Looking for Virtue in Remoteness: Policy Recommendations for Sustainable and Inclusive Growth in the Peruvian Amazonia

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Table of contents

Table of Figures

EXECUTIVE SUMMARY

Loreto is a place full of contrasts. Although it is the largest department in Peru, it is one of the least populated in the country. Its capital, Iquitos, is closer to Brazil and Colombia's border states than it is to the capitals of its neighboring regions in Peru - San Martin and Ucayali. Iquitos can only be reached by air or river, making it one of the largest cities in the world without road access.

Since its foundation, Loreto's economy has depended on the exploitation of natural resources: from the Amazon rubber boom at the end of the 19th and the beginning of the 20th centuries, to the oil extraction and exploitation of forest resources that predominate today. This model has brought with it significant environmental damage and has produced a pattern of slow and volatile growth, which has opened an ever-widening gap between the economy of the region and that of the rest of the country. Between 1980 and 2018, Loreto grew at an average compound annual growth rate four times lower than the rest of Peru. Otherwise stated, while the rest of Peru has tripled the size of its economy, Loreto increased it by just under one-third.

Within the last decade (2008-2018), the region has distanced itself from its Amazonian peers in the country (Ucayali, San Martín, and Madre de Dios), which have grown at an average annual growth rate five times higher. Loreto's average per capita income fell from three-quarters of the national average in 2008 to less than half of it by 2018. In addition to - or perhaps as a consequence of - its economic challenges, Loreto is also among the departments with the worst indicators of social development, including the highest levels of anaemia and child malnutrition in Peru.

In this context, the Growth Lab at Harvard University partnered with the Gordon and Betty Moore Foundation to develop a research study that would provide inputs and policy recommendations to boost the development of the region and foster sustainable prosperity. The project *"Economic Growth and Structural Transformation in the Amazon Region of Loreto, Peru"* was executed between November 2019 and July 2020 and comprises three essential inputs for the design of a productive development plan:

a) A report on the productive ecosystem of Loreto, the sophistication of its productive knowhow and its potential (*Economic Complexity Report of Loreto*),

b) A report on the main constraints that inhibit growth and materialization of opportunities for productive diversification in Loreto (*Growth Diagnostic of Loreto*), and

c) A report on public policy recommendations to overcome or mitigate the effects of the main identified constraints and promote structural transformation in Loreto (*Policy Recommendation Report).*

This document is the last in this sequence of inputs. It is a self-sufficient text that summarizes the findings of the first two reports and articulates them in a set of policy recommendations on how to promote sustainable prosperity and productive diversification in Loreto, given its geographical location and the environmental services it provides to the rest of the country and the world.

In terms of economic complexity, our analysis highlights that along with the natural resource extraction industry, other economic activities have developed in Loreto, resulting in a more complex ecosystem than initially expected, given its remote location and challenging circumstances. This finding aligns with Loreto's economic trajectory when we observe it by differentiating its oil and non-oil sectors. Over the past two decades (1998-2018), the gross value added of the hydrocarbon and mining sectors has fallen significantly, contracting at an average compound annual growth rate of 4% - which is equivalent to a cumulative decrease of 56%. During that same period, the non-oil economy of Loreto grew at an average rate (4.2%), which is not only close to the average rate of the rest of the country (4.7%), but is also less volatile than its oil counterpart. The impacts of the evolution of the non-oil sector are also reflected in lower unemployment compared to the rest of Peru, and higher real wages, which are at par with other Amazonian regions of the country.

The productive ecosystem that we have documented allows us to infer that Loreto has a knowledge agglomeration and productive capabilities that have the potential to be deployed in activities with greater value added and contribute to raising the productivity, wages, and living conditions of its inhabitants. Based on the available information, two technological proximity measures were calculated. They enable the identification of economic activities that are relatively close to Loreto's current vector of capabilities and that can lead the productive transformation of its economy. As a result of this process, 55 industries grouped into five thematic areas were identified: food and chemical industries (13 industries), tourism and creative industries (13 industries), forestry, wild flora and fauna activities (12 industries), manufacturing and transportation services (10 industries), and construction manufacturing (7 industries).

This analysis focused on this subset of industries as we identify they can produce tradable goods and services that can be sold outside of Loreto, both to the rest of Peru and worldwide. Therewith, the aim of a diversification strategy based on these industries, is to increase the market size for Loreto's industries and facilitate economies of scale, reduce its dependence to fluctuations in local demand, and generate foreign exchange that can be used to import final and intermediate goods that are not are produced in the region.

The higher knowhow agglomeration and the observed technological proximity to higher value-added industries should have already led Loreto to a productive transformation and therefore, higher levels of income per capita. But the absence of this transformation raises a series of questions: Why has the region been unable to leverage its stock of know-how to grow rapidly and diversify into more sophisticated industries? Why haven't these high-potential economic activities materialized spontaneously? A plausible hypothesis is that Loreto's remote location served as a protective barrier, in a similar way an import tariff would. The costs imposed by its remote location discouraged imports, and instead, encouraged local entrepreneurs to meet local demand. In this way, in Loreto, the diversity of industries detected is consistent with high levels of economic complexity, but not with the level of income that is usually noted in other economies since industries are less efficient and are restricted by the size of local demand.

This dynamic makes it more necessary to promote a strategy to remove the most binding constraints to sustainable development and boost the competitiveness of the industries that are already in Loreto,

as well as those that could be developed with the current *stock* of productive capacities and *know-how* of the department. During the investigation, the team conducted an exhaustive revision of a wide spectrum of complementary factors that are necessary to support production, using the Growth Diagnostic methodology (Hausmann, Klinger, and Wagner 2008). Three binding, and interrelated, constraints to sustainable growth were identified in the diagnostics process: i) river connectivity in the department, ii) electricity as a cross-cutting component for the productive transformation of Loreto, and iii) the inability of the State to address information and coordination failures associated with the process of self-discovery. This is not to say that these three are the only constraints to growth in Loreto, but it does suggest that improvements in these capabilities will likely have a greater impact on growth compared to other possible constraints.

Our research-based policy recommendations contain elements to reduce or mitigate the identified limiting constraints and suggest institutional devices that can facilitate coordination in the design, execution, evaluation, and adoption of productive development policies.

In terms of addressing water connectivity as a binding constraint, our recommendations focus on the promotion of more efficient, predictable, and unobstructed means of moving goods by the existing waterways, considering the high environmental and economic costs of the other alternatives. According to the team's research and coincident with that of other researchers, the direct costs of river transport are relatively low, but companies have to bear costs that go well beyond the freight rate, related to the time, risks, and uncertainties of current arrangements.

Reducing the costs and times of river transport of goods, including the associated uncertainty, and increasing the presence of the State, were the precise objectives of the recent Amazon Waterway Project. This project has the potential to improve the navigability conditions along 2,687 km (around 1,670 miles) of the Marañon, Ucayali, Huallaga, and Amazonas rivers and thus contribute to the development of trade in the North Interoceanic Corridor that integrates the port of Paita with the rest of the Peruvian Amazonia. According to the Ministry of Economics and Finance (MEF), the waterway would reduce transportation times by 20% and increase the cargo transported by 3.5 times.

However, the current formulation of the waterway project leaves many unanswered questions as to its potential environmental impacts. Overall, the studies carried out to date - the Environmental Impact Assessment (EIA) and the Feasibility Analysis - lack sufficient information to establish the environmental sustainability of the project and its effects on the socioeconomic developments of Loreto and the rest of the areas that would be affected by the waterway. In addition, the environmental considerations are not in line with the analyses performed on other comparable projects such as the Paraguay-Parana Waterway and ignore the current state of the art knowledge in terms of environmental impact valuations contained in the guidelines of international organizations such as the World Bank and the Organisation of American States (OAS). In this sense, in addition to analyzing the environmental implications of the Amazon Waterway project based on the EIA and the Feasibility Analysis this report provides additional recommendations to incorporate environmental considerations in the implementation of the project.

With regards to electricity, Loreto's current arrangements depend on one of the most expensive, volatile, and polluting sources of power generation: diesel and residual fuel plants. The institutional arrangement that governs the provision of electricity in the region prevents its stakeholders from internalizing these costs, therefore the signs that identify restrictions within a growth diagnosis are more difficult to observe. Rates paid by the companies are regulated and do not reflect the long-term marginal cost of providing electricity service. Since they do not cover this cost, the current arrangement means that the rest of the country grants a cross-subsidy to companies in Loreto. The subsidies lead to the higher relative use of the service, making firms in Loreto more intensive in the use of electricity than would be expected if the economic and environmental costs were internalized.

In this context, the provision of cheap renewable energy sources can play a strategic role in the sustainable development of the region. First, it would reduce the marginal costs of existing and potential industries, stimulating the emergence of larger firms, which demand more energy but can produce exportable goods and services. Second, it would contribute to reducing environmental pollution from the existing generation system. Finally, it would eventually free up oil production, currently destined for diesel and residual fuel plants, helping boost the hydrocarbon exports of the region.

Solar energy is the only technically viable renewable source with the potential to reduce fuel consumption in thermal power plants and produce savings in the electrical system. Its practical viability however, depends on its economic benefits – the cost relative to oil prices, and the size of efficiency losses – and the distribution of the net gains. Considering the large initial investment, solar energy provision is feasible in scenarios of relatively high oil prices and relatively low efficiency losses. Beyond the economic benefits of the initial investment, it is necessary to consider additional environmental advantages of replacing the current power plants with solar energy. Initial investment subsidy schemes by the state and environmental organisations can be evaluated. much more positively if we consider the possibility that technological progress would further reduce the costs of provision and storage of solar energy (in batteries) in the medium term, making solar energy a much cheaper and sustainable option overall.

The second set of considerations - the distribution of benefits among the different stakeholders - is also crucial for the viability of solar energy in Loreto. The provision of energy at significantly lower costs has the potential to benefit the rest of the country (if the transfers that currently support the electricity subsidy in Loreto decrease), the private sector in Loreto (if all the savings derived from the change in provision are transferred to the energy rate), or to the government of Loreto (if the current subsidy is maintained and transferred to the regional government). In all cases, there seem to be enough benefits to promote Paretian arrangements among the relevant actors, a necessary condition to promote their active participation and materialize the opportunity.

The last binding constraint to growth in Loreto identified in this research is the limited capacity of the State to resolve coordination and information failures associated with the process of self-discovery. This process – through which a place finds new products and services that it can produce competitively – is one of the keys aspects of productive diversification and structural transformation. By its very nature, self-discovery is often subject to numerous failures that inhibit or delay the

deployment of existing productive capacities into new and higher value-added industries. Our findings suggest that Loreto tends to diversify less into nearby industries than the other regions of Peru, indicating that it is less able to circumvent coordination and information failures. This lack of capabilities translates into a slower process of self-discovery and might explain why Loreto has not been able to leverage its agglomeration of productive knowhow to develop new industries with higher value-added, and that might be capable of sustaining higher wages.

A relatively small number of thematic areas and industries need to be prioritized to strengthen state capacity and solve coordination dilemmas- Because Loreto's binding constraints impact the 55 identified industries with high potential differentially, we focus on a process to narrow down the list of priority industries.

The process subjects the 55 industries to various filters that include industry-level dependency on the identified constraints, in addition to other factors including viability, attractiveness, and compatibility with environmental considerations. The latter is a special consideration due to the geographical location of Loreto, the fact that the Peruvian Amazonia is one of the largest reserves of biodiversity in the world, and the importance of its environmental services to the planet.

Determinants of viability at the industry level (how feasible it is to develop a particular industry in Loreto) include, among others, the intensity of electrical energy use, the industry's propensity to export by air (as a way to temporarily evade river traffic restrictions), the intermediate inputs available in Loreto and required by the industry, and the intensity with which these activities are observed in similar locations. Among the determinants of the attractiveness of each industry (how desirable it is to develop it in Loreto) we consider the industry's ability to attract Foreign Direct Investment (FDI) from Latin America and worldwide, propensity of their firms to export, and ability to generate employment. Overcoming unemployment or underemployment is a priority of the region.

Finally, the set of environmental factors included the propensity of the industry to undermine water quality and aquatic biodiversity, the intensity of land use (which can lead to increased deforestation in the region), ecological and air pollution by toxic substances, and the emission of greenhouse gases.

This sifting results in a smaller group of more sophisticated industries that are relatively close to the productive capacities of Loreto (greater complexity), but that are also consistent with the environmental considerations, have a high probability of materializing (feasibility) and which are attractive from the point of view of generating foreign exchange (via investment or export) and creating jobs. Based on each industry's score on each of these axis, four groups were created and incorporated to a four-phase strategy that considers existing industries (intensive margin) and industries that are not yet present in Loreto (extensive margin).

With this in mind, we therefore recommend a number of policies and institutional devices to strengthen the capacity of the State to resolve coordination and information failures, accelerate the emergence of new sectors and promote the structural transformation of Loreto's economy. Our recommendations are based on existing structures, seek to optimize their operation, and create subunits dedicated exclusively to Loreto.

The first of these mechanisms is the creation of regional Executive Roundtables for public-public and public-private coordination on the sectors identified here as priorities. Peru is a pioneer in the successful implementation of Executive Roundtables, but the different productive structures of the departments of Peru suggest that this initiative should evolve naturally toward the subnational level. This is particularly true for Loreto, which lacks formal coordination mechanisms between public and private actors for the design and execution of its productive development policies. A coordinating unit in charge of analyzing the factors constraining the emergence or growth of an industry, with the capacity to mobilize the relevant actors around the provision of the necessary inputs, has the potential to increase the efficiency and competitiveness of the industries of the department.

