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Industry 4.0 movement in Brazil and the challenges of the productivity of the economy

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The Issue

Brazil needs an industrial and technological policy aligned to the assumptions of Industry 4.0, to help face the challenges of the low productivity of the Brazilian economy.

The Question

Does the Industry 4.0 can mitigate the low productivity of Brazilian economy?

The context of Industry 4.0 in Brazil

Source	Summary
Brazilian Chamber of Industry 4.0 (I4.0 Chamber, 2021)	<p>The incorporation of technologies 4.0, such as additive manufacturing, advanced robotics, big data, data analytics, internet of things – IoT and the artificial intelligence, have the potential of significant gains of productivity for Brazilian industry.</p> <p>However, the biggest challenge is to promote the adoption of 4.0 technology in small and medium companies, primarily due to:</p> <ul style="list-style-type: none">▪ less availability of resources.▪ lack of trained professionals.▪ lack of knowledge of the causes of the problems and their possible technological solutions.▪ lack of estimate of the return on investment in technology.
Brazilian Agency of Industrial Development (ABDI, 2017)	<p>The adoption of fourth industrial revolution technologies by Brazilian industry, could provide a saving of approximately US\$ 14 billion:</p> <ul style="list-style-type: none">▪ predictive maintenance of machinery pool = US\$ 7 billion▪ gains of productive efficiency = US\$ 6 billion▪ saving of energy = US\$ 1,4 billion
Industrial Innovation and Research Brazilian Association (Embrapii, 2018)	<p>One of Brazil's great challenges is to increase the competitiveness of national industry, which depends a lot on its innovative capacity and on the increase of productivity in all the major sectors of the economy.</p>

The context of Industry 4.0 in Brazil

Source	Summary
National Confederation of Industry (CNI, 2020a)	<p>Brazil is still in penultimate place in the general ranking of Brazil Competitiveness survey, among 18 selected economies, according to the criteria of being economies with similar characteristics to Brazil, or that compete with the country in the global market: South Africa, Argentina, Australia, Canada, Chile, China, Colombia, South Korea, Spain, India, Indonesia, Mexico, Peru, Poland, Russia, Thailand and Turkey.</p> <p>In the Technology and Innovation factor, in relation to the set of 18 countries that make up the sample, Brazil reached the fifth highest investment in research and development (R&D) as a proportion of GDP (1.26%), well below that reached by South Korea (4.55%) and China (2.13%).</p> <p>By way of comparison with developed countries with higher per capita income, Brazilian situation is even weaker:</p> <ul style="list-style-type: none">▪ Japan (3.5%)▪ Germany (2.9%)▪ United States (2.8%)▪ France (2.2%)

The methodology

A broad bibliographic review, theoretical references, such as books, scientific articles, electronic portals of agencies, internationally renowned consultancies, and Brazilian government studies, analysis of technical reports, analysis of statistical indicators, and review of historical stages about the economic development of Brazil, from a more multidisciplinary approach.

The article follows a **qualitative research line**, aiming to **focus on deepening the researched topic** and the explanation of aspects of Brazilian industrial reality that exceed the domains of technology and manufacturing management, permeating the issues of economy's productivity, sectorial performance and international comparisons.

As for its main objective, **the article is the exploratory type**, with the aim of increasing the comprehension about the topic.

The Innovation and Productivity

Economic history teaches us the relevance of **technological innovation as a driver of development in capitalist society** but conditioned to **productivity gains** in the economy. The economy's productivity, in turn, is dependent on the pace and application of technological innovations (Gordon, 2016; Mokir, 2014; Mokir, 2013; Schumpeter, 1939).

According to (Senna, 2017) the **two concepts of productivity** are considered relevant: **labor productivity** and **total factor productivity (TFP)**.

The **digital revolution**, in which Industry 4.0 is inserted, has changed the way in which the gross domestic product is divided between **those who own labor** and **those who own capital**.

Brazil in international productivity comparisons

Considering Brazil's performance in **labor productivity** and **total factor productivity (TFP)**, we can say that our evolution is not the best (Bonelli; Veloso; Pinheiro, 2017).

