina, Chile and Mexico, which may come as a surprise to many observers. South Korea tops all countries (including those not included in the graph), and China has already caught up with or overtaken some older industrial economies, such as Italy, the UK and France. Thus, it is not that

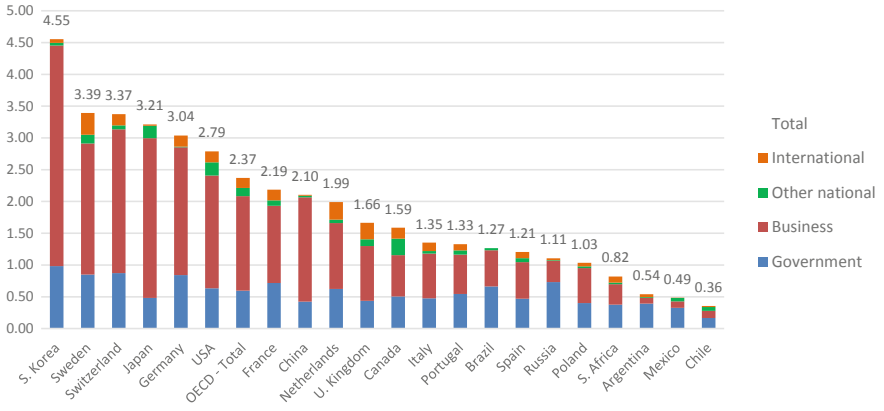

Fig. 12 R&D expenditure as % of GDP, by funding sector, all sources. Brazil and comparison group of countries, 2017 (2016 for Brazil). *Sources* OECD MSTI (accessed October 2, 2019), MCTIC/Brazil

Brazil's industry is not spending on R&D, simply that most of that spending does not appear to be directly related to innovative industrial activities that translate into new, technologically advanced, competitive products.

5.5 *Summary of Results and Final Comments: Whither Now, Brazil (and Latin America)?*

Our initial analysis and survey of the historical development of university–industry interactions in industrializing countries leads us to conclude the following:

(a) All countries that have industrialized and specifically participated in innovation since 1800 have also developed a strong higher education system, eventually including many research-intensive universities.
(b) Although scientific activities by universities may not necessarily be causally linked to industrial innovation, the latter cannot occur without a highly trained and relatively large group of scientists and engineers.
(c) Thus, even if a research-intensive university system is no guarantee of an innovative industrial system, it is likely to be a necessary condition.
(d) Comparison of the post-1945 Brazilian and Latin American industrialization experience with some Asian countries' recent innovative industrialization success suggests that the structure of economic and industrial development determines whether industrialization will develop innovative and competitive companies, or a peripherical system of low-tech companies and their subsidiaries dependent on imported innovation.
(e) The basic ingredients of the Asian model of industrialization followed successively by Japan, South Korea and China are: good basic and higher education; and incentives for industry to compete internationally in consumer goods markets with increasing level of technological sophistication.

The equivalent analysis in the case of Brazil suggests:

(a) From their humble origins in the 1930s, Brazilian universities have developed the first and second missions of research universities: capacity to educate large numbers of undergraduate and graduate students, and to develop basic research.
(b) Their expansion included education in engineering, which, despite some quality issues, positions Brazil among countries with the largest numbers of enrolled and graduating engineering students.
(c) The first phase of expansion (1960–80) was directly related to economic expansion and industrialization; the second (since 1995) came first from growth of demand from the young population completing secondary education, then from government subsidies, coupled to some economic expansion, but not from industry demands.

(d) University–industry interactions in the form of collaborative research, direct innovation through patent development, or start-up creation, resembles that in other countries.
(e) Brazilian industry has never been particularly innovative, even during the "golden era" between 1945 and 1980, with a very protectionist import-substitution model relying heavily on foreign investment to bring finished innovation packages to local plants.
(f) The transformation industry sector has been losing ground in Brazil's economic structure since the mid-1980s following the collapse of import-substitution industrialization in the early 1980s.
(g) Innovation by industry in Brazil therefore lags that of industrialized nations by a very large margin, which is also beginning to happen with respect to the more successful emerging economies.
(h) Brazil's level of patent production is very low internationally, and even in the national office, there has been a reduction of patent filing by industry (and a growth by universities).

Brito Cruz (2019) argues convincingly that universities cannot be expected to fill the innovation void left by a decaying industrial sector in Brazil. The outlook is bleak for Brazil and Latin America generally, apart from the not yet consolidated case of Chile, although there are a few success stories, such as Embraer and the agricultural sector (Montoro and Migon 2009; Pedrosa and Chaimovich 2015). Recent trends in innovation related to the technological service industry, as well as opportunities in the areas of alternative energy sources and biodiversity, may open the way for real change. Preparatory work will be required, however, as Brazil's basic education system still lacks quality, as international assessments of results show (OECD 2016). Again, Chile seems to be the only LA country[24] making real progress, which could eventually result in jumps in industrial and service-sector innovation.

So the challenge for Brazil and Latin America is to create an economic environment that challenges industry, now including the IT service sector, to innovate, possibly by exposing their economies to international competition. Will we succeed, or will we, by 2050, then 2100, still be chasing the growing group of emerging economies, especially in Asia, but eventually in Africa, that will be succeeding where we have failed?

The perennial concern that dramatic changes—including the rise of information technologies in education—is leading universities to become obsolete, is misplaced. These institutions are capable of continuous adaptation and remain relevant, simply because of what they do best—educating the young, conducting research, and transmitting that "invisible product, knowledge," which "may be the most powerful single element in our culture, affecting the rise and fall of professions and even of social classes, of regions, and even of nations" (Kerr 2001).

[24]The scores for Argentina in PISA 2015 are only for the Buenos Ayres area, which are significantly above of the those in previous editions.

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