



The SENAI Innovation Institutes' Impact on the Brazilian Economy

What is the Economic Value of Innovation?

Macroeconomic Impact Study
Executive Summary

This study was conducted as part of a research project commissioned by SENAI to Fraunhofer IPK and Fraunhofer ISI.



Fraunhofer Institute for Production
Systems and Design Technology



Fraunhofer Institute for Systems
and Innovation Research

Brazilian Industry Demands Innovation

At the turn of the millennium, Brazil's economy was on an upward trajectory. Between 2002 and 2011, its gross domestic product (GDP) grew fivefold, reaching an impressive US\$ 2.6 trillion. However, political crises and the COVID-19 pandemic caused significant setbacks, shrinking GDP to approximately US\$ 2.1 trillion today. While Brazil remains the ninth-largest global economy, it faces pressing challenges - particularly in its capacity for innovation.

Brazil's economy has long relied on raw material exports like soy, coffee, and meat, which, together with a strong oil & gas industry, drove rapid growth in the early 2000s. Yet, this reliance on commodities, coupled with high oil prices and social programs, has proven unsustainable. Industrial leaders recognized the need to shift toward greater value creation in technological sectors, essential for sustainable growth. Despite pockets of innovation, Brazilian industry largely lacks a culture of research and development (R&D). High-tech sectors remain underdeveloped, with Brazil heavily reliant on imports for advanced products.

The gap between academic research and industry further compounds the challenge. While Brazilian universities show good results in basic research, the capacities and capabilities for applied, industry-oriented research are still relatively low. Few non-university institutions conduct R&D for the industry, leaving multinational corporations as the primary players in Brazil's innovation landscape - often limited to adapting products for local markets.

Therefore, in 2011, the National Confederation of Industry (CNI) and the Entrepreneurial Movement for Innovation (MEI) launched the ambitious initiative to create a nationwide network of applied research institutes capable of turning scientific results into industrial productivity and business success. SENAI answered that call by establishing the SENAI Innovation Institutes (ISIs) - a new generation of research centers designed to close the gap between science and industry.



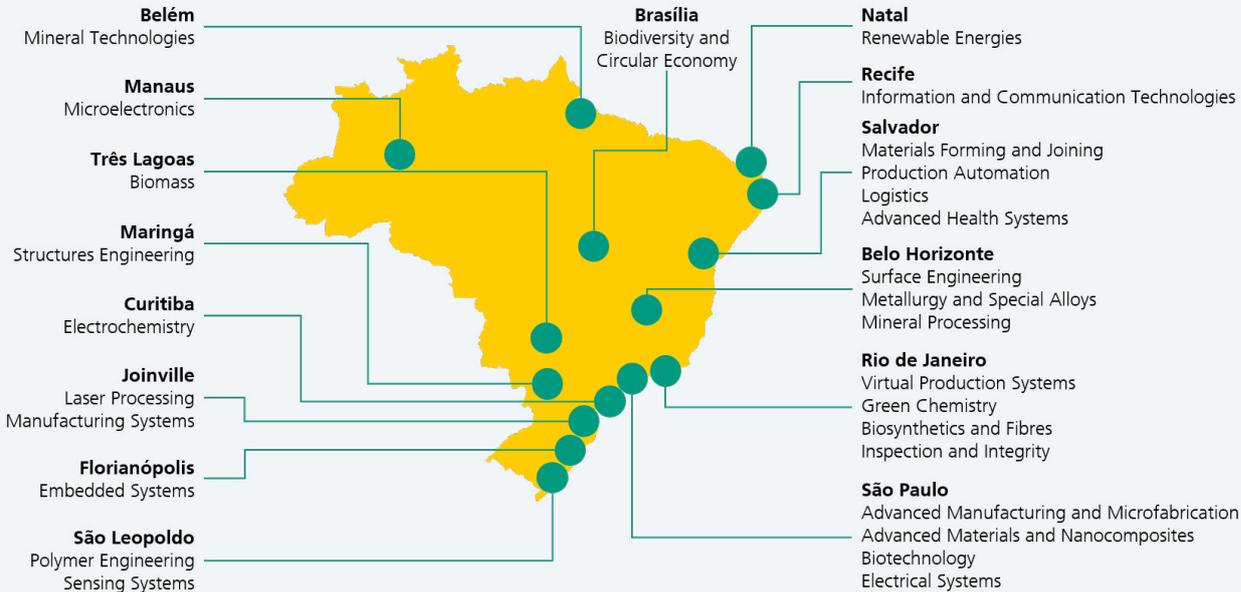
SENAI Innovation Institutes Built for the Brazilian Industry