Brazil's performance was good until 1980, but weak during and after the foreign debt crisis of the 1980s: **Brazilian productivity was about a quarter of the US in 1950**, reached almost **40% in 1980**, and returned to about **25% from 2007 onwards**. More **recent data confirm the stagnation of Brazil's low productivity**. According to Pastore (2019) the average **Brazilian worker's productivity is just a quarter of an American worker** and a **third of a German or Korean worker**.

Brazil and Latin America

Brazil's productivity between **1950 and 1980** grew **3.5%** per year versus **2.5%** in the remaining **Latin American countries**.

Throughout the 1980s, both Brazil and Latin America had similar productivity declines, around **2% per year**.

In the **1990s and 2000s**, productivity **grew more in Brazil** than in the rest of the Latin American countries.

More recently, Brazilian productivity became worse compared to Latin American productivity, that is, while productivity **fell by about 0.3 percent per year in Brazil between 2010 and 2015**, it increased by **0.8 percent per year** in the rest of the **Latin American countries**.

Source: (Bonelli; Veloso; Pinheiro, 2017).

Brazil and developed countries

Table 1. Average total factor productivity growth rates in selected periods - Brazil and selected developed countries (% per year)

Countries	1991-2000	2001-10	2011-14
Brazil	0,8	-0,3	-1,6
United States	0,7	0,7	0,1
United Kingdom	0,4	-0,1	-0,4
Japan	0,1	0,5	0,0
South Korea	2,2	2,2	0,3

Source: (Bonelli; Veloso; Pinheiro, 2017)

Brazil's total factor productivity - TFP increased only in the 1990s, having fallen in the 2000s and especially in the recent period.

Brazil and BRICS

Table 2. Average growth rates of total factor productivity in selected periods - BRICS
(% per year)

Countries	1991-2000	2001-10	2011-14
Brazil	0,8	-0,3	-1,6
China	1,5	4,2	0,7
India	1,0	1,8	0,7
Russia	-1,3	3,2	1,7
South Africa	-0,8	-0,3	-2,8

Source: (Bonelli; Veloso; Pinheiro, 2017)

The thesis about Brazil's historically low productivity is confirmed by comparison with the BRICS countries, with the exception of South Africa.

Brazil and a sectorial vision

Table 3. Sectorial Productivity – Brazil and selected countries

Countries	Total	Agriculture	Industry	Services
Brazil	14.689	4.779	19.389	15.814
United States	89.318	66.271	109.937	85.647
Ireland	84.949	27.976	114.873	80.397
Australia	67.555	65.469	88.358	61.589
France	66.488	50.027	64.056	69.225
Japan	64.967	18.102	70.607	65.400
Great Britain	56.729	25.184	70.852	54.643
South Korea	52.503	24.290	74.759	44.429
Mexico	25.260	6.109	31.423	27.836
China	14.792	3.599	25.661	18.549
India	8.423	2.224	11.984	17.307
Average SEA	46.994	25.250	52.802	48.218
USA/Brazil	6,1	13,9	5,7	5,4
Average SEA/Brazil	3,2	5,3	2,7	3,0

Source: (Veloso *et al.*, 2017)

Note: Productivity is calculated from Socio Economic Accounts (SEA) data converted to international prices using PPP - purchasing power parity measures. Productivity data are expressed in US\$ PPP, using the added PPP. With the exception of Brazil, countries are ordered in descending order by total productivity. The highest productivities of each sector are marked in bold.

Low Brazilian productivity, compared to other countries, is associated with differences in the level of sectoral productivity or in the sectoral allocation of employment.

This scenario emphasizes the importance of the **binomial innovation and productivity in the context of Industry 4.0**. in Brazil, whose phenomenon of low productivity occurs in all sectors.