To reduce information failures associated with the process of self-discovery, we suggest organising regional business competitions which are consistent with environmental considerations. Initiatives like this already exist in Peru, for example, the Innovate Peru Program (Programa Innovate Peru). However, as with the Executive Tables, it is important to give existing funds a subnational character, according to the specifics characteristics of each region, so as to increase their impact. We recommend the expansion or creation of a program similar to Bio Challenge (*Reto Bio)* , exclusive to the department of Loreto, focusing not only on enhancing the value of the area's natural resources but also on generating productive capacities. We further recommend partnering with environmental conservation organizations working in the Peruvian Amazonia, that can help fund and/or organize this type of competitions. This initiative can contribute to filling information gaps that hinder the emergence of new industries in Loreto. Moreover, it can also engage industries in the prevention of ecologically damaging activities, instead promoting activities related to environmental preservation.

To foster the emergence of the priority industries not currently present in Loreto, it is necessary to develop an investment promotion agency within the department. The productive agendas of the places are usually monopolized by the demands of the actors who are present. For this reason, it is important to attract business leaders and new business models to the region to promote its structural transformation.

To achieve this, we recommend the creation of a Decentralized Office for Productive Development in Loreto. Its central objective would be to lead public-public and public-private coordination and integrate Loreto's productive development policies with the existing plans and programs. The Office would play a role in promoting and attracting investment to the region and would be an integral actor for the organization of the regional executive roundtables and competitions for sustainable business plans that have been suggested in this report. We recommend that this Decentralisation Office serve as a complement to the existing Regional Development Agencies and the Decentralization Secretariat of the Office of the President of the Council of Ministers of Peru, by advancing the frameworks that are more convenient for the region.

Overall, the overarching goal of this research project is to help break the dichotomy between environmental sustainability and economic development that has predominated much of recent debates in Loreto. Our work has shown that Loreto has a significant agglomeration of knowhow, reflected in a relatively stable growth rate in its non-oil sector, similar to that of the other Amazon regions. This does not seem to be evident in the conventional view and the narrative heard by the

research team in numerous field interviews with different institutional actors. The current prevailing narrative instead places its attention on the role that the shocks suffered by the forestry and oil sectors, the decline of the associated rents and their distribution, and the conflicts derived from their extraction played the department's recent economic trajectory.

This perception is the result of the eventful history of Loreto, forged in fits and starts through a sequence of interactions involving native peoples organized in communities who extracted excessively from the Amazonian environment to meet their needs, and successive waves of adventurers who also exploited the region's natural resources. The weight of that legacy is not trivial. Even today, the debate over the production methods of extractive industries attracts a disproportionate amount of attention within the discussion of development and public policy in Loreto. As a result, the rest of the productive ecosystem is set aside, whose variety and sophistication can open up opportunities for the diversification and productive transformation of the department. Precisely, these agglomerations of knowledge, in which new industries with higher value-added are identified and that can be developed by redeploying existing capacities, are what our research methods aim to document.

It is important to note that extractive industries such as oil do not respond to knowledge agglomerations, but rather tend to locate where the resource is. In the case of Loreto, the sustained decrease in oil production since its boom began in the late 1970s seems to be indicative of very particular structural constraints, unlike those identified for non-extractive industries in this report. Further, Loreto's particular situation imposes additional costs on oil extraction, which is also subject to coordination failures made more complex by the synergies and complementarities between the different types of crude oil. The current low levels of oil production contrast with the region potential and suggest that the state has failed to address the many coordination failures and dilemmas of oil exploitation in the jungle. Although in Peru, there are some examples of what can be achieved with political will and institutional capacity, the specific challenges of oil extraction in Loreto cast doubts on the prospects of oil as a growth engine.

Our research cannot elucidate whether oil is part of Loreto's long-term future, but it documents the department's productive capacities that have the potential to open up opportunities for diversification and structural transformation into activities compatible with environmental conservation. To materialize this potential, the report identifies and prioritises these activities, describes the binding constraints to growth and sets forth policies aimed at overcoming or mitigating them. The report recommends institutional devices to strengthen the regional government's capacities. This set of inputs has the potential to change the prevailing narrative in Loreto and help break the false dichotomy between environmental conservation and economic development. This change in narrative can be fundamental step to help Loreto overcome geographical barriers, promote inclusive growth, and improve the living standards of its citizens.

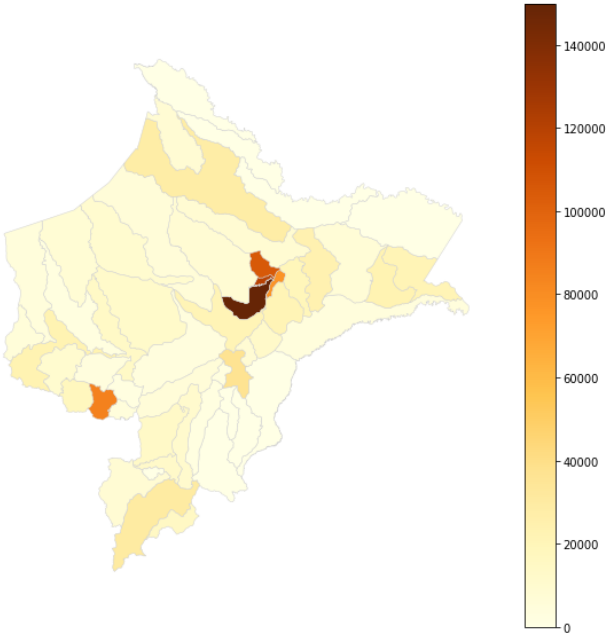
1. LORETO'S GROWTH TRAJECTORY

1.1 Characteristics of the Department of Loreto

Loreto is the most isolated and remote department in Peru. Its 369,000 square kilometers cover about one-third of the country and consist mainly of low Amazon jungle, with an altitude of between 70 and 220 meters above sea level. To the Northwest, Loreto borders with Ecuador; to Northeast with Colombia; to the East with Brazil; and to the southwest the Peruvian departments of Amazonas, San Martín, and Ucayali. Loreto has a population of approximately one million people making it one of the least densely populated regions of Peru. About half of its inhabitants live in its capital, Iquitos. Iquitos is closer to the border with Brazil and Colombia than to the nearest regional capitals Tarapoto and Pucallpa (460 and 540 kilometers, respectively). Iquitos is not integrated to the national electrical grid nor to the national highway system, thus it can be only accessed by air or by river.

Loreto is a heterogeneous department, where urban and rural realities coexist. According to the 2017 census, Loreto has 316,000 inhabitants in rural areas (34% of the department's population) and 607,000 in urban areas (66%), mostly concentrated in the cities of Iquitos and Yurimaguas. 60% of the population lives in 6 of the 53 districts of the department (see Figure 1). The rest of the population is scattered in remote areas, only accessible by river and in a few cases by air.

Figure 1. Loreto's population density by district

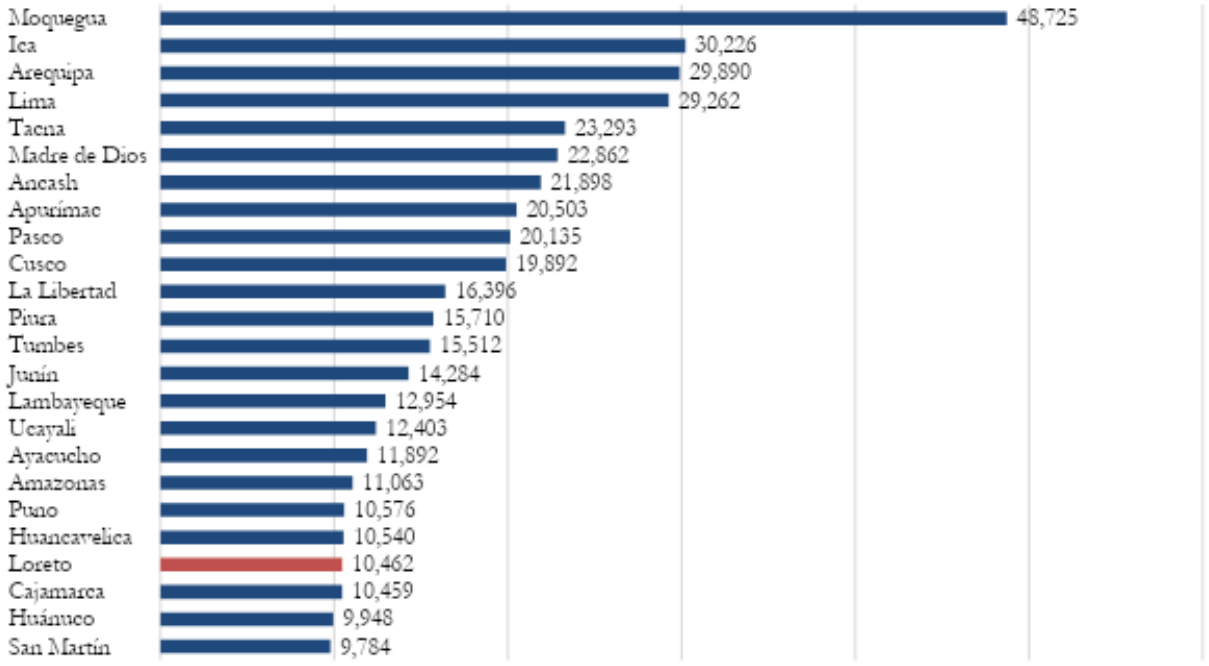


Source: ENAHO (2018), prepared by the authors.

Loreto is one of the poorest departments in Peru. With a Gross Value Added (GVA) per capita of just 10,462 soles (approx. US$3,150), Loreto is the fourth department with the lowest income per capita in the country (see Figure 2). This level of GVA per capita is equivalent to two-thirds of the

average for the rest of Peru (15,611 soles, approx. US$4,702). The GVA has been used to characterize the level of income per capita of Loreto instead of the GDP because, as in other countries in the region, neither the National Institute of Statistics and Data Processing (INEI, by its acronym in Spanish) nor the *Banco Central de Reserva de Perú* (Central Reserve Bank of Peru-BCRP) release GDP figures at a regional level. Although GVA is a good approximation of GDP at market prices, there are conceptual differences between the two indicators.

Figure 2. Gross Value Added per capita, by region (current soles, 2018)

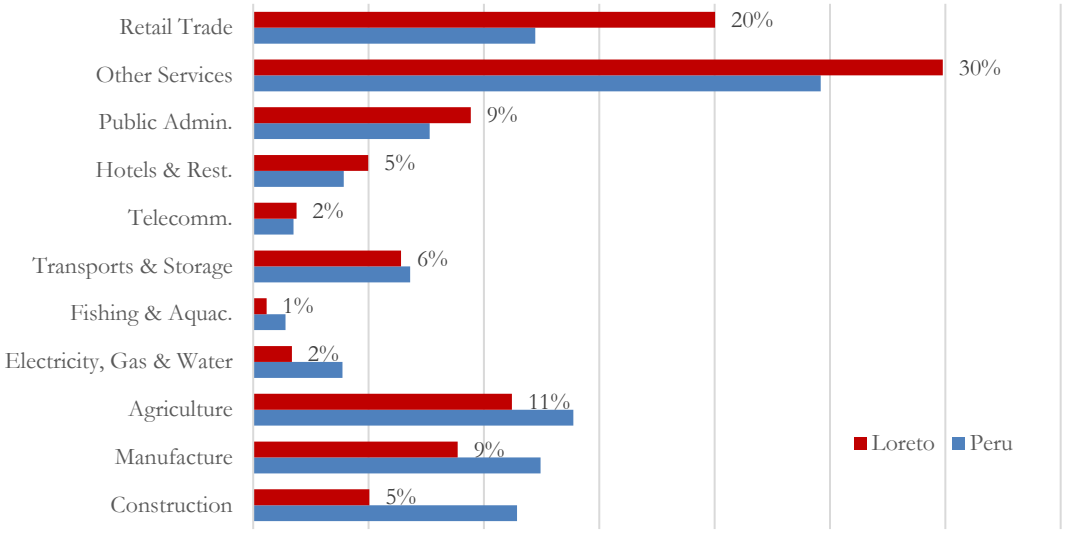


Source: INEI, calculations by the authors.

Loreto's economy is also differentially dominated by the services and commercial sectors, and less by the construction sector vis a vis the national average. According to aggregate data from INEI, the department's largest economic sector is services, which account for 23% of GVA[1]. The oil sector follows with 18% of value added, followed by commerce (17%), agriculture and livestock (9%), public administration and defense (8%), manufacturing (7%), and other sectors (the remaining 17%). As Figure 3 highlights, this composition of GVA differs from the country's average, especially when extractive sectors, such as mining and oil, are excluded. For example, share of commerce in GVA is eight percentage points higher than average region, while construction is six percentage points lower than the average.

[1] Figures from INEI for GVA current 2018.

