

FOURTH INDUSTRIAL REVOLUTION  
AND THE BRAZILIAN STATE:  
science, technology, and innovation

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## LIST OF FIGURES

- Figure 1- RD&I obligations in the oil and gas sector  
(1998-2019) .....
- Figure 2 -RD&I distribution per company (1998-2019).....
- Figure 3 -Investments by ANEEL's R&D Program  
(R\$ millions) .....
- Figure 4 -Public State Expenditures. Investments in R&D  
by State governments in 2016 (R\$ millions).....
- Figure 5 -Publications per year and per category  
(2016-2019) .....

## LIST OF TABLES

- Table 1 - Divergence in the National Innovation System  
in the 1980s.....
- Table 2 - The National Innovation System in the 1980s  
by taking into consideration some indicators.....
- Table 3 - Greatest oil producers based on concessions  
in 2017.....
- Table 4 - Greatest gas producers based on concessions  
in 2017.....
- Table 5 - Obligation of investments in Research,  
Development and Innovation (RD&I) based  
on concessions, 2017.....
- Table 6 - Topics and investments of ANEEL's R&D Calls.....
- Table 7 - RD&I State Laws.....

# Table of Contents

ACKNOWLEDGEMENT .....	5
LIST OF FIGURES .....	6
LIST OF TABLES .....	6
PRESENTATION .....	9
INTRODUCTION.....	11
<b>1. THE INDUSTRIAL REVOLUTIONS AND THE INFORMATION SOCIETY .....</b>	<b>15</b>
1.1 The Industrial Revolutions .....	15
1.2 Information society and the Fourth Revolution.....	21
1.3 Fourth Industrial Revolution and the Action of the State Sphere.....	32
<b>2. INDUSTRIAL REVOLUTIONS AND THE REINVENTION OF THE STATE .....</b>	<b>36</b>
2.1 The evolution of the National State based on the dialogue with the Industrial Revolutions .....	36
1.2 The Economic Law and the role of the State .....	46
2.3 Economic Development and the action of the Brazilian State: a reading on sustainable development .....	51
<b>3. THE BRAZILIAN ECONOMIC CONSTITUTION AND THE FOURTH INDUSTRIAL REVOLUTION: SCIENCE, TECHNOLOGY AND INNOVATION .....</b>	<b>61</b>
3.1 Brazilian Constitutional Economic Law .....	61
3.2 Federal Constitution, freedom, free-initiative and State intervention .....	62
3.2.1 Action and Intervention .....	66
3.2.2 Other intervention modes .....	69
3.2.3. Regulation, inspection, incentive, and State planning...71	
3.3 The sphere of the Fourth Industrial Revolution, Sciences, Technology and Innovation (ST&I) in the Federal Constitution .....	72
3.4 State intervention in ST&I .....	76
3.5 The role of ST&I and sustainable development .....	83
3.6 Limits of the Intervention by the Brazilian State intervention in ST&I.....	87

- 4. INSTRUMENTS OF THE BRAZILIAN LEGAL SCIENCE,  
TECHNOLOGY, AND INNOVATION FRAMEWORK..... 94
- 4.1 Legal Science, Technology, and Innovation Framework ..... 94
- 4.2 Financial Instruments ..... 98
- 4.3 Granting of scholarships ..... 102
- 4.4 Research and development in contracts signed for the  
concession of public services or for sectoral regulations ..... 104
  - 4.4.1 About the Legislation: case studies ..... 104
    - 4.4.1.1 Oil and Gas ..... 104
    - 4.4.1.2 Piped Gas Distribution Sector ..... 111
    - 4.4.1.3 Electric Power..... 112
- 4.5 State experiences ..... 114
- 4.6 Complex networks ..... 119
  - 4.6.1 Fapesp – Research, Innovation and Diffusion  
Center (Cepids): case study ..... 119
    - Phase 1* ..... 120
    - Phase 2* ..... 123

  

- 5. CONCLUSION ..... 124
- REFERENCES ..... 128
- APPENDICES ..... 146



## PRESENTATION

The Industrial Revolutions can be understood as historical moments concerning technological development, which took mankind to production, social and economic changes. The Fourth Industrial Revolution presents elements that were not observed in the previous revolutions if one considers the combination of disruptive technologies that present exponential features. Accordingly, science, technology, and innovation (ST&I)<sup>1</sup> can be seen as bases for the accumulation of knowledge and techniques that all together have led to the herein addressed revolutions, since they work as a round structure for feedback. Based on such a scenario, it is possible observing the complexity of the interaction among several social actors, including the State, to create the environment favorable for investments done in ST&I.