Since 1942, SENAI - Brazil's National Service for Industrial Training - has been shaping the future of the country's workforce. As Latin America's largest private vocational training provider, SENAI has empowered over 73 million people with technical skills across 28 industries. With around 28,000 employees and a presence in more than 2,000 municipalities, SENAI is a cornerstone of Brazil's industrial landscape.

Today, SENAI is more than a training powerhouse. It is also a driving force behind applied research, technological development and innovation in Brazil. Inspired by global models like Germany's Fraunhofer Society, the Dutch TNO, and Canada's NRC, the SENAI Innovation Institutes (ISIs) were built to deliver real-world impact from 2012 onwards.

By 2024, 27 SENAI Innovation Institutes were up and running, employing approximately 1,500 researchers and serving the Brazilian industry - from global players to local startups - with state-of-the-art research and technological developments. Backed by an initial investment of SENAI and the Brazilian Development Bank (BNDES), the ISIs have become a powerful catalyst for innovation across the country. With cutting-edge facilities, top-class researchers, and with support from Fraunhofer IPK, the network's strategic planning and implementation emphasized agility, industry collaboration, and responsiveness to business needs. The ISIs integrate seamlessly into national and international frameworks, with many accredited as ANP, CATI and EMBRAPPII units. Over 56% of the executed R&D projects involve SMEs, and the network helped connect 185 startups with 90 large companies.

Figure 1: Locations of the SENAI Innovation Institutes



Turning Innovation into Economic Growth

What began as a visionary investment in applied science now begs a bold question: How do we know this investment in innovation is truly paying off?

Using the staggered rollout of the SENAI Innovation Institutes across the country, Fraunhofer researchers were able to isolate and quantify their economic contribution. The idea behind the approach is on a general level rather intuitive: compare the development of GDP over time in regions in which ISI institutes were founded with the development of GDP in regions without ISI institutes and thereby infer to the economic impact of the ISI institutes. After roughly 10 years of operation, this impact is surprisingly large and positive: The SENAI ISI network is responsible for 0.66% of Brazil's entire GDP.

This finding is more than symbolic - it's grounded in causal analysis and backed by extensive data. Depending on the model, GDP per capita increased by 985 to 1210 BRL in the regions where the ISIs are active. These effects are robust, statistically significant, and show a consistent pattern over time.

Even more telling: the study reveals that it is mainly research-intensive projects that drive this growth. While technical services and consultancy also play a role, it is applied R&D that

»The SENAI ISI network is responsible for 0.66% of Brazil's entire GDP.«

makes the decisive difference. This confirms what SENAI stands for - innovation that is not just theoretical, but transformative. With this level of impact, the SENAI ISIs are not just a research success story. They are a blueprint for how targeted investment in applied science can unlock broad-based economic value.

By linking SENAI's R&D activities to measurable economic outcomes, the macroeconomic impact study carried out by Fraunhofer IPK and Fraunhofer ISI provides policymakers, industry leaders, and the broader public with clear evidence of how targeted investment in applied research fuels national economic development. It also reflects SENAI's broader mission: to foster an economy where research benefits businesses, empowers workers, and drives inclusive, sustainable growth. By making the impact of innovation visible, this study aims to inspire stronger partnerships between government, industry, and academia - unlocking the full potential of Brazil's industrial future.



Value Chain of Innovation Creates Multiple Impact

The SENAI Innovation Institutes have significantly contributed to strengthening Brazil's innovation ecosystem through strategic investments, extensive project implementation, and measurable economic impacts. With an overall investment of approximately 2.2 billion BRL, SENAI has successfully established the national network of Innovation Institutes, fostering collaboration across diverse sectors and enhancing Brazil's capacity for technological advancement.