The need for a forward-looking industrial policy

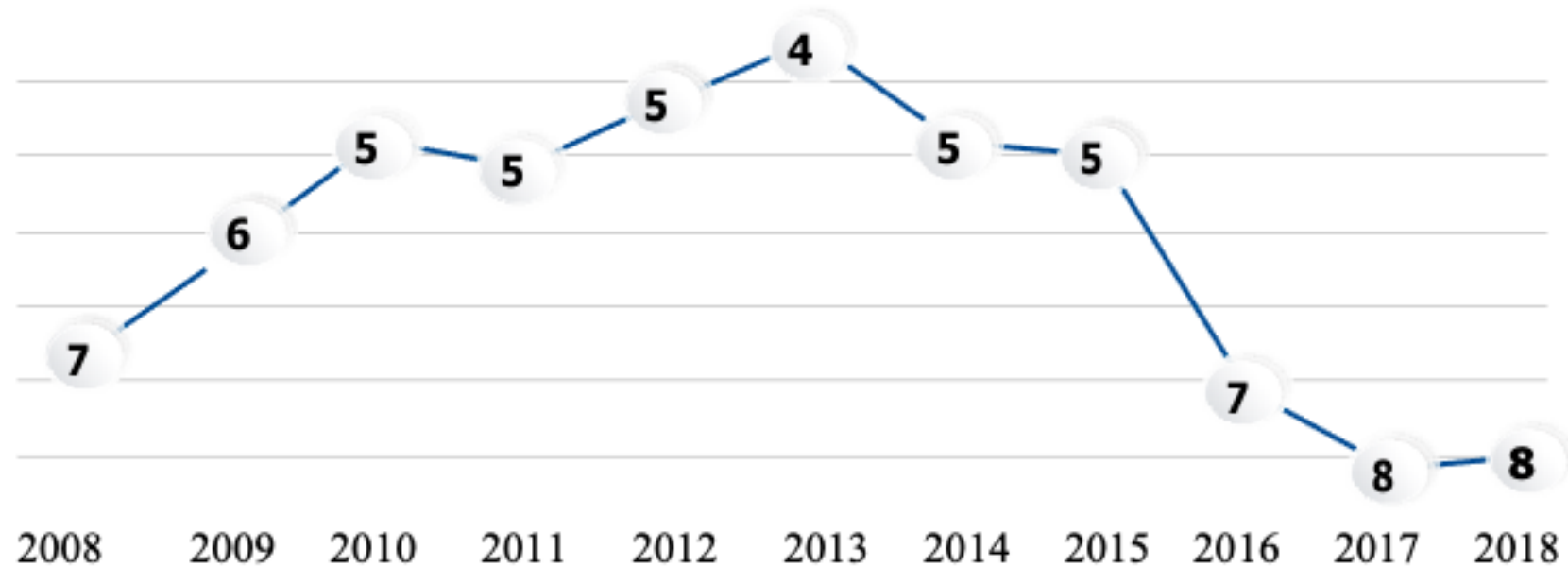
According to Morceiro (2019), the **Brazilian industry of transformation**, which had led economic growth in the five decades preceding 1981 in the industrialization stage, **lost dynamism from 1989 on**. The result of this was the **poor performance of the industrial sector** in terms of **economic growth, technological development, and export performance**.

Brazil faces a challenging process of stagnation in its technological development.

In their work, (Miguez *et al.*, 2018) highlight the **importance of the manufacturing industry for economic growth, productivity growth and employment growth**. This sector is the main source of productivity gains in the economy (Andreoni; Chang, 2016), configuring itself as a **learning center of modern economies** and a major **inducer of innovations of a technological nature** (Rosenberg, 1963). The authors call attention to the role of manufacturing as a **source of organizational innovations** and of **demand for high productivity activities in the other sectors**.