Figure 3. Composition of non-oil GVA in Loreto and Peru, 2018



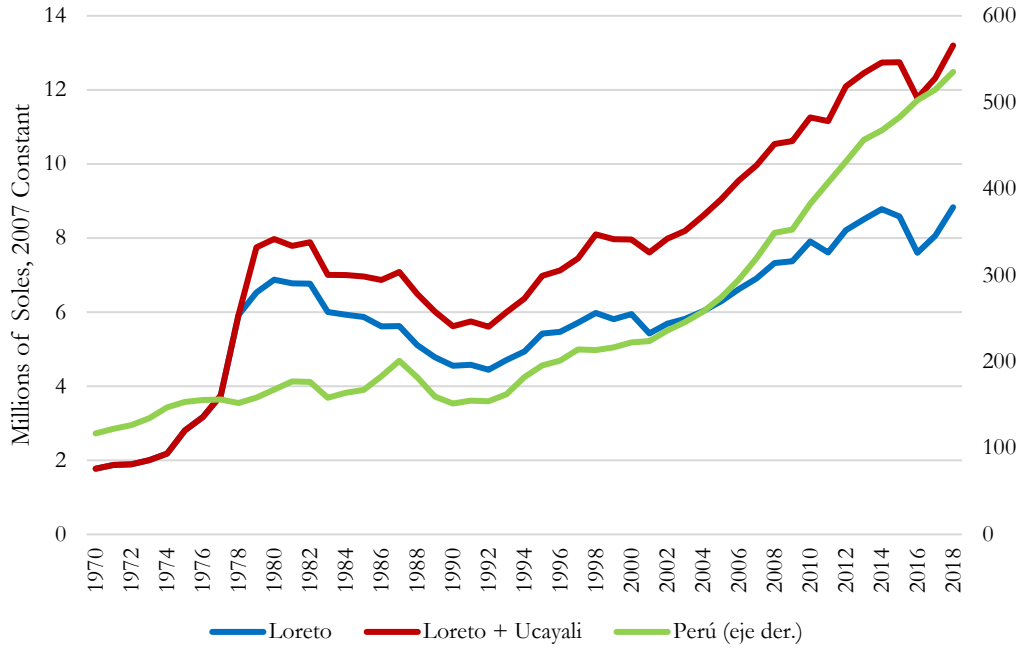
Source: INEI, own calculations.

1.2 Growth Trajectory

Since 1980, Loreto has grown at a slower rate than other regions and the income gap between them has steadily increased, a pattern that has intensified over the past decade. Loreto has become relatively less prosperous rather than converged in per capita income with the rest of the country. After the discovery of oil in the 1970s, Loreto's real GVA [2] quadrupled in ten years (Figure 4). However, after the boom, the economy lagged with respect to the rest of the country, growing at an average compound annual rate (CAGR) of just 0.7%, four times lower than the rest of the country (3.0%). While Peru's economy has tripled in size, Loreto has only grown by 30%. This trend has continued in the last decade. Between 2008 and 2018, the GVA per capita of Loreto grew by only 0.6% per year, a quarter of the rest of Peru (2.5%) and a fifth of the other Amazonian departments of the country (2.9%). At a rate of 0.6% per year, it would take Loreto over a hundred years to double the size of its economy. As expected, the gap with the rest of the country has been widening, with GVA per capita in Loreto going from being equivalent to 75% of the national GVA per capita in 2008 to less than half (49%) by 2018.

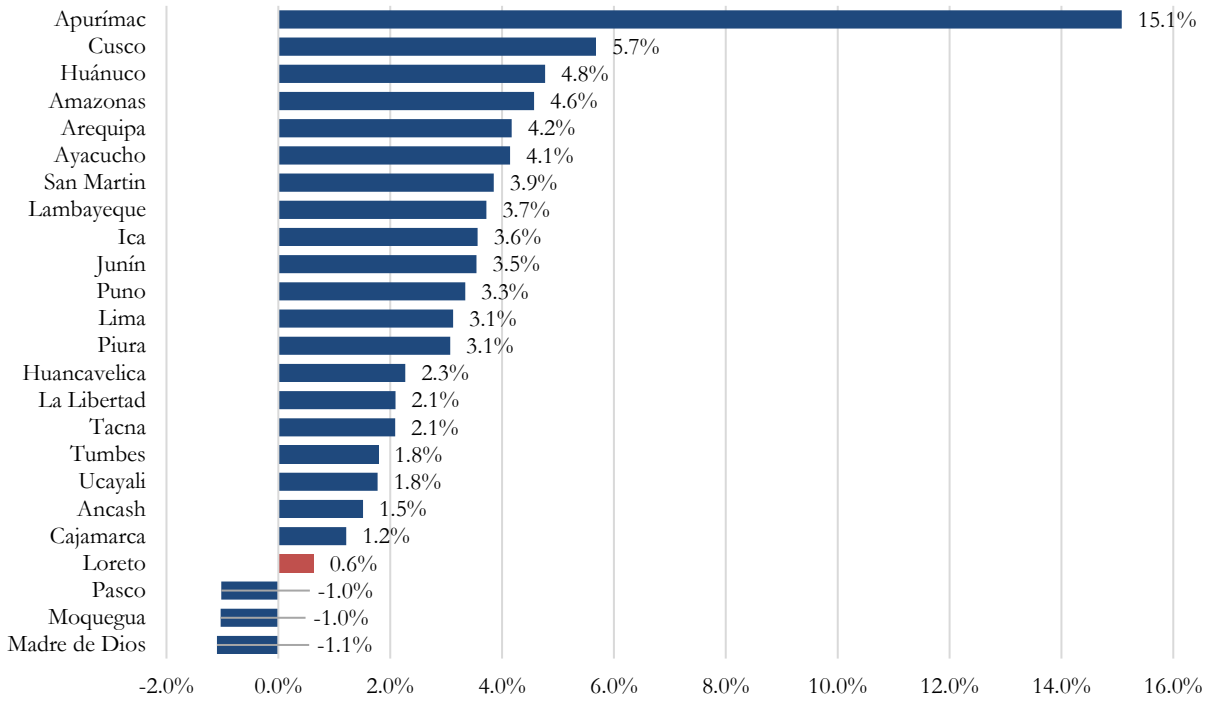
[2] At that time, the department included the current Department of Ucayali.

Figure 4. Gross Value Added, Peru and Loreto



Source: INEI, Mendoza and Gallardo (2012), own calculations.

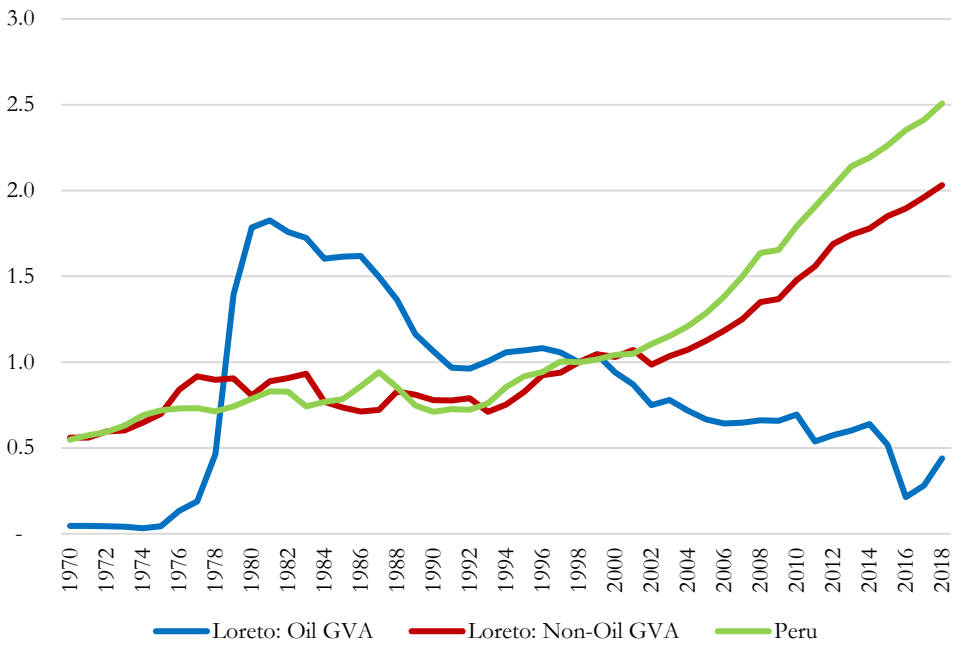
***Figure 5.** Growth in Real GVA per Capita, by region (2008-2018)*



Source: INEI, own calculations.

There are significant differences between the evolution of the oil sector and the rest of the economy. While previously the main engine of growth in Loreto, the oil sector has fallen behind compared to other sectors which have continued to grow steadily. As Figure 6 shows, the GVA of the oil sector has continuously contracted over the past four decades (1980-2018). For example, over the last twenty years, the oil activity declined at an average annual rate of 4.0%, resulting in a cumulative fall of 56%[3]. On the other hand, the non-oil economy has grown at a real CAGR of 4.2% in the last decade and 3.6% in the last two decades, slightly lower than the growth registered by the Peruvian economy (4.4% in the last decade; 4.7% in the last twenty years).

Figure 6. Loreto and Peru: Real Growth per sector (1980=1)



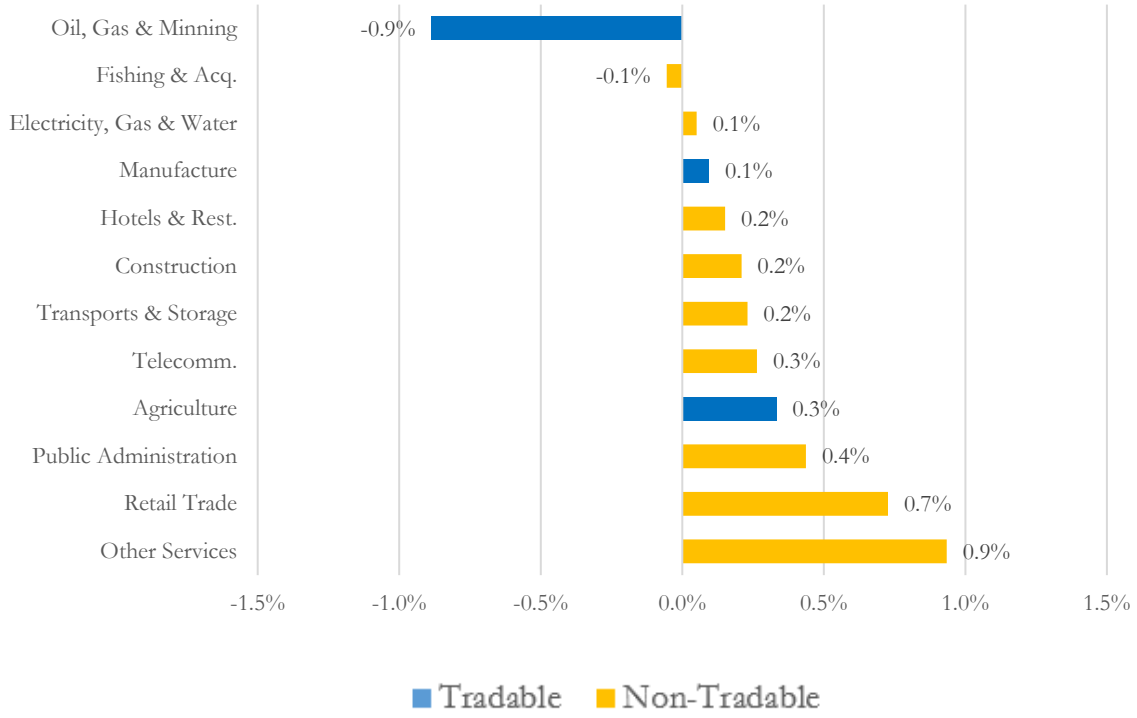
Source: INEI, own calculations.

The non-tradable sector has been Loreto's main engine of growth in the last decade with non-oil tradables contributing but to a lesser extent. As Figure 7 shows, non-tradable economic activities, such as "other services" (education and health), commerce, and public administration contributed 2.1 percentage points of total growth (2.4%). When adding the remaining non-tradable sectors, their contribution reached 2.9 percentage points, outpacing Loreto's overall growth over the

[3] The figures for the decline of oil activity, from INEI mining and oil GVA statistics, show a smaller drop in volume than PeruPetro's oil production figures. The differences could originate from several factors, including the quality of the crude oil extracted, variations in natural gas production, and conceptual differences between real oil GVA and production volumes.

period. For its part, the contribution of the non-oil tradable sectors was just 0.5 percentage points, less than a fifth of the non-tradable sectors.

Figure 7. Loreto: Sectoral Contribution to Growth (2008-2018)



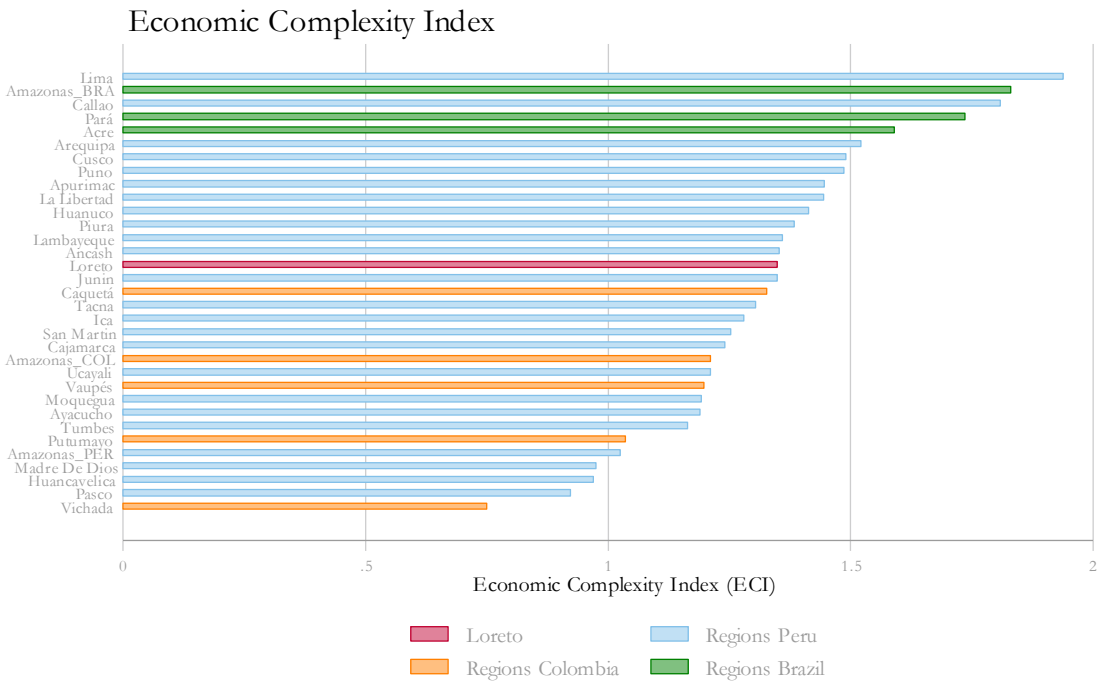
Source: INEI, own calculations.