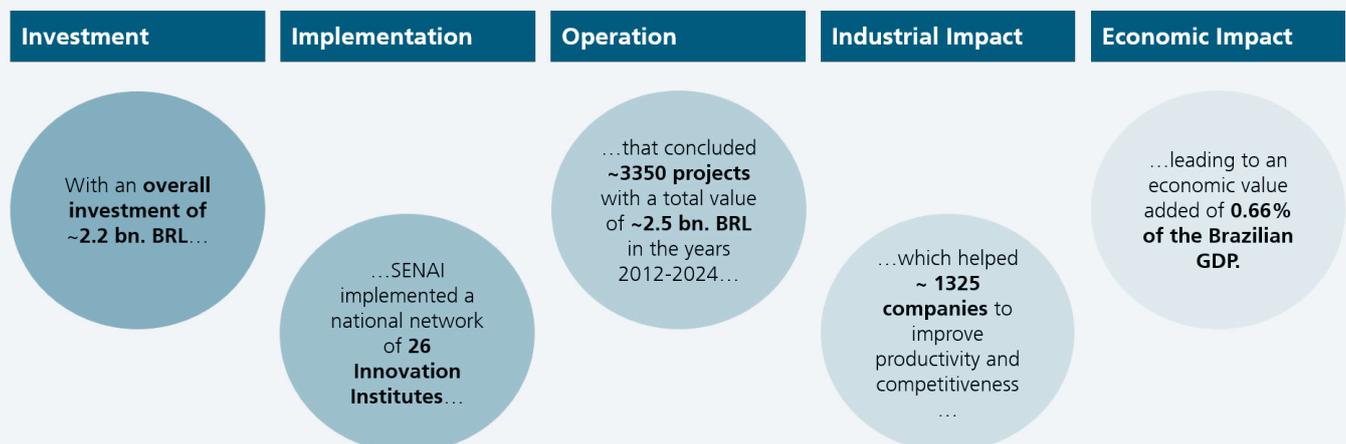
Between 2012 and 2024, the network facilitated the completion of approximately 3,350 R&D and innovation projects, with a total value of nearly 2.5 billion BRL. These projects have driven substantial industrial improvements, benefiting over 1,325 companies by enhancing productivity and competitiveness - an essential element for sustaining Brazil's economic growth in an increasingly globalized and digitized industrial landscape.

The cumulative economic impact of these initiatives has added 0.66% to Brazil's GDP, with a remarkable return on investment: for every 1 BRL invested in the SENAI ISI network, there is an average GDP contribution of 18 BRL per year. This underlines the high effectiveness and national importance of SENAI as a driver of innovation-led economic development.

»International Benchmarks and Future Outlook«

Similar studies for the German innovation system had shown that the Fraunhofer Society – the largest network for applied research in Europe with 75 institutes – contributes approximately 1.6% to the German GDP while all national universities together account for 8% of the country's value creation. These international benchmarks show a clear potential for further innovation-driven economic growth in Brazil and inspired SENAI to elaborate a new technological strategy which will guide the future development of the ISI network and SENAI's research business as a whole. With a focus on the most relevant value chains and business sectors, this strategy aims at solving future challenges of the Brazilian industry, like a fully digitalized and low carbon economy as well as sustainable food production or smart cities and mobility. By following this future-oriented pathway of technological development and innovation, SENAI strives to increase its impact on the sustainable economic growth of Brazil even more in the upcoming years.

Figure 2: SENAI Innovation Institutes' Overall Impact on the Brazilian Economy



State-of-the-Art in Econometrics as the Methodological Basis

The impact of the SENAI ISI network extends beyond immediate project outcomes. It has facilitated the practical application of scientific research, translating theoretical knowledge into tangible industrial solutions. This role as an intermediary between universities, research centres and the industry is crucial for maintaining the flow of innovation within Brazil's economic framework. Therefore, the SENAI ISI network is an exemplary case for measuring the economic effects of scientific research due to its unique setup. The staggered establishment of the institutes across diverse regions provides variation, which is ideal for applying a difference-in-differences (DiD) method to estimate causal impacts.