The need for a forward-looking industrial policy

4.1 Brazil's position in the global competitiveness ranking

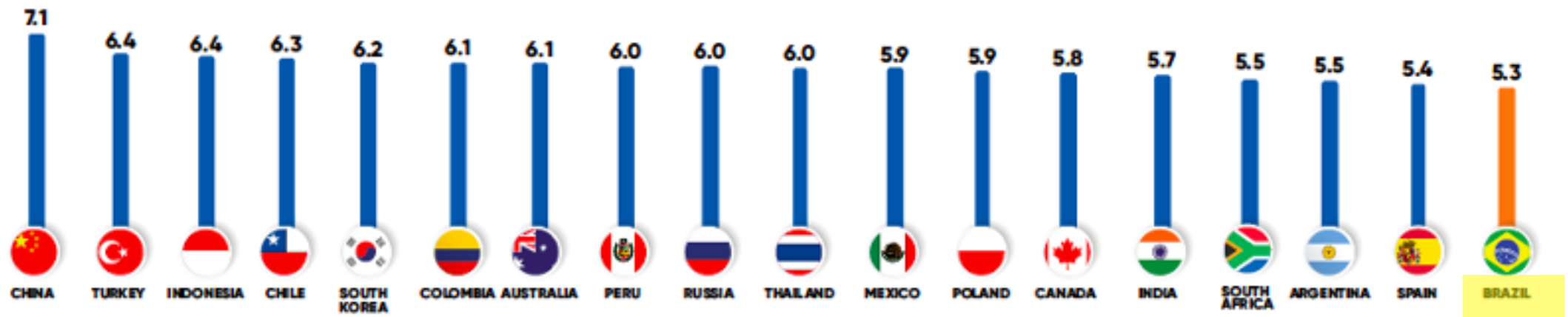


Source: (CNI, 2018)

Over the past ten years (2006-2016), Brazil recorded the worst evolution in productivity among its 10 main trading partners. According to (CNI, 2018) during this period **labor productivity in Brazilian industry increased by 5.5%**, while in the **US it grew by 16.2%** and in **Argentina by 11.2%**.

The need for a forward-looking industrial policy

4.2 Ranking of the macroeconomic environment factor



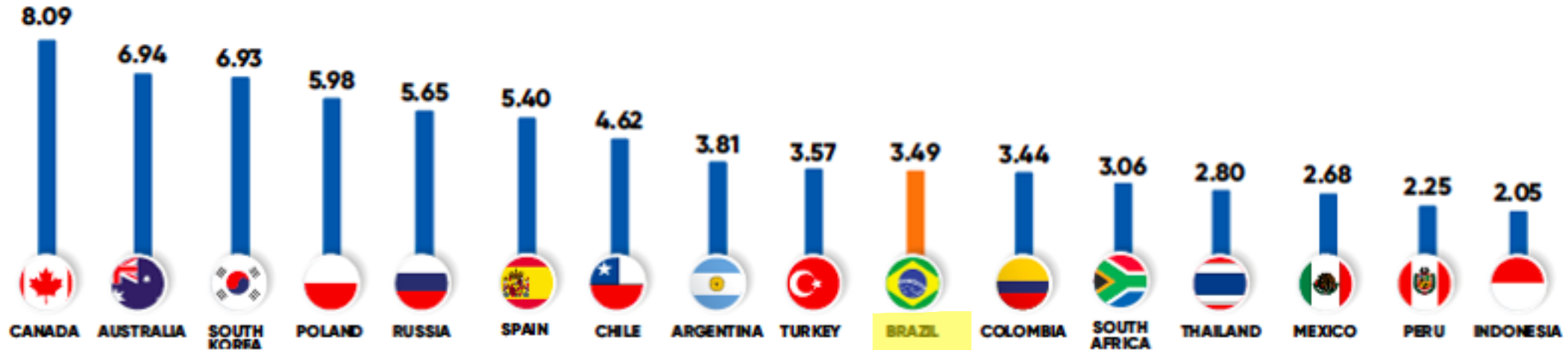
Source: (CNI, 2018)

Note: Mean scores (0 = worst performance; 10 = best performance)

Solid macroeconomic fundamentals reduce uncertainties about the future and increase investor confidence.