The significant differences between the growth trajectories of the oil sector and the rest of the Loreto economy suggest the need to develop differentiated strategies. While the region's main growth engine has been the non-oil economy, and in particular the non-tradable sector, the oil sector has been steadily declining for forty years. This reality suggests that policy recommendations will be more relevant and effective to the extent that they consider these sectors separately.

2. THE ECONOMIC COMPLEXITY OF LORETO

Loreto has an intermediate level of economic complexity and productive know-how comparted to the rest of Peru's departments and the Amazonian regions of Brazil and Colombia[4]. Despite its geographic isolation and the predominance of natural resources in its economic history, the Economic Complexity Index (ECI) of the region is higher than that of all the Amazonian provinces of Peru and Colombia (see Figure 8).

Figure 8. Economic Complexity Index (ECI), Loreto and Peer Regions



Source: Own calculations based on Dun & Bradstreet.

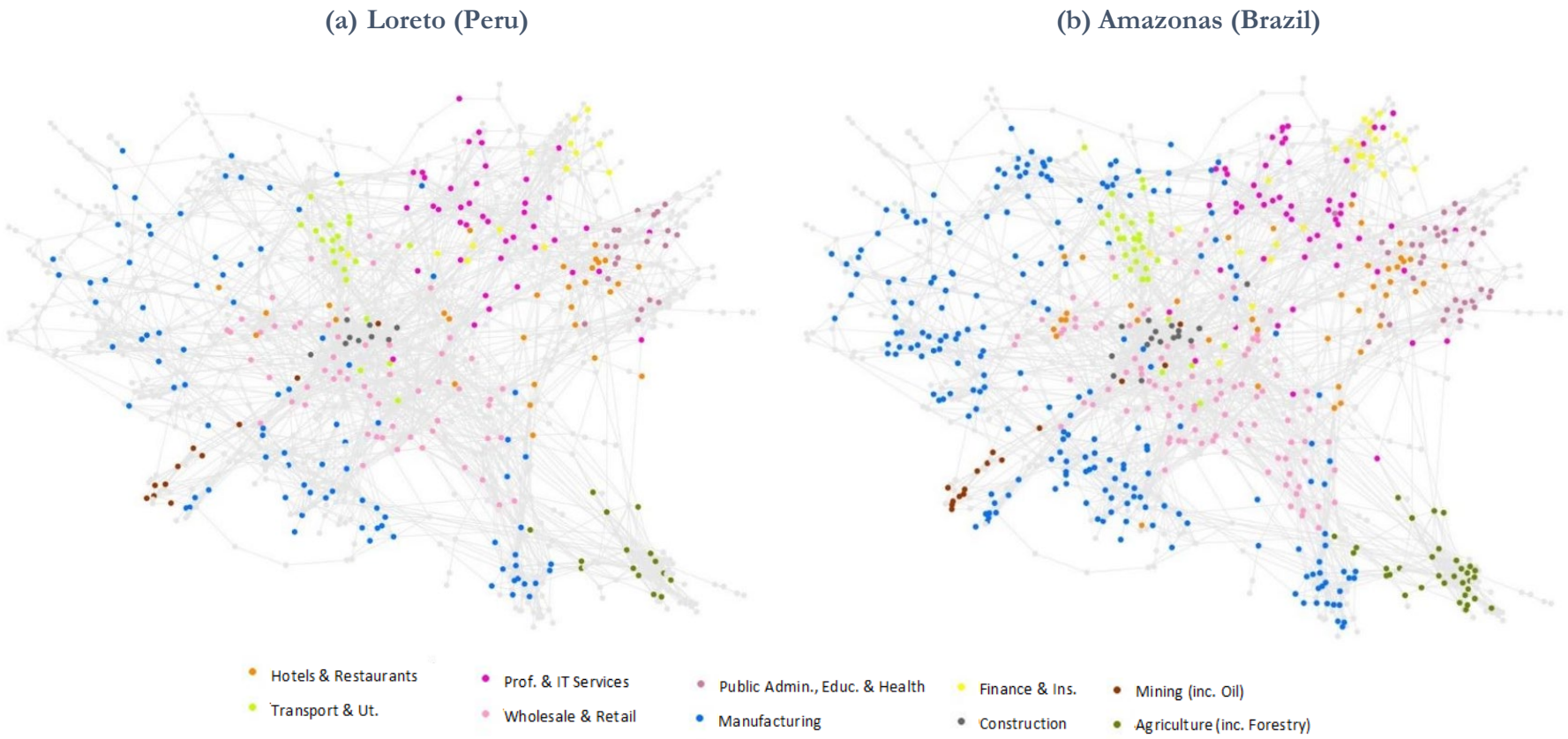
Sources: Calculations by the authors, based in Dun & Bradstreet.

Loreto's industry space is fairly dispersed, with a limited number of nodes and connections. Using the measure of distance based on co-production at the establishment level, networks of existing productive capacities were mapped in the department of Loreto (Figure 9a) and in Amazonas, Brazil (capital Manaus, Figure 9b). Colored nodes represent industries that exist locally, and the gray nodes represent the industries that do not have any firm registered in the corresponding code. It is possible to identify several crucial differences between the two. First, Loreto has fewer colored nodes (308)

[4] Given the limited information and to adapt the Economic Complexity measures to the subnational context of Peru, using the Dun & Bradstreet (2019) firms database, we have identified as "present" any industry or service where at least one signature is registered in the place with the corresponding code. Specifically, a region is capable of producing or providing a good or service, as long as there is at least one signature registered in the corresponding industrial code that identifies said good or service. For further details on the calculations, see Hausmann et al. (2020b).

than Amazonas (557), reflecting a lower relative diversity. Second, the clusters in Loreto are less populated and more dispersed. Notably, most industries are grouped around the professional services cluster (purple), the transport, storage, water, and electricity cluster (green), and the trade cluster (pink). Industries included in the manufacturing category (blue) tend to be more dispersed and with less populated clusters than those observed in Amazonas. Finally, the dispersion between industries translates into a larger average distance to missing industries, a measure of how far apart the missing industries are in terms of productive capabilities.

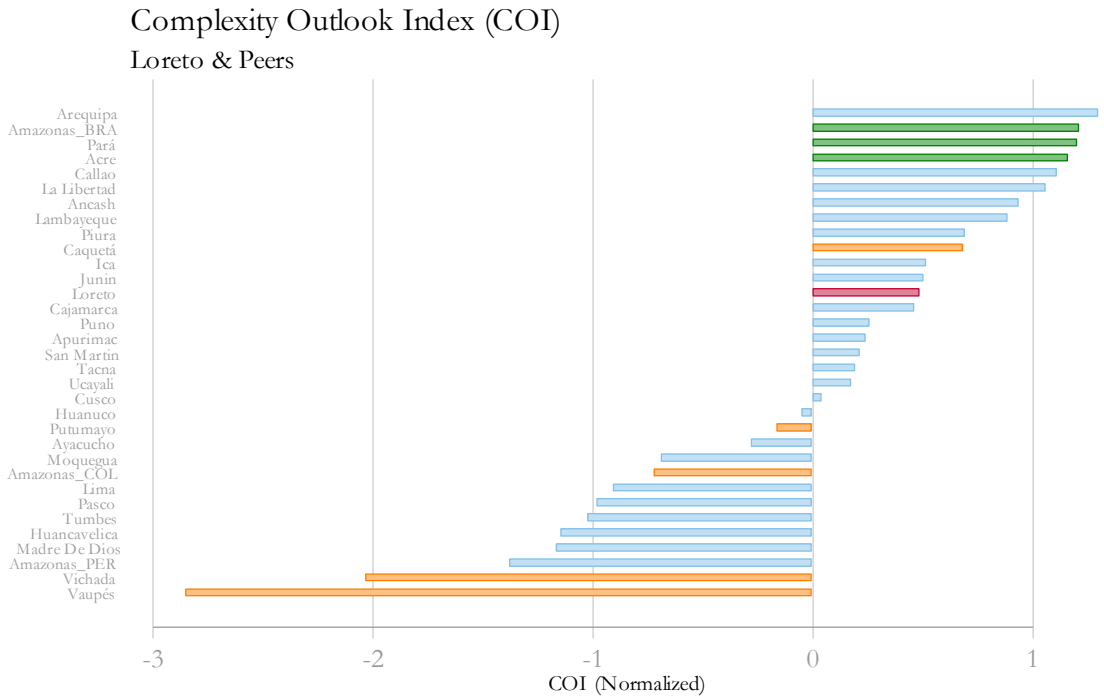
Figure 9. Industry Space, Selected Regions



Source: Own calculations based on Dun & Bradstreet.

The industry space also provides a measure of diversification possibilities for Loreto, which has a high potential for diversification. This measure, the Complexity Outlook Index (COI), constitutes an additional indicator of the strategic value that developing a particular industry would have in each region, depending on how well connected their current industries are, with others more complex industries that are absent. Figure 10 depicts the COI for the departments of Peru and peer Amazonian regions. Overall, Loreto's results are positive, ranking 13th out of 33. A high COI indicates a high potential to diversify and increase a region's complexity, while a low COI suggests greater risks in the diversification process and the need for coordinated leaps to more strategic areas.

Figure 10. Complexity Outlook Index, Loreto and peer regions



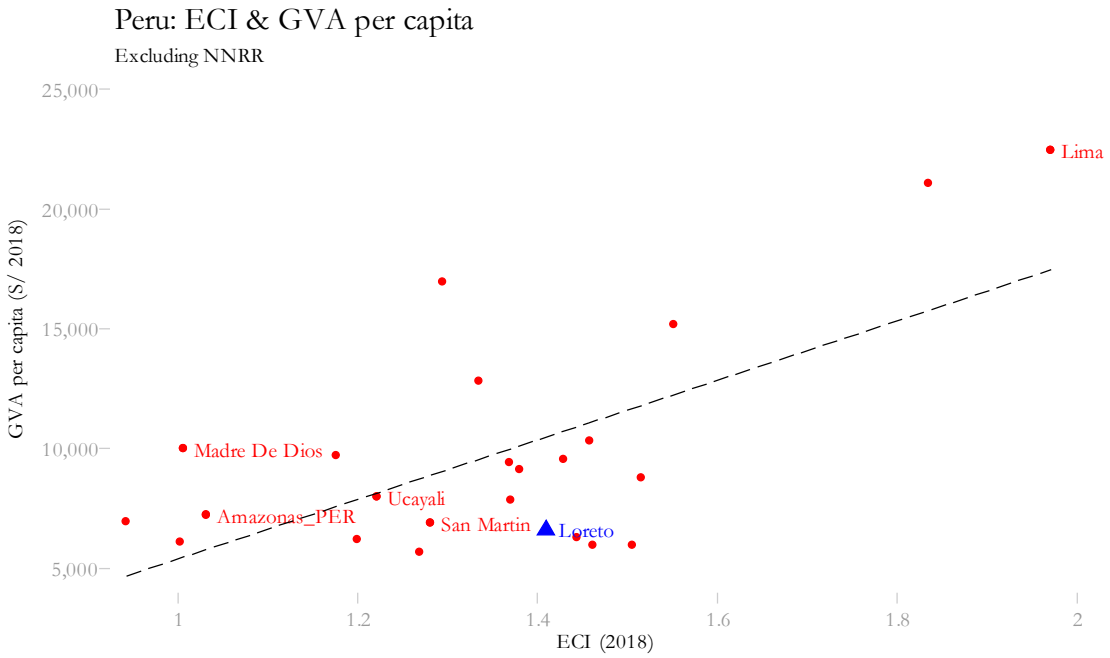
Source: Own calculations based on Dun & Bradstreet

Source: Own calculations based on Dun & Bradstreet.

The fact that Loreto has a lower level of income than would be expected given its level of economic complexity suggests that it has the potential to diversify its economy and boost growth, as soon as it overcomes its binding constraints. This is true even considering that Loreto has oil in its productive matrix, a resource that usually generates income that does not match the level of knowhow agglomeration (oil is one of the least complex activities). Hausmann et al. (2011) have documented that the regression errors between a country's income-complexity position and the predicted value according to the regression line are informative regarding future growth dynamics. Thus, places with income levels lower than expected, based on their level of economic complexity, tend to grow faster. Conversely, places with higher per capita income than expected given their

complexity level tend to lag. In this sense, economic complexity is not just a symptom or a consequence of prosperity, but an engine of growth.

Figure 11. Economic Complexity Index (ECI) and Gross Value Added (GVA) per capita, Loreto and other departments in Peru



Source: Own calculations based on Dun & Bradstreet.
* Excluding the department of Moquegua.