Trying to assess the economic value of scientific research is a recurring topic in science studies. The different types of impact studies usually suffer from difficulties in establishing causality, because scientific organisations are usually not randomly located across space. They are attracted to economic or cultural centres, become embedded in their regions and then evolve with them, often over the course of centuries. Disentangling such deeply ingrained relationships to cleanly identify the causal economic effects of science and research is, irrespective of the level of statistical sophistication, usually rendered almost impossible simply due to the blurring of what is cause and what is effect. Thus, most of the existing analyses remain subject to the criticism that the estimated effects may, to a non-substantial degree, reflect associations rather than causation.

In the present study, the responsible researchers of Fraunhofer ISI addressed this methodological gap by estimating the effects on GDP using the difference-in-difference (DiD) approach. The staggered foundation of the SENAI Innovation Institutes in Brazil since 2012 offers the unique opportunity for a quasi-experimental setting usually unavailable in studies analysing the economic effects of scientific research. Basically, the case of the Brazilian ISIs allowed to compare the economic development of "treated" regions, i.e. regions with ISI activity, before and after the establishment of the respective institute, with the parallel development of "untreated" regions. Building on historical and institutional insights from interviews on the foundation process, it was possible to show that the selection process to determine the location of each innovation institute (the "treatment" of the region) was based on two main criteria: a) strategically maximise the prospective success of the institutes and b) achieve a certain level of regional balance in the Brazilian territory. Thus, the Fraunhofer researchers were able to make the case that the characteristics of the regional selection process were driven by fixed-effects-like selection based on long-term regional characteristics and therefore satisfy conditions under which the crucial parallel trends assumption in DiD-estimation will hold.

On this methodological basis, a causal relationship between the foundation of the SENAI Innovation Institutes and the development of GDP in the regions in which they are active could be established. The estimates of this causal relationship are statistically significant and adhere to the high methodological standards of the latest developments in econometrics.

References on the Macroeconomic Impact Study of the SENAI Innovation Institutes

Scientific Working Paper

Schubert, T., Darold, D., & Will, M. (2024): Measuring the Causal Economic Effects of Scientific Research: Evidence from the Staggered Foundation of the SENAI Innovation Institutes in Brazil. *Papers in Innovation Studies*, No 2024/14. Lund University. <https://journals.lub.lu.se/piis/article/view/27648>.

Scientific Conference Paper

This paper has been peer reviewed and presented at the scientific conference “European Forum for Studies of Policies for Research and Innovation” (Eu-SPRI) in Dortmund, Germany, on 11th June, 2025.

Title: 123290 Measuring the Causal Economic Effects of Scientific Research - Evidence from the Staggered Foundation of the SENAI Innovation Institutes in Brazil

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See conference program under: <https://euspri2025.de/index.php/programme-10-june-13-june-2025/>

Scientific Journal Paper

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Further References on the Methodology and Relevant International Studies

Allan, G., Figus, G., & Schubert, T. (2022). Understanding the Macroeconomic Effects of Public Research: An Application of a Regression Microfounded CGE-Model to the Case of the Fraunhofer-Gesellschaft in Germany.

Arnold, E., Clark, J., & Jávorka, Z. (2010). Impacts of European RTOs: A Study of Social and Economic Impacts of Research and Technology Organisations: A Report to EARTO.

Frietsch, R., Lutz, J., Neuhäusler, P. et al. (2016): The Impact of Fraunhofer on the German Innovation System.

Jones, B. F., & Summers, L. H. (2020). A calculation of the social returns to innovation (Vol. 27863). National Bureau of Economic Research.

Schlegel, T., Pfister, C., Harhoff, D., & Backes-Gellner, U. (2022). Innovation effects of universities of applied sciences: an assessment of regional heterogeneity. *The Journal of Technology Transfer*, 47(1), 63-118.

Schubert, T., & Kroll, H. (2016). Universities' effects on regional GDP and unemployment: The case of Germany. *Papers in Regional Science*, 95(3), 467-490.

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Disclaimer

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