The need for a forward-looking industrial policy

4.3 Education ranking

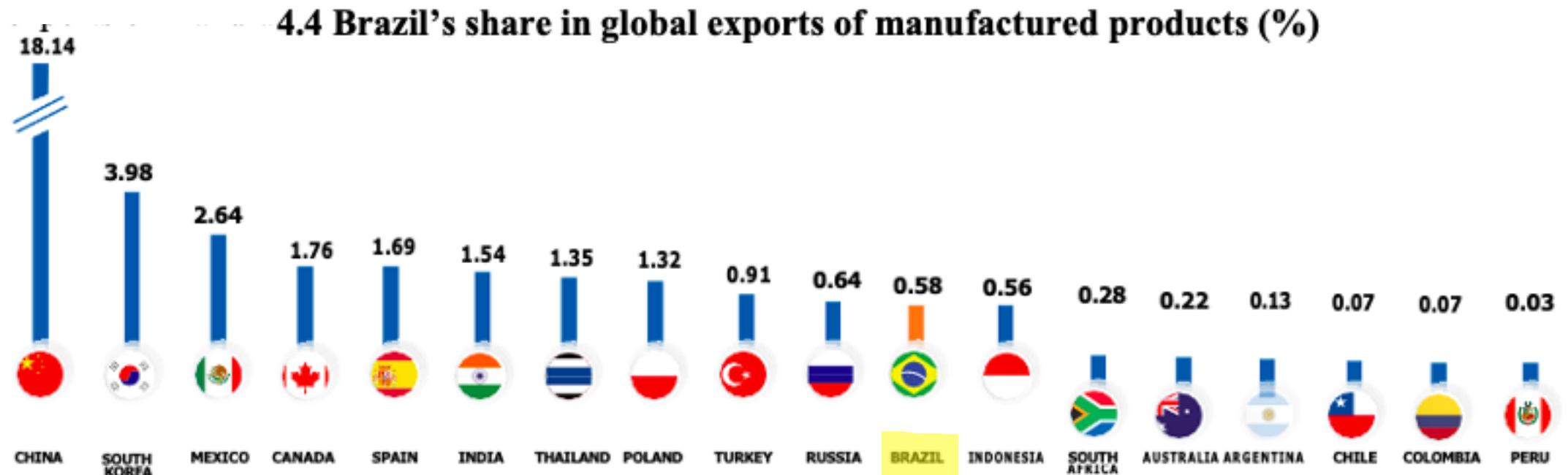


Source: (CNI, 2018)

Note: Mean scores (0 = worst performance; 10 = best performance)

In Brazil, the **unsatisfactory quality of basic education** and the **limited supply of technical and vocational training courses**, constitute **barriers to productivity growth** and to the **competitiveness of companies**.

The need for a forward-looking industrial policy

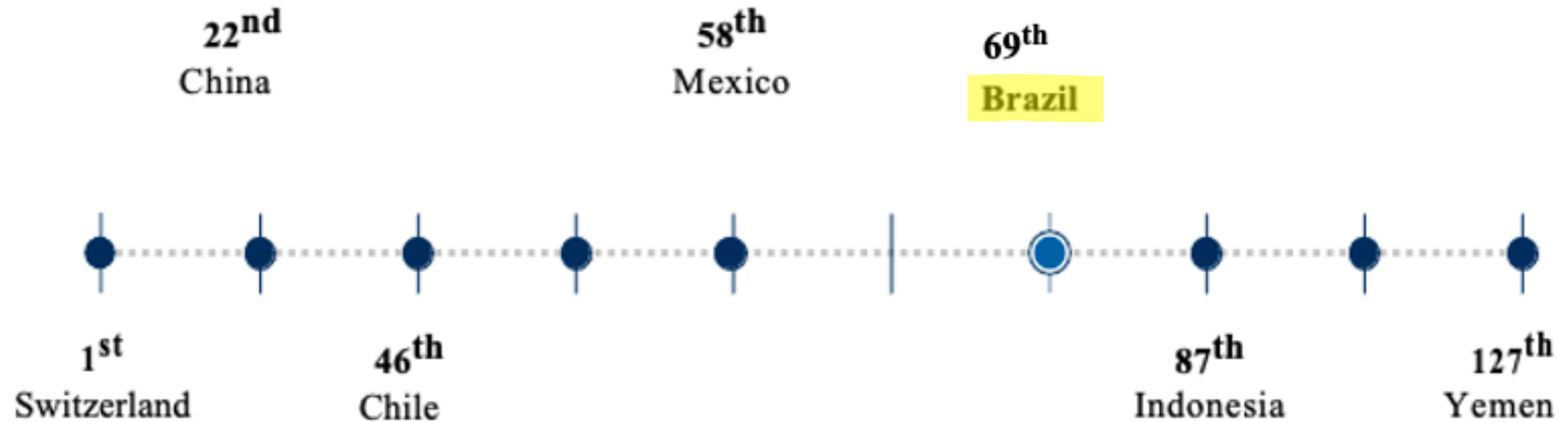


Source: (CNI, 2018)