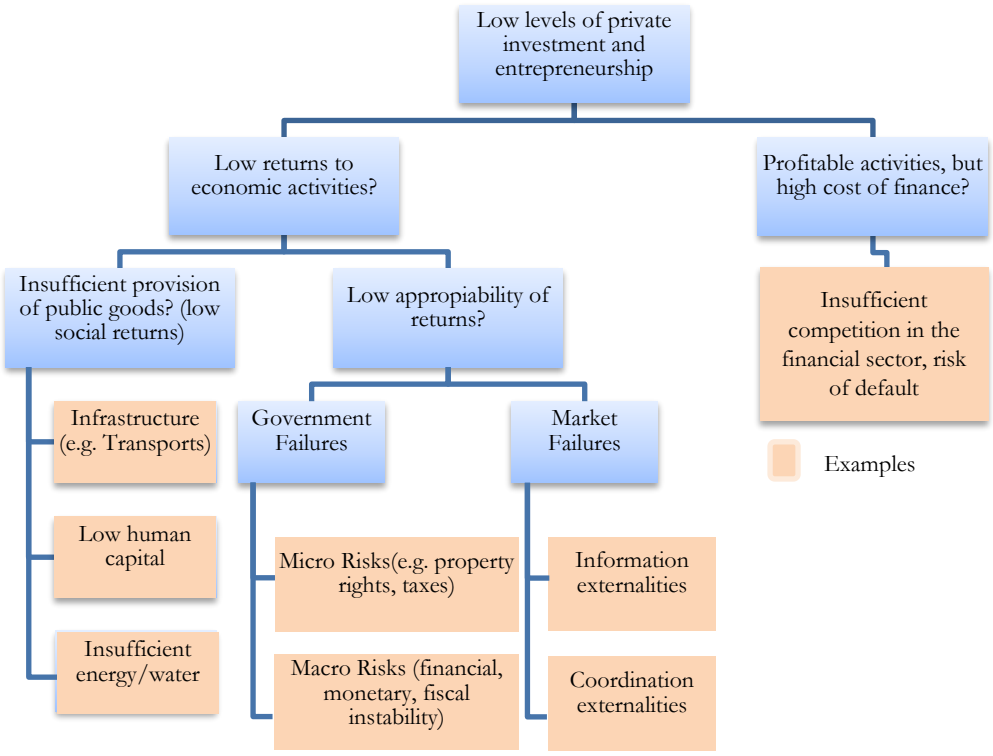
The most productive places tend to be those where there is a greater knowhow agglomeration. Therefore, our approach and recommendations tend to be more relevant for locations with larger urban agglomerations such as the city of Iquitos. This does not mean that our recommendations eschew other of Loreto's urban centers or rural areas. On the contrary, there may be important complementarities. However, due to the focus on economic complexity, rural areas are not the focus of this report.

3. ISOLATION AS A CONSTRAINT TO SUSTAINABLE GROWTH AND DEVELOPMENT

Loreto's remoteness could explain why its income levels are lower than expected, given its amount of productive knowhow. Over the years, the distance and time it takes to move people and goods between the department, the rest of the country, and the world have probably acted as an entry barrier. In other words, it has acted as a natural barrier against external competition. These trade and competitiveness restrictions have resulted in lower levels of efficiency and competitiveness for most of Loreto's economic activities. Nevertheless, the productive knowhow that Loreto has generated in these activities can be redeployed to diversify its economy, and create new sources of income for the region.

Our Growth Diagnostic of Loreto[5] (Figure 12) has identified three binding constraints to Loreto's growth: i) connectivity in freight transport, ii) information and coordination failures associated with the process of self-discovery, and iii) electric power supply. The subsections below summarize the evidence supporting each constraint.

Figure 12. *Decision Tree for Growth Diagnostics*



Source: Hausmann, Klinger and Wagner (2008), prepared by the authors.

[5] Hausmann et al. (2020a)

3.1 Transportation Connectivity

Loreto's geographic isolation is severe and hinders transportation in several ways. Transportation in Loreto can be analyzed in at least three dimensions: i) the route, whether between Lima or the rest of Peru and Iquitos (interdepartmental transportation) or between Iquitos and the rest of Loreto (intradepartmental transportation), ii) the type of transport, whether aerial or fluvial, and iii) cargo, whether of people or goods (see Figure 13).

Figure 13. Stylized Facts on the Movements of People and Goods in Loreto

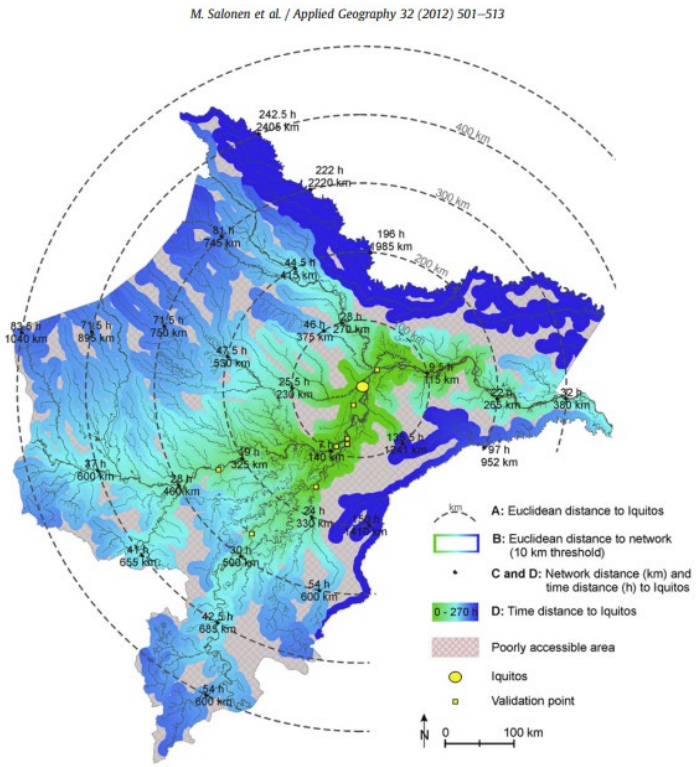
	Fluvial Transport	Air Transport
Outbound: Between Lima (or rest of Peru) and Iquitos	- Cargo vessels - Precarious passenger ferries	- Daily passenger flights with cargo capacity
Within: Between Iquitos and the rest of Loreto	- Small vessels for passengers and cargo	- Limited availability to selected destinations with little capacity for cargo and passengers

Source: Prepared by the authors.

Of all the types of transport that were considered, the river transport of goods between departments is the most relevant in economic terms. This type of transportation faces significant challenges. Loreto's capital, Iquitos, is closer to Brazil and Colombia than other Peruvian intermediate cities. Two of the closest, Yurimaguas and Pucallpa, are 400 kilometers (3-4 days of navigation) and 530 kilometers (4-7 days) away, respectively.

The literature on Loreto's mobility suggests that its degree of remoteness is better measured in transportation time rather than in direct monetary costs. Maraa Salonen et al. (2012) highlight that 90% of cargo and people traffic takes place within Loreto's river system, which in such study is conceptualized as a series of concentric circles (see Figure 14). They also propose that the network distance best captures the distance between two points, as opposed to the Euclidean distance. While the concentric circle closest to Iquitos is characterized by high boat traffic and the use of the *peque-peque* – a small, slow boat with little cargo-carrying capacity – the farthest circles are characterized by larger boats that make longer trips. In addition, the authors document that the route with the highest cargo traffic and quantity of boats, by a significant margin, is Pucallpa-Iquitos, followed Yurimaguas-Nauta (see Figure 14). Outside of these highly frequented routes, the volume of trade is limited not only by distance but also by the irregular frequency of boats.

Figure 14. Navigation times in concentric circles around Iquitos



Source: Salonen et al. (2012)

Transportation costs and time between Pucallpa and Iquitos vary with the water levels and with the direction of the river. In his 2011 study, Francisco Luis Pereyra Reategui documented the costs of business activity along this route. Sailing upstream, it takes 130 (150) hours and 3,400 (3,900) gallons of gasoline to move one metric ton from Iquitos to Pucallpa at high (low) water levels. From Pucallpa to Iquitos – sailing downstream – it takes 72 (96) hours and 1,000 (1,400) gallons of fuel. However, the author reports that the Iquitos-Pucallpa route costs 25% (30%) less at rising (low) water levels than in the opposite direction. According to this information, taking a ton of cargo from Pucallpa to Iquitos is more expensive than from Iquitos to Pucallpa, although the former takes significantly less time and consumes less fuel. This suggests that transport service providers are granting an implicit cross-subsidy to those who move goods from Iquitos to Pucallpa (exporters), which is covered by those who move the goods in the opposite direction (importers). This stylized fact is consistent with anecdotes heard by the research team about cargo ships arriving in Iquitos full of merchandise and leaving empty.

Compared to other types of transportation, the monetary cost of river transportation of goods is relatively low. Moving a kilo of cargo between Lima and Iquitos (via Pucallpa) costs between ten and fifteen cents per kilo. Iquitos transport companies quote between 10 and 15 cents per kilo for

shipments from Lima to Iquitos, with between 12 and 20 days of delay. These figures are consistent with other sources, such as Mendoza and Gallardo (2012), who reported that, under certain assumptions, the cost for a manufacturing company in Iquitos to move cargo on the same route was US¢13/kg [6]. These prices are also in line with the statistics of the United States Bureau of Transportation Statistics, which states that the transport of one kilo for a distance of 530 km (the distance between Pucallpa and Iquitos) would cost an average of 9.8 US¢/kg. In general, the cost of river transport is lower per kilo-kilometer than land transport (whether by truck or rail) and much lower than the cost of air transport, which costs between 12 and 16 times more.

Transportation is an essential challenge for Loreto, especially for the production and consumption of perishable goods. Transportation times in Loreto's River system–especially between Iquitos, Yurimaguas, and Pucallpa–impose various costs on companies producing perishable goods. In addition to monetary costs, transit time can result in the partial, or total destruction, of the value of perishable goods. In other words, for the producers of a subset of agricultural goods, river transport times are a fundamental restriction as they limit the possibilities of producing and exporting perishable goods in Loreto. For the rest of the companies that produce non-perishable goods, transportation is also a significant obstacle. Transportation times also impose additional financial costs on companies, such as higher inventory costs – both in transit and on land – and storage, as well as higher financial costs (interest) on higher working capital investments.

The costs associated with transportation and logistics from Loreto's remote location, ultimately act as a tariff barrier protecting certain local industries. Local suppliers could meet the demand with less efficiency than their potential competition outside the region, at a margin that corresponds to transportation costs. This could explain the fact that Loreto has a more sophisticated, productive ecosystem than one would be expected given its income level. If so, reducing costs through the provision of a more efficient alternative – more predictable, regular, and with greater transportation capacity – may be one of the strategies that allow some industries in the region to take the leap in efficiency necessary to meet the demand of regions beyond Loreto.

3.2 Self-Discovery

The process of self-discovery, which involves finding new goods and services that a place can produce competitively, is one of the key aspects of productive diversification and structural transformation. By its very nature, the process is often subject to many failures that inhibit or delay

[6] The authors reported the following information: in 2012, it cost a large manufacturing company 7,700 soles to move a 40-foot container from China to Peru, 4,100 soles to move cargo from the port of Callao to Pucallpa, and another 4,500 soles to move cargo from Pucallpa to Iquitos. This corresponds to a price per ton of 366 soles from China to Callao, 195 soles from Callao to Pucallpa, and 214 soles from Pucallpa to Iquitos under the following assumptions: the 40-foot container is standard (maximum load of 28 tons), 90% of use and average exchange rate for 2012 of 2.65 soles per dollar.

the redeployment of existing productive capacities into new, higher value-added industries. The economic literature classifies these as market-related information failures, and coordination failures between actors, that are more associated with government actions (Hausmann and Rodrik, 2002). Information failures relate to the costs involved in determining whether a new economic activity can be profitable in a particular location. Pioneer entrepreneurs bear this cost, only to realize that in the process – if successful – they signal potential competitors who may enter the market taking advantage of their initial investment. Successful discoveries are relatively easy to imitate, so entrepreneurs tend to invest less than the socially optimal amount. In addition to this information, and appropriation, failures associated with private economic activity, there are also coordination failures that could inhibit productive diversification. This second type of failure tends to occur within the public sector (for example, when there is no knowledge in the public sector about the public goods required to make a new economic activity possible), between the offices within the public sector (for example, when it requires harmonization of regulation at the municipal, departmental, and federal levels), or even between private actors (when there are several industries that depend on one another and are not capable of coordinating simultaneous investments to guarantee the provision of intermediate goods or other productive inputs).

Experiences of self-discovery are not entirely unrelated to Loreto's history. Since its foundation, it has depended significantly on primary products such as rubber, oil, and wood, but the reality is that a much more complex productive ecosystem grew around these industries than would be expected given the circumstances, as we saw earlier. Cotton and barbasco at the beginning of the 20th century, or more recently, goods derived from *camu-camu* and ornamental fish, are the product of the ecosystem that has emerged parallel to the exploitation and export of more conventional natural resources (Mendoza and Gallardo, 2012).