Thus, the aim of this book is to analyze the role and limits of actions taken by the Brazilian State within the ST&I context, from the position of the 1988 Constitutional Economic Order. Among some specific goals, the idea is to assess arguments focused on finding ways to make sure that the State will not stop promoting or delaying the technological development, as well as assessing the instruments already in place in the Legal Framework of Science, Technology, and innovation (Legal Framework), mainly in the energy sector. The study followed the literature review methodology, based on the qualitative method, to analyze the action instruments used by the State in ST&I.

Results have pointed towards the reasoning about changes in the Legal Framework in order to allow a judicial environment favorable to the maturity of the National Innovation System based on the presence of countless instruments to promote ST&I. Therefore, it was possible observing lack of coherence in policies

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<sup>1</sup> The author used the acronyms ST&I and RD&I (or R&D) with the same meaning.

that obstruct technology given the aims of the Legal Framework. There was the absorption of sustainability concepts by social and environmental matters in order to qualify the ST&I policies, but it was not possible observing whether such embodiments would actually be barriers, but new efficiency and accountability dimensions in the ST&I definition scope. Therefore, the final considerations will show the role of State as essential actor in ST&I reinforcement by also analyzing how standards focused on the mandatory investments in specific sectors had the power to encourage these very sectors and to lead to satisfactory outcomes throughout the assessed period-of-time.

## INTRODUCTION

**K**laus Schwab starts his book “Fourth Industrial Revolution” (2015) warning about the context of an age full of challenges, among them, one finds the task of understanding and modeling the new technological revolution that, according to him, will imply changing mankind.<sup>1</sup>

Schwab and Davis mention the several movements and insurgent disruptive technologies, such as “artificial intelligence (AI), robotics, additive manufacturing, neurotechnologies, biotechnologies, virtual and augmented reality, new materials, energy technologies, as well as ideas and capabilities whose existence is not yet acknowledged”.<sup>2</sup>

Therefore, it is important pointing out the consequent reformulation of both communication and means through which society experiences and understands reality, starting from the government itself, since it has to adjust itself and comply its institutional apparatus with the new times.

The role of institutions, mainly of the State, is seen within a reformulation bias, as well as in the bias of adjusting the taxation challenges linked to a whole range of disruptive technologies. Among other social conformation instruments, Law becomes an actor in the very hard time following-up the fast changes faced by its operating institutions, a fact that can put in check several of its formal mechanisms.

According to Baldwin, because of the Fourth Industrial Revolution and of its socioeconomic effects, the role of State lies on helping this process by creating laws that slow down technology in order to avoid unemployment throughout the transition process.<sup>3</sup> He sees the importance of laws to protect workers. Based on his opinion, it will be necessary creating a conduct code to ensure that those who stand behind a computer

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<sup>1</sup> SCHWAB, Klaus. **A Quarta Revolução Industrial**. Edipro. Kindle Edition, 2015.

<sup>2</sup> SCHWAB, Klaus; DAVIS, Nicholas. **Aplicando a Quarta Revolução Industrial**. (Translation: Daniel Moreira Miranda). São Paulo: Edipro, 2018, p. 20.

<sup>3</sup> BALDWIN, Richard. **O FIM da Globalização?** Lecture by the Professor in April, 1st, 2019. Human Rights Group of the Law School at USP.

will be over 18 years and will be working under proper labor conditions. Overall, he is optimistic with this scenario. According to the State, this a point with no return and the new age can come faster that one could even imagine because the brain tends to think that the transformation process will take the same pace it took in the past, but history shows that technological advancements are not linear - they can be so, at first, but soon, surprisingly, they get faster.<sup>4</sup>

As for the Brazilian scenario, the relationship among science, technology, innovation, development and actions by the State through regulations, according to André Ramos Tavares, based on his interpretation of Article 218<sup>5</sup> and 219<sup>6</sup> of the 1988 Federal Constitution, points out confirmation elements substantiated by the construction of a concept of development, according to which, knowledge and innovation are the keys for the country's progress, since they would help overcoming the economic structure of underdevelopment.<sup>7</sup>

Accordingly, the role of State must lie on encouraging and promoting scientific development, technology and innovation by stimulating innovation in companies, the construction and maintenance of technological parks and the action of inventors. Thus, besides the rules of the Economic Order in the Federal Constitution, it is possible observing the need of weighing about the action of the State so that its policies, *lato sensu*, do not end up representing barriers to the herein addressed scientific, technological and innovation development.