Brazilian industry has been losing competitiveness in the international market. Brazil's share in global exports of manufactured products **decreased from 0.82% in 2005 to 0.58% in 2015.**

The need for a forward-looking industrial policy

4.5 Global innovation index (2017)



Source: (CNI, 2018)

Adopting a consistent industrial and innovation policy is essential for industry to reach a new level of competitiveness. **Innovation is the engine of long-term productivity gains.**

Opportunities and challenges of Industry 4.0 for Brazil

Source	Opportunities
MCTIC report (Federal Government of Brazil – Ministry of Science, Technology, Innovations and Communications, 2017)	500 Brazilian companies (% of respondents): <ul style="list-style-type: none"> ▪ increase of productivity = 86.6% ▪ decentralization of production = 61.2% ▪ environmental protection = 34.3% ▪ food safety = 29.9% ▪ employment = 23.9% ▪ energy efficiency = 64.2%
(Rossato, 2018)	700 Brazilian business leaders (% of respondents): <ul style="list-style-type: none"> ▪ developing new business models = 44% ▪ preparing the workforce for the digital future = 98% ▪ using technologies to solve organizational challenges = 22%
(PricewaterhouseCoopers, 2016)	Research on Industry 4.0 with Brazilian executives (% of survey respondents expecting gains of over 20% in the next five years): <ul style="list-style-type: none"> ▪ generate additional revenue for companies = 37% ▪ cost reductions = 32% ▪ gains in efficiency = 41%

Opportunities and challenges of Industry 4.0 for Brazil

Source	Challenges
(Graglia; Lazzareschi, 2018)	The generation of jobs in volume and quality in Brazil, goes through the greater protagonism of the industry and requires a serious discussion about the professional training of Brazilians, to face the imperatives of Industry 4.0.
(Morceiro, 2019)	A new industrial and technological policy that also contemplates the incentive for the training of workforce in the fields of: STEM - science, technology, engineering and mathematics and, biological , which are more related to technological innovation.
(IEL, 2018)	Coexistence of companies with varying levels of capacity and competitive performance in the most diverse productive systems.
(Furtado, 2017)	Modesty of technological efforts , characterized by the reproduction of processes and products already existing in the market, a certain mimicry of what was produced and of the production models of other countries , but without the elements of technological dynamism necessary for Brazil.
(Federal Government of Brazil – Ministry of Science, Technology, Innovations and Communications, 2017)	The major concerns in the field of new technologies: the management of information and knowledge , the internet of things and artificial intelligence , digitalization and cyber-physical systems , sensors , actuators and interoperability.

Conclusion

Broader context, beyond the attributes of industrial technology and manufacturing management.

Manufacturing industry share in the composition of the gross domestic product - GDP, has been **decreasing steeply since 1989**:

- Brazilian deindustrialization
- Low qualification of the employed labor force
- Weak orientation to innovation and technological development

Brazil needs an **industrial and technological policy** aligned to the assumptions of **Industry 4.0**, to help face the **challenges of the low productivity of the Brazilian economy**.

The imperatives of **Industry 4.0** can be a **strategic motto** for the **reallocation of employment among sectors**, aiming at **increasing aggregate productivity** in Brazil and **fostering innovation**.

Brazil is in search of a **new industrial model**.

Brazil urgently needs to align itself internationally with efforts to **identify the most appropriate technologies** for the **strengthening and relevance of its industry**, enabling it to be a **relevant player internationally**, especially in view of the **reshoring movement that has taken place in developed countries**, and the development of new markets that allow Brazil to participate in **global value chains**.