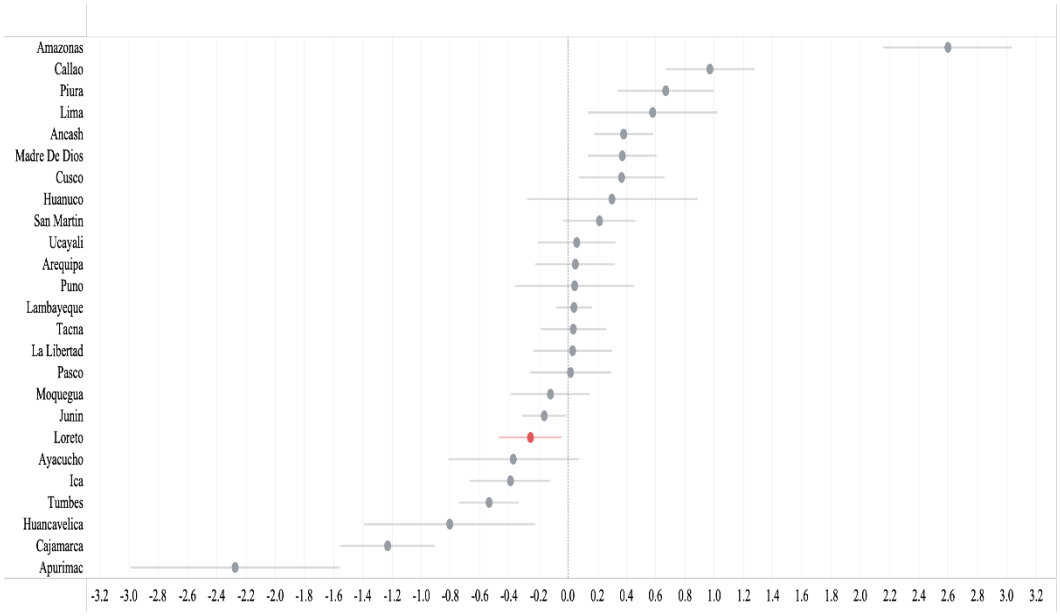
One way to identify if there are coordination failures is when the emergence of new industries requires significant government involvement. The case of AJE and the tourist port of Loreto are illustrative of this[7]. AJE's case exemplifies a successful venture that combined the participation of a company with market knowledge, the ability to sell products internationally, and the willingness to invest in the Amazonia. State mediation facilitated the incorporation of Amazonian communities into value chains for the production of *camu-camu* and *aguaje* – super-fruits with important natural properties and that are abundant in the area – beverages, in a sustainable manner. Partnering with the Ministry of the Environment (SERNAP and the Pacaya Samiria Nature Reserve), the Regional Government of Loreto, the company Frutama, and the NGO *Naturaleza y Cultura Internacional* (NCI), the company was able to integrate the Amazonian communities into its value chain. On the other hand, the tourist port project in Iquitos is an example where coordination failures have not been

[7] If self-discovery activities are constrained by the existing incentive structure, it is common for the state to participate in solving those constraints (Sabel et. al., 2012). In general terms, the public sector responds to coordination failures by establishing support mechanisms to facilitate coordination between public and private actors.

resolved, inhibiting the emergence and growth of tourism, and other sectors. The lack of a tourist port to receive visitors and the failed attempt between the state and the private sector to provide one, due to licensing and construction problems, highlights the difficulty of successfully solving coordination failures.

Quantitatively, Loreto has diversified less into neighboring industries than other regions of Peru, suggesting a slower process of self-discovery, with less capacity to solve coordination and information failures. In particular, in terms of productive capacity, Loreto's marginal propensity to diversify into industries that are close to it was evaluated (Figure 15). As reported in *The Economic Complexity of Loreto*, it is a well-documented fact that places tend to diversify into industries that require similar know-how to those industries already in place. This empirical regularity can be confirmed in the data for Peru at the departmental level, where the density variable (an indicator of technological distance) is positively, and statistically significantly, associated with the appearance of new industries at the subnational level.

***Figure 15.** Differential Effect of density on the probability of jumping into close industries, Loreto, and regions of Peru (VCR<0.25)*



Note: The graph shows the coefficient of the interaction between the variable of density and a dummy variable per region for jumps from industries with a revealed comparative advantage (RCA) lower than 0.25 to an RCA of 1 or more, in a period of 5 years.

In Loreto, a negative and statistically significant sign indicates that the department is less likely (in terms of know-how) to diversify into neighboring industries than other regions of the country[8]. This result is consistent with the difficulties in resolving the coordination and information failures described above. The inability to resolve the dilemmas associated with the process of self-discovery could explain why the department has a considerable level of knowledge agglomeration but has failed to translate it into the emergence of more sophisticated industries capable of sustaining higher wages.

The patent registry may also provide clues to recent self-discoveries. According to patent information from the National Institute for the Defense of Competition and Intellectual Property (*Instituto Nacional de Defensa de la Competencia y Protección de la Propiedad Intelectual-INDECOPI*), six invention patents were registered in Loreto between 2014 and 2018 (Figure 16). In fact, the department was the only one among its Amazonian peers in Peru to register Invention Patents (3). Similarly, Loreto and San Martín lead in the registration of collective knowledge patents, aimed at protecting the knowledge of native communities regarding the use, applications, and properties of biological resources. Between 2014 and 2018, 1,852 collective knowledge patent registrations were registered in Loreto. This surpasses San Martín (1,137) and Madre de Dios (158) registrations. Although these patents can be the basis for developing products with commercial value, such as

[8] Our results are robust regarding several definitions of "jump", see Hausmann et Al. (2020).

pharmaceuticals and cosmetics, to date this opportunity has not been capitalized on a large scale (Indecopi, 2016).

Figure 16. Patents by type and selected region (2014-2018)

Types of patent	Loreto	San Martin	Ucayali	Madre de Dios	Median	Average	Lima and Callao
Utility models	2	2	3	1	6	41	686
Industrial designs	1		2		4	35	357
Invention patents	3				3	29	331

Source: Indecopi.

There is strong evidence to conclude that information and coordination failures that surround the process of self-discovery are a binding constraint to the diversification of the Loreto's productive matrix. The department has a greater knowhow agglomeration and productive capacities than the rest of its national Amazon peers, but to date it has not been able to coordinate the actions of different public and private actors to capitalize on these benefits. Our statistical analyzes indicate that Loreto has a differentially lower capacity to diversify into new adjacent industries with higher value-added, in terms of productive capacities. Still, AJE's anecdotal evidence shows that it is possible to coordinate the action of different levels of government and various private actors to develop new, more sophisticated products that capitalize both on Loreto's know-how and its natural comparative advantages. But it is also true that in other cases, the department has been unsuccessful in coordinating the provision of public and private inputs, inhibiting growth in the identified thematic areas of interest, such as tourism. The existence of some patent activity and the numerous collective knowledge patents suggest that Loreto has capacity for innovation and a significant stock of know-how in its native communities. However, the department has not yet been able to capitalize on it at a large scale. This highlights that developing institutional capacity to coordinate actions across different levels of government, and the private sector, is paramount to help solve the coordination and information dilemmas and unlock Loreto's economic potential.

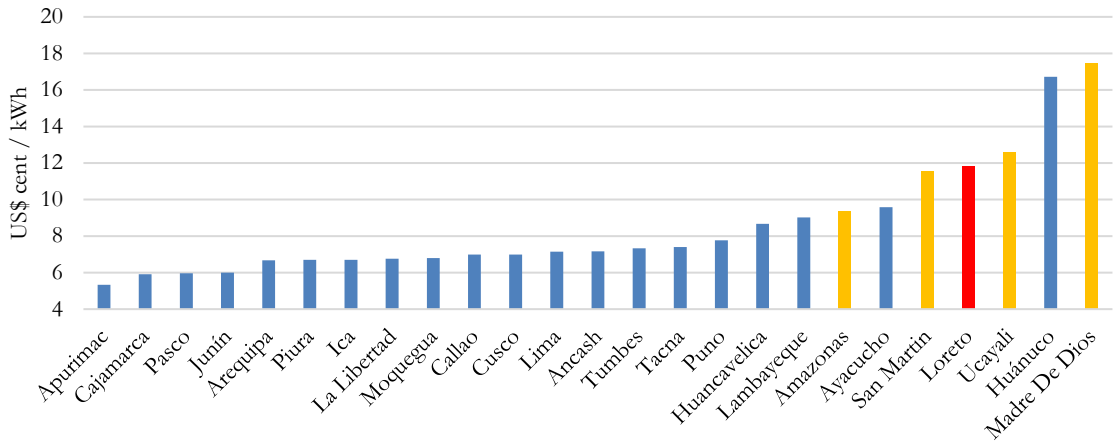
3.3 Electrical Energy

Loreto is not connected to the national electricity grid and uses very expensive isolated thermal generation and distribution systems that require subsidies and pollute the environment. *Electro Oriente*, Loreto's regional generation and distribution company, supplies electricity to Loreto from at least 14 thermoelectric plants that consume hydrocarbons, mainly diesel (D2) and residual fuel (R6). The regulator, the Supervisory Board for Investment in Energy and Mining (*Organismo Supervisor de la Inversión en Energía y Minería -OSINERGMIN*), sets the price of electricity in a staggered tariff schedule. The marginal costs associated with the generation of electricity with diesel

fuel and residual fuel are higher than the average price of electricity, thus *Electro Oriente*'s revenues are insufficient to cover the costs of the system. Losses are covered by a monthly subsidy under the 2006 compensation mechanism for isolated systems[9]. To give an example of the size of this subsidy, *Electro Oriente* received 10,217,668 soles (US $3.08 million) in subsidies for December 2019, and 116,121,766 (US $35.3 million) for 2019 overall. This type of electricity generation also has high environmental costs, emitting carbon dioxide and polluting particles.

Despite the subsidy, electricity in Loreto is more expensive for the industrial sector and relatively cheaper for the commerce and services' sectors. According to the Ministry of Energy and Mines (MEM), [10] industrial electricity in Loreto (including the agriculture and livestock, construction, manufacturing, mining, and fishing sectors) had an average cost of 11.8 ¢ US$/kWh in 2018, compared to the national average of 6.83 ¢ US$/kWh. That is, on average, electricity for the department's industrial sector is 73% more expensive than the national average (Figure 17), while electricity for commerce and services is only 12% more expensive than the national average (Figure 18).

***Figure 17.** Average price of power for the industrial sector, 2018*

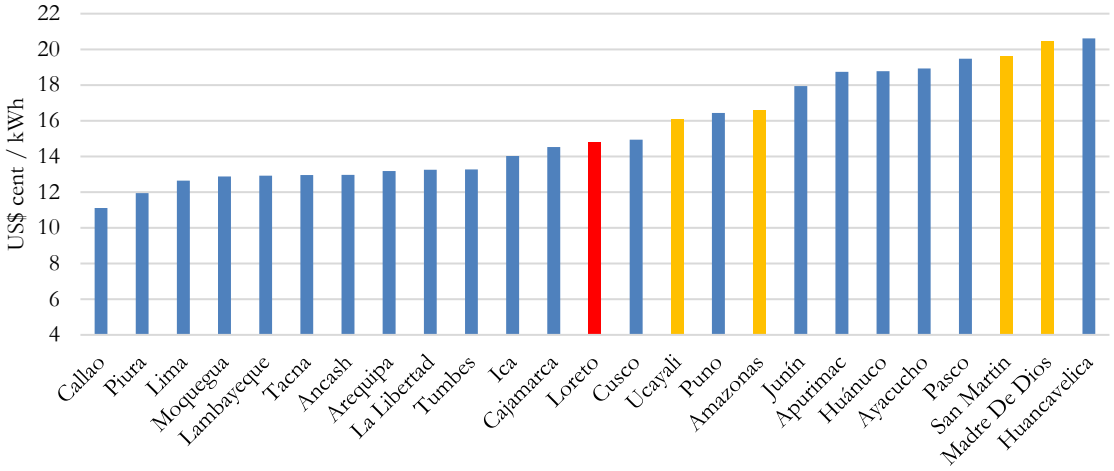


Source: MINEM.

[9] ""Tariff Regulation: Isolated Systems" (n.d.)

[10] In particular, we refer to Chapter Two of the report "*Estadística Eléctrica por Regiones*" (Electric Statistics by Regions) from MINEM. the MINEM Electricity Statistics by Regions report.

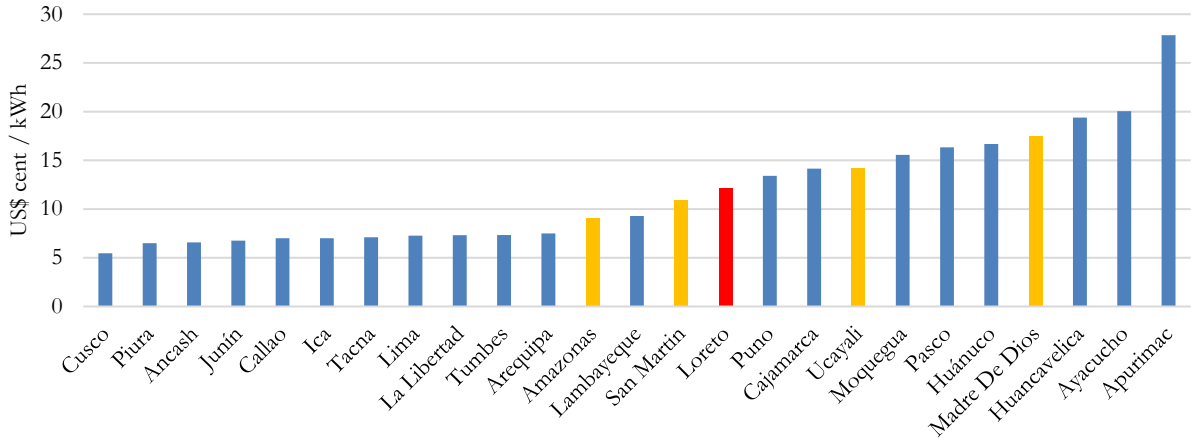
Figure 18. *Average price of electricity for commercial and services sectors, 2018*



Sources MINEM.

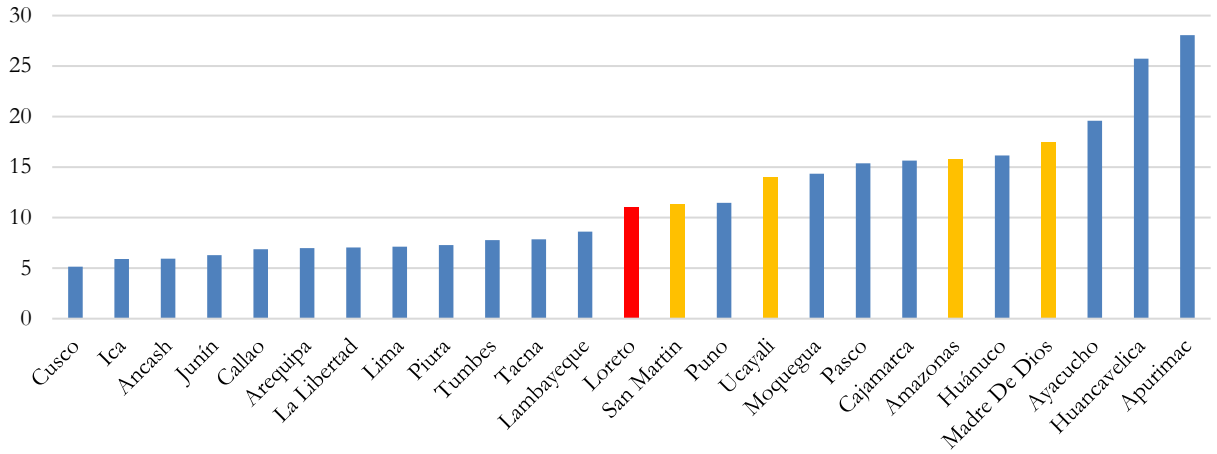
However, high electricity costs for mining and oil activities are driving the average cost of electricity for the industrial sector up. Excluding them, the average cost of electricity for the other industrial sectors is relatively lower – especially for the manufacturing sector. As Figure 20 shows, when mining and oil are excluded, Loreto goes from being the fourth department with the most expensive electricity to the eleventh. Electricity for the manufacturing sector alone is cheaper in Loreto than in any other Amazonian department and is in line with the national average for the sector (Figure 21).

Figure 19. Average price of electricity for the industrial sector, excluding mining and oil, 2018



Source: MINEM.

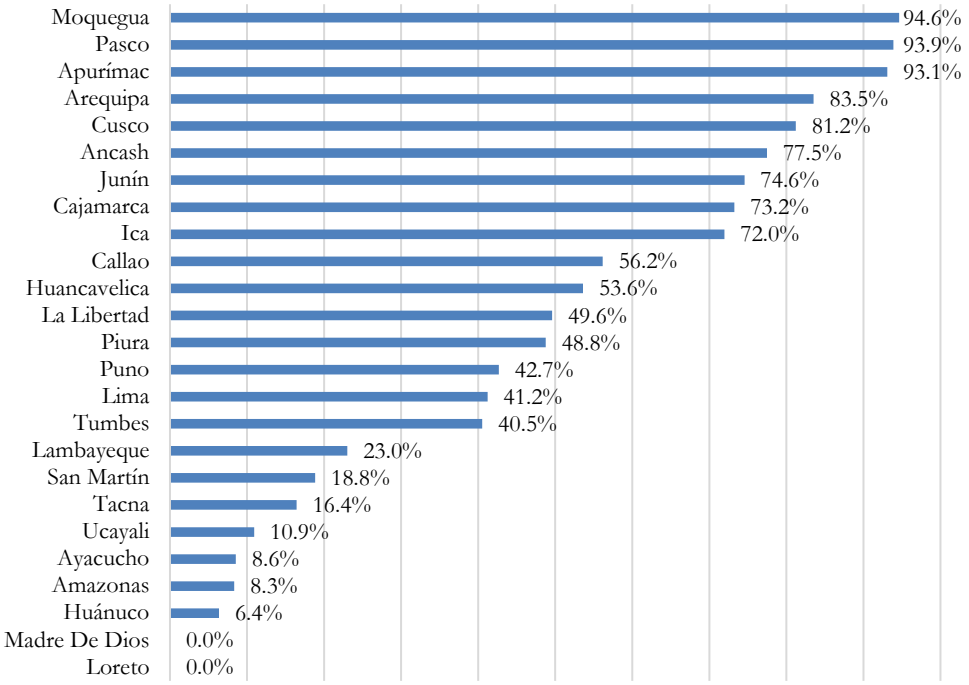
Figure 20. Average price of electricity for the manufacturing sector, 2018



Source: MINEM.

In the Peruvian electricity market, a small group of customers buys electricity at an "unregulated" rate, consuming more than half of the country's energy. This practice has not been extended to Loreto and Madre de Dios, no companies are large enough to secure the unregulated rate. In 2018, 1,834 end-users (0.02% of the total) purchased 26,716 GWh of electricity (58% of total generation) from private generators and distributors, through public contracts that can be accessed on the OSINERGMIN website. As highlighted in Figure 22, the share of unregulated energy in Amazonian departments is relatively low and it is zero in Loreto.

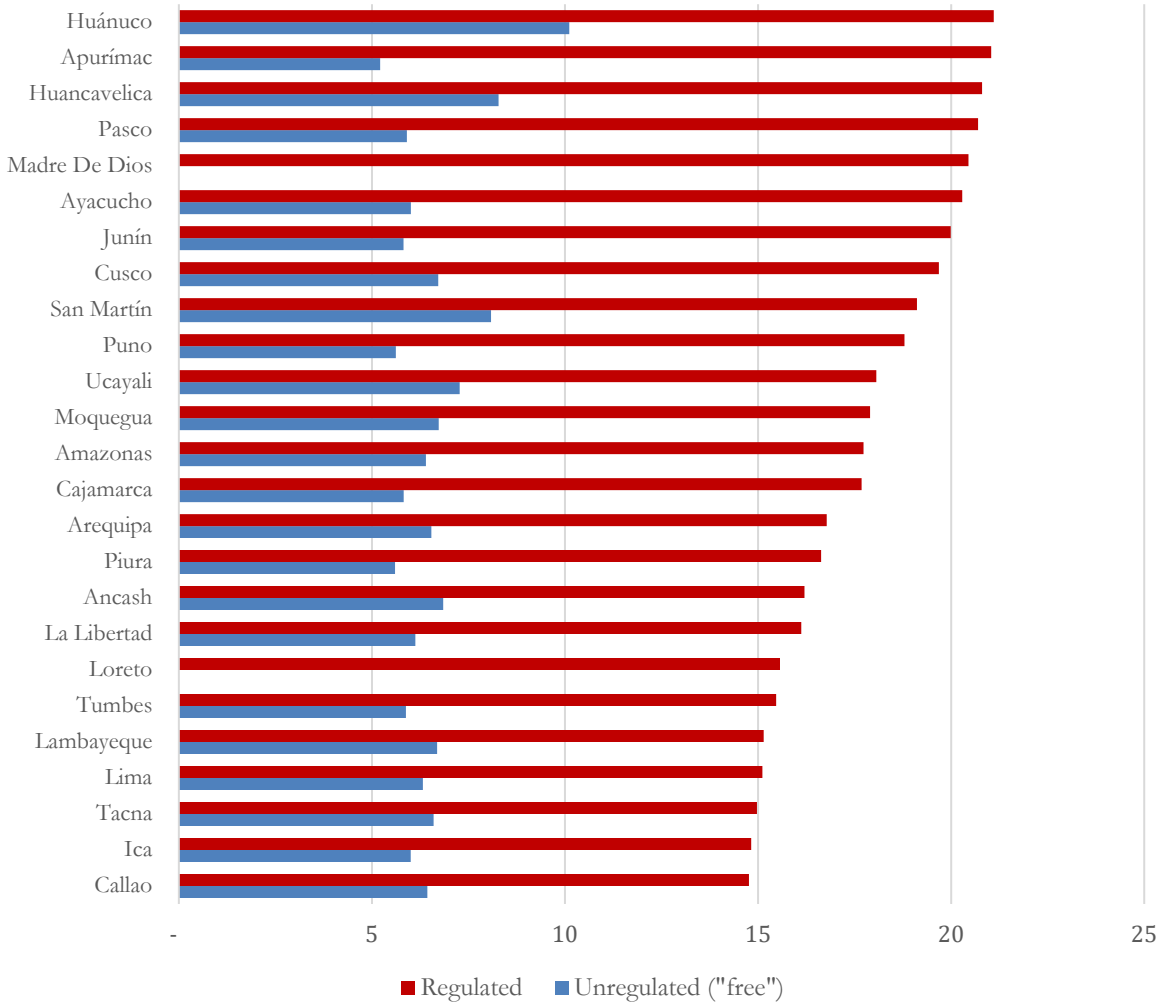
Figure 21. Sales of unregulated energy (% of the total), 2018



Source: MINEM, own calculations

Currently, due to oversupply in the Peruvian market, the average rate for the unregulated electricity market is lower than the regulated rate. While the average unregulated electricity rate is 6 cents per kWh, the average regulated rate is 16 cents, a difference of 152%. The gap between the average unregulated and regulated rate varies by region, with greater differences across departments (see Figure 23). Once supply and demand in the electricity market are in equilibrium, the gap between rates is likely to narrow again.

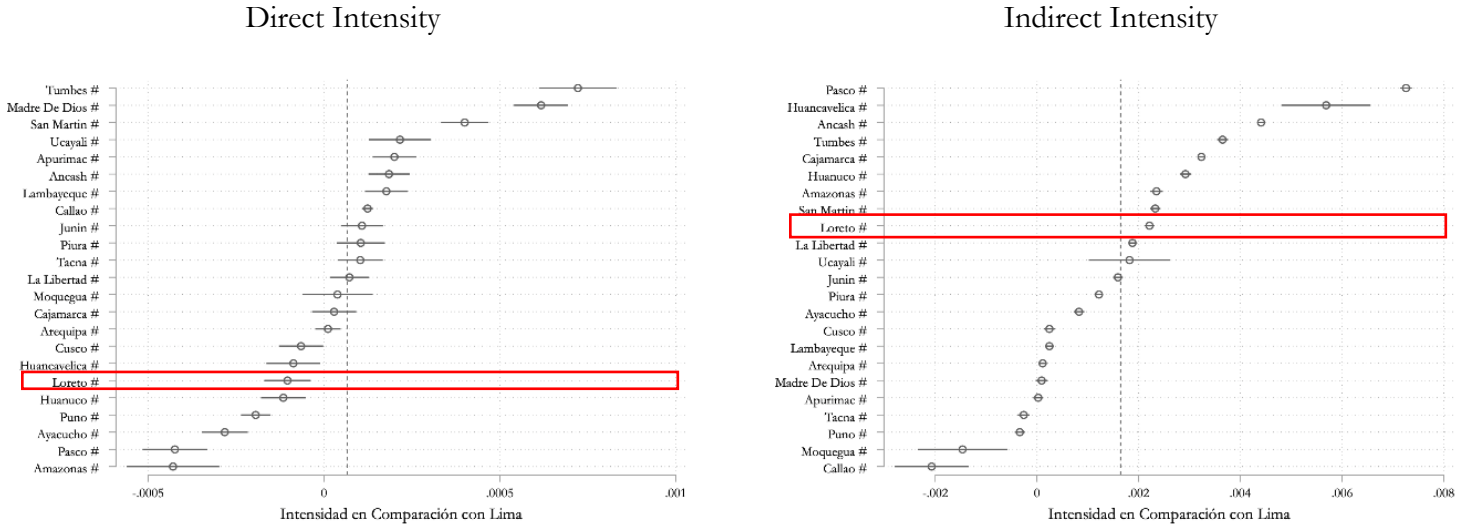
Figure 22. Average electricity rate, regulated and unregulated ("free") (US$ cent/kWh), 2018



Source: MINEM.

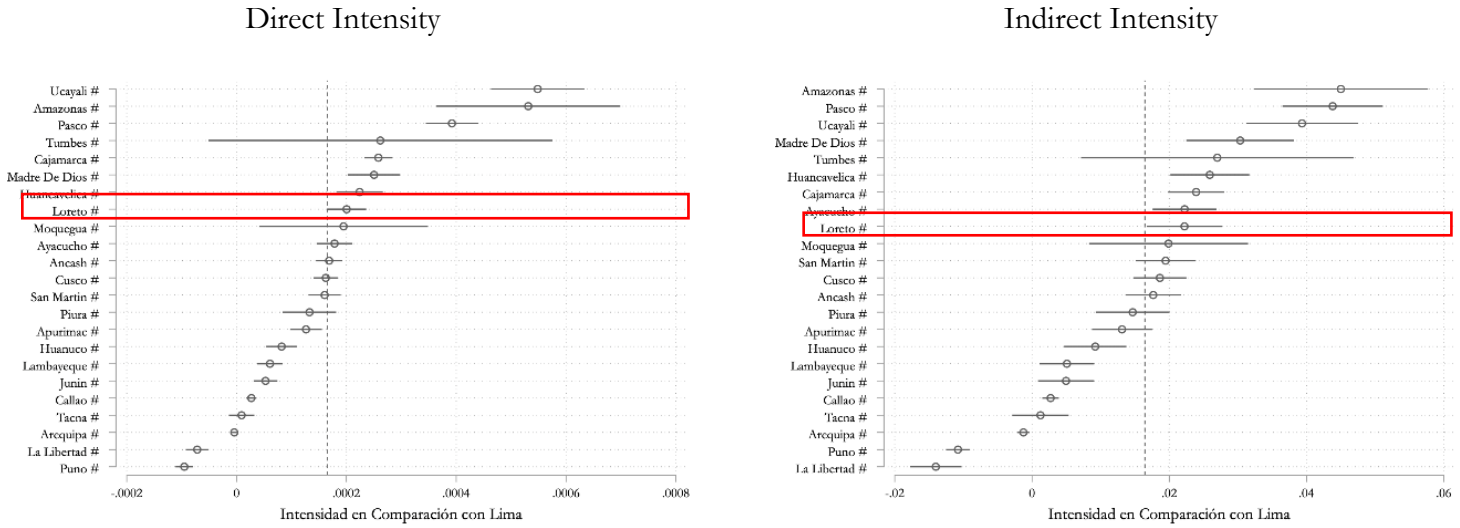
Loreto's manufacturing companies use energy more intensively than in other parts of Peru. This could indicate that electricity costs are not a significant restriction for current companies in the sector, which benefit from the subsidy. For the rest of the industries, the results of the same analysis are less informative. Figure 24 and Figure 25 rank the departments of Peru from the most intensive to the least intensive in electricity usage for all companies, and for the subset of manufacturing companies. The analysis for all companies (Figure 24) is not informative however, since Loreto's direct electricity consumption is slightly less intensive than the average for Peru (and vice versa for indirect consumption). The evidence is stronger for the manufacturing industries in Loreto since they tend to be more intensive in the direct and indirect use of electricity than the national average (Figure 25). If it was not for the electricity subsidy, this evidence would make electricity an unlikely candidate as a binding constraint for Loreto's manufacturing sector.