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<sup>4</sup> Idem

<sup>5</sup> Article 218 - The State will promote and encourage the scientific development, research, scientific and technological qualification, and innovation.

<sup>6</sup> Article 219 - The internal Market is part of the national patrimony and it will be encouraged to make cultural and socioeconomic development feasible, as well as the well-being of the population and the country's technological autonomy, based on the terms of Federal law.

Single paragraph. The State will encourage the formation and reinforcement of innovation in companies, as well as the other entities, public or private, as well as the construction and maintenance of technological parks and poles, and of other environments focused on promoting innovation, the action of independent investments and the creation, elaboration, diffusion and transference of technology. (Included by Constitutional Amendment n. 85 from 2015).

<sup>7</sup> TAVARES, André Ramos. APPs e plataformas on-line na intermediação econômica no Brasil. In **Rev. de Dir. Constit. e Econ.** Unialfa. N. 1, vol. 1, 2019.

Therefore, the aim of the present study was to analyze the following scientific question: Given the features of the Fourth Industrial Revolution and of issues emerging from it, what would be the role and limits of intervention by the Brazilian State in the context of science, technology, and innovation, by taking into account the 1988 Constitutional Economic Order?

In terms of limits, it is possible understanding restrictions that could contribute to the creation of a pro-technology State. In other words, there must be arguments focused on ways to encourage the State to keep on promoting technology rather than obstructing it by trying not to set the bias of a State working as barrier for technology.

With respect to the role of the State, the aim of this study is to assess the instruments in the Legal Framework of Science, Technology, and Innovation, with emphasis on the legislation and on the models of contractual clauses that demand business investments in the energy sector, mainly in the electric power production, and oil and gas sectors.

The study followed the literature review design and adopted the qualitative method to analyze the action instruments of the State in face of the on-going transformations.

This book is divided in five chapters, besides the present introduction. The first chapter followed a conceptual approach about the Industrial Revolutions, in order to deal with changes grouped within the understanding of the Fourth Industrial Revolution. The second chapter addresses the reflection about the role of the Brazilian State and its development proposals, as well as its historical development, to highlight the challenges brought by the Fourth Industrial revolution. The third chapter discusses the traditional State intervention mechanisms to point out the regulation trends by focusing on the National Innovation System. The fourth chapter approaches the instruments of the Legal Framework of Science, Technology, and Innovation by analyzing the legislation of the energy sector, which concerns the mandatory investments in research, and in technological and innovation development. The last chapter highlights the final consideration of the present research.



# THE INDUSTRIAL REVOLUTIONS AND THE INFORMATION SOCIETY

## 1.1 The Industrial Revolutions

With respect to the expansion of the human consciousness, it is possible observing the continuous assimilation of an intellectual archive that allows evolution in several aspects, among them, one finds the embodiment of information, technology and innovation as elements intrinsic to the contemporary reality. Accordingly, in historical terms, man has been experiencing “Revolutions” that change its *modus operandi* and relationship with its surroundings.

Manuel Castells, in the chapter concerning the “Revolution of the Information Technology”, starts from the attempt to define the word revolution.<sup>8</sup> Thus, he states a historical viewpoint by pointing out that the late 20<sup>th</sup> century brought along the experiencing of one of these rare time lapses in History, which is featured by the transformation of the material culture by mechanisms, by a new technological paradigm that organizes itself around the information technology.

Klaus Schwab mentions the meaning of this word that regards rupture, and completes: “the revolutions have been happening when new technologies and new forms of perceiving the world trigger a deep change in the social structures and economic systems”.<sup>9</sup>

The First Industrial Revolution started before the last 30 years of the 18<sup>th</sup> century. It was featured by new technologies such as the invention of steam engines, spinners and the replacement of manual tools and<sup>10</sup> the construction of railroads, which triggered the mechanical production.<sup>11</sup> David Landes highlighted the

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<sup>8</sup> CASTELLS, Manuel. **A sociedade em rede**. Translated by Roneide Venancio Majer. São Paulo: Paz e Terra, 1999, p. 87-161.

<sup>9</sup> SCHWAB, Klaus. **A Quarta Revolução Industrial**. Op., cit., p. 16.

<sup>10</sup> ROSA, Carlos Augusto de Proença. **História da ciência: o pensamento científico e a ciência no século XIX**. 2. ed. Brasília: Funag, 2012.