***Figure 23.** Intensity in the use of electricity of regions in Peru (all companies)*



Source: Dun and Bradstreet 2019, BEA 2012, ENAHO, prepared by the authors.

Figure 24. Intensity in the use of electricity in regions of Peru (manufacturing companies)



Source: Dun and Bradstreet 2019, BEA 2012, ENAHO, prepared by the authors.

Ultimately, given the presence of energy subsidies in Loreto then, electricity – in terms of access and costs – is unlikely to be a binding constraint on current economic activity in Loreto. Excluding mining and oil, (regulated) prices are on par with peers, at intermediate levels. Industries in Loreto use electricity significantly more intensively than the national average and only 4.5% of companies in the region consider electricity to be one of the main obstacles to their growth.

However, these results must be considered with caution in a market where, due to the subsidy, the rates paid by companies for electricity service are regulated and do not correspond to the long-term marginal cost of electricity service provision. Interestingly, none of the Loreto's existing companies demand enough energy to fall into the unregulated rate segment. Since Loreto's electricity depends on one of the most expensive, volatile, and polluting sources of energy generation, local companies benefit from the cross-subsidy granted by the rest of the country. This very reason would therefore motivate the existence of industries that use electricity more intensively.

Electricity in Loreto probably has a more strategic role in its sustainable development than our initial results suggest. The absence of companies with a sufficient electricity demand to qualify for the unregulated rate may be an indication that the marginal cost of electricity is a restriction to the growth of current companies, and more importantly, to the establishment of industries that tend to organize themselves around larger firms.

Energy generation through alternative sources can be the cornerstone of the sustainable development strategy in Loreto. First of all, it would free up oil production, helping boost the region's exports. Second, it would help reduce environmental pollution produced by the current electricity generation methods. Finally, it could have a very considerable impact on the productive ecosystem of Loreto, by lifting restrictions on the arrival of industries that tend to organize themselves into larger firms and are more intensive in energy demand.

4. TOWARD A PRODUCTIVE DIVERSIFICATION OF LORETO: A ROADMAP

4.1 Identification of potential sectors

Quantifying the levels of existing knowhow in Loreto and the technological proximity between its sectors, allows us to identify a set of industries that can boost its productive development. These industries require a set of productive capabilities similar to those that already exist in the region as well as capabilities that still need to be developed. The focus public policy interventions should then be on developing the missing productive capacities. Thus, Loreto's growth and diversification will come from a combination of industries which already exist in the region (intensive margin) and new ones with high potential to emerge (extensive margin). Ultimately, about the objective is to promote the emergence and growth of industries with the potential to generate quality jobs in Loreto and sustain higher wages. The identification of sectors and the institutional devices that make it possible to identify the bottlenecks that are inhibiting their appearance or growth, must follow a rigorous, iterative, and dynamic process.

We follow three essential steps to identify the industries with the greatest potential. First, tradable (goods and services) sectors are selected[11]. Sectors are then ranked and prioritized based on economic complexity metrics. In the intensive margin, we select those industries with greater economic complexity (Product Complexity Index - PCI) than the average for the region and that have at least two registered firms.[12] In the case of the extensive margin, two additional metrics were considered in addition to PCI. The first is the strategic value (SV), which expresses how many and how complex are the links of the potential industry to other sectors within the Industry Space. The second is the measure of distance, which combines the definitions of co-location and co-production.[13] We intend to give greater weight to this indicator, prioritizing industries that are close in terms of productive capabilities, which can pave the way for greater diversification in Loreto towards other more complex sectors. Two different rankings of industries in the extensive margin are possible depending on the distance measure used. The first is derived from the measure of distance based on the co-location of firms and results from weighting the distance (50%), the strategic value (35%), and the economic complexity (15%) of each industry.[14] The second is derived from our measure of distance based on co-production at the establishment level, and is calculated by weighting distance

[11] In this approximation, the activities of the categories Retail Trade, Construction, Wholesale Trade, Real Estate Services, Insurance, Personal Services, Waste Management, Land Transportation, Ambulatory Health Services, and Private and Public Administration are excluded. This reduces the number of industry codes from about 738 to 476 in the extensive margin and from 308 to about 173 in the intensive margin.

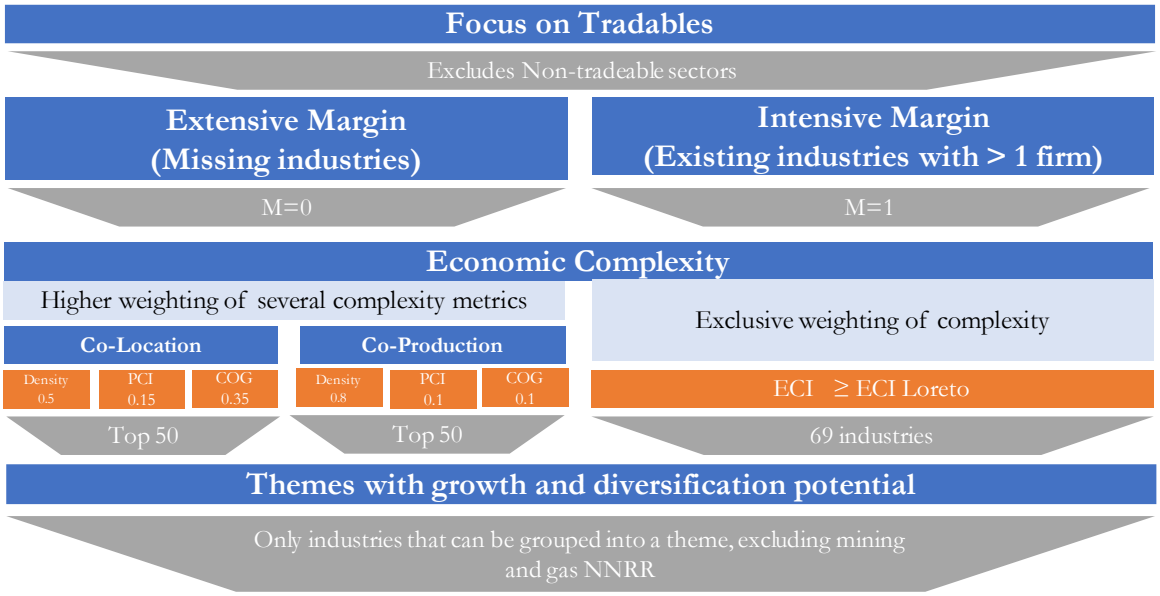
[12] This reduces the number of industry codes from 173 to 126.

[13] Each measure has its advantages and disadvantages and their methodology is described by Hausmann et al. (2020b).

[14] The sector density (the inverse of the distance measure) is used for calculation and presentation purposes.

(80%), strategic value (10%), and economic complexity of each industry (10%).[15] The classification system, both for the intensive and extensive margins, is described in detail in Figure 25. On the left-hand side of the figure– which correspond to the two distance measures – the 50 industries with the highest weighted score were included for each of the measures. On the right side, all the industries in the intensive margin that have a complexity index (PCI) greater than Loreto's average were included.

***Figure 25.** Sector Identification*



The resulting sectors were grouped into five thematic areas that provide an initial roadmap for Loreto's productive diversification and structural transformation path. Using the industry classification system as a guide, the groups that concentrate most of the selected industries are selected as the areas or themes for growth and diversification. From there, the process requires making some more discretionary decisions[16]. Broader categories (as opposed to focusing on very specific industrial sectors) can allow for more effective and targeted government interventions to raise the productivity of existing industries and maximize the probability of success in attracting new business models. This reduces the total potential activities to 28 in the intensive margin, and the total activities in the extensive margin to 27, resulting in a list of 55 industries (Figure 27). These thematic areas – shown

[15] Th co-production measure puts a greater emphasis on distance within a *cluster*, A greater weight to distance then allows to better capture the distance of the industries that are within reach given Loreto's productive capabilities. With co-location we use the suggested weights buy the Atlas of Economic Complexity for a balanced strategy.

[16] The extraction of natural resources such as mining and gas is excluded, because these are activities that do not depend on the knowledge agglomeration but tend to be located where the resource exists. Moreover, they are among the least economically complex of the entire industrial spectrum. Second, individual activities that do not correspond to any of the five main thematic areas have been eliminated. This second intervention stems from a more practical consideration.

in Figure 26 in no particular order of priority – are i) forestry, wild flora, and fauna activities, ii) Food and chemical industries, iii) Manufacturing and transportation services, iv) Tourism and creative industries, and v) Construction for manufacturing. We hope that these industries can lead the structural transformation and diversification of Loreto.

Figure 26. Thematic Areas for Productive Diversification

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*Figure 27. Thematic areas and industries for productive diversification**

Forestry, Flora and Fauna Activities (12)

- Fruit and Tree Nut Combination Farming
- **Nursery and Tree Production**
- Floriculture Production
- Finfish Farming and Fish Hatcheries
- Other Aquaculture
- **Finfish Fishing**
- Support Activities for Forestry
- Cut Stock, Resawing Lumber, and Planing
- **All Other Converted Paper Product Manufacturing**
- Wood Kitchen Cabinet and Countertop Manufacturing
- Surveying and Mapping (except Geophysical) Services
- Environmental Consulting Services

Food and Chemical Industries (13)

- **Fats and Oils Refining and Blending**
- Breakfast Cereal Manufacturing
- **Fruit and Vegetable Canning**
- Cookie and Cracker Manufacturing
- **Dry Pasta, Dough, and Flour Mixes Manufacturing from Purchased Flour**
- **Soft Drink Manufacturing**
- Distilleries
- Medicinal and Botanical Manufacturing
- **All Other Basic Organic Chemical Manufacturing**
- Other Basic Inorganic Chemical Manufacturing
- **Plastics Material and Resin Manufacturing**
- **Paint and Coating Manufacturing**
- **Soap and Other Detergent Manufacturing**

Manufacturing and Transportation Services (10)

- **Motor and Generator Manufacturing**
- **Ship Building and Repairing**
- **Motorcycle, Bicycle, and Parts Manufacturing**
- **Inland Water Freight Transportation**
- **Inland Water Passenger Transportation**
- Marine Cargo Handling
- Packing and Crating
- **General Warehousing and Storage**
- Farm Product Warehousing and Storage
- Other Warehousing and Storage

Tourism and Creative Industries (13)

- **Motion Picture and Video Production**
- Commercial Photography
- **Travel Agencies**
- Tour Operators
- **All Other Travel Arrangement and Reservation Services**
- Landscaping Services
- Historical Sites
- **Zoos and Botanical Gardens**
- Nature Parks and Other Similar Institutions
- Bed-and-Breakfast Inns
- All Other Traveler Accommodation
- Recreational and Vacation Camps (except Campgrounds)
- **Full-Service Restaurants**

Construction Manufacturing (7)

- **Pottery, Ceramics, and Plumbing Fixture Manufacturing**
- **Clay Building Material and Refractories Manufacturing**
- **Glass Product Manufacturing Made of Purchased Glass**
- Ready-Mix Concrete Manufacturing
- Concrete Block and Brick Manufacturing
- **Other Concrete Product Manufacturing**
- **All Other Miscellaneous Nonmetallic Mineral Product Manufacturing**

*Industries in bold correspond to the intensive margin.

4.2 Inputs for the Development of Diversification Opportunities

The analysis of economic complexity is the first step in the process of identifying industries with the potential to promote productive diversification. Additional filters are then necessary to prioritize industries based on: their viability in Loreto, their attractiveness based on Loreto's characteristics and needs, and to the extent to which they are compatible with environmental sustainability. The latter is of particular importance given the geographical location of Loreto, and the importance of the environmental services that the Amazon Rainforest provides to the country and the world.

This additional criteria of environmental sustainability, attractiveness, and viability forms the basis of the prioritization system to narrow the selection of the industry groups[17]. First, the environmental sustainability axis has been quantified at the industry level, based on the effects on soils, rivers, and the air, including the emission of toxic substances and greenhouse gases. The viability axis aims to estimate the probability that the industry will develop in Loreto according to: its presence in comparable regions in the Amazon, its ability to access intermediate inputs, and its dependence on the binding constraints - mainly river connectivity and electrical energy. The less dependent on binding constraints, the more viable the industry is considered[18]. Finally, the attractiveness axis approximated the industry's desirability in Loreto according to its potential to attract investment, increase exports and create jobs.

The suggested prioritization system incorporates four viability, four attractiveness, and five environmental sustainability indicators.[19] This approach should be considered as an initial suggestion and can be redefined iteratively (based on experience) and dynamically (incorporating changes that occur over time and how it impacts the relative weight of factors) by those responsible of designing productive development policies in the region.

The four proposed viability indicators are as follows:

- **Presence in comparable regions**. The probability of developing an industry in Loreto is considered based on the presence of this industry in comparable regions. The performance in this factor is calculated by adding the number of regions in which the industry exists within 11

[17]The analysis has been developed equally for existing industries (intensive margin) and industries that are not present in Loreto (extensive margin). Although existing industries are viable by definition, they still have significant potential for growth, and their location on the defined axes of viability is informative of the possibilities of realizing said potential.

[18]The Growth Diagnostic of Loreto (Hausmann et al., 2020a) identified three binding constraints to growth in Loreto: the river connectivity of the department, the inability of the state to resolve coordination failures associated with the self-discovery process, and electric energy