<sup>11</sup> CONCEIÇÃO, César Stallbaum. **Da revolução industrial à revolução da**

likelihood of gathering changes brought by the First Revolution into three principles: replacing the human effort and skills by machines, replacing animated sources of energy by inanimate ones, using new and more abundant raw materials.<sup>12</sup>

The Second Industrial Revolution, which took place after 1830, highlighted the decisive role of science in promoting innovation. It launched the use of electricity and the Assembly line, which enabled mass production.<sup>13</sup> Therefore, it highlighted the internal combustion engine and scientific-bases chemical products, the efficient role of steel and the beginning of communication technologies through the outspread of the telegraph and the invention of the telephone. Sectors representing most of the workforce in this Revolution, and at least half of the National Gross Product (GDP), were not affected by new industrial technologies.

According to Castells, there were essential continuities between the First and Second revolutions, “as well as some crucial differences, the main one was the decisive importance of scientific knowledge in order to support and guide technological development after the 1950s”.<sup>14</sup>

Celso Furtado points out the territorial change of the Industrial Revolution in the 19<sup>th</sup> century, since England was the first to guide the flow of resources and intended to rule the ways of the new international division of labor, but such an attitude was not accepted by the developed countries at the time.<sup>15</sup>

In developed countries like the USA and Germany, reactions to the British domination were linked to the greater centralization of economic decisions partially made based on the primacy of the banking system or, yet, on the coordinating guardianship embodied by the State itself.<sup>16</sup>

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**informação:** uma análise evolucionária da industrialização da América Latina. PhD thesis in Economy – Federal University of Rio Grande do Sul, Economic Sciences School, Post-Graduation Program in Economy, Porto Alegre, 2012. – Porto Alegre, 2012. 209 f.

<sup>12</sup> LANDES, David. **Prometeu desacorrentado:** transformação tecnológica e desenvolvimento industrial na Europa ocidental, desde 1750 até os dias de hoje. Translated by Marisa Motta. 2 ed. Rio de Janeiro: Elsevier, 2005.

<sup>13</sup> SCHWAB, Klaus. Op., cit., p. 17.

<sup>14</sup> CASTELLS, Manuel. **A Sociedade em rede.** São Paulo: Paz e Terra. 1999, p. 91.

<sup>15</sup> FURTADO, Celso. O capitalismo pós-nacional. In: **Economia do Desenvolvimento**, Rio: Contraponto, 2008, p. 171-2.

<sup>16</sup> FURTADO, Celso. Op., cit.



Yoneji Masuda approaches the preliminary stage (between 1945-1070) of the Third Industrial Revolution (Technological Revolution), with emphasis on the use of computers in national projects concerning national defense and spatial exploration. He also addresses a second stage of it, which is based on the addition of computers to business management between 1955 and 1980. The third stage starts in the 1970s, when computers become an asset focused on society's well-being. The fourth stage, which started in 1975, is featured by the expansion of computer using to solve personal issues.<sup>17</sup>

Schwab points out the beginning of the Third Revolution in the 1960s, as well as its relation to the development of computers. This is the reason why this stage was “called the digital revolution or the computer revolutions”, which was “boosted by the development of semiconductors, of the mainframe computation (in the 1960s), of personal computers (in the 1970s and 1980s) and the internet (in the 1990s)”.<sup>18</sup> Juliana Abrúcio Florêncio, by following this same line of reasoning, states that the internet, in association with both the hardware and the software, is the great innovation of modernity.<sup>19</sup>

Yet, among the information technologies, one finds the convergent set of microelectronics, computing (software and hardware), telecommunications, broadcasting and optoelectronics technologies, as well as new scientific fields such as the genetic engineering and its group of knowledge and applications, not mentioning the great technological advancements in advanced materials, energy sources and their application in medicine and production techniques, transportation technologies, among others.<sup>20</sup>

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<sup>17</sup> MASUDA, Yoneji. **A sociedade da informação como sociedade pós-industrial**. Rio de Janeiro: Rio, 1982, p. 74.

<sup>18</sup> SCHWAB, Klaus. **A Quarta Revolução Industrial**. Edipro. Edição do Kindle, 2015, sp.

<sup>19</sup> FLORÊNCIO, Juliana Abrusio. **Proteção de dados na cultura do algoritmo**. Tese de Doutorado em Direito. Pontifícia Universidade Católica de São Paulo, São Paulo, 2019, p. 33.

<sup>20</sup> MEDEIROS, Marcos Fernando Machado de; ALLOUFA, Jomária da Mata; ARAÚJO, Maria Arlete Duarte. Uma análise teórica do uso da tecnologia da Informação na prática científica. **Ciências Sociais em Perspectiva**, 10-18, 1<sup>o</sup> sem. 2011, p. 193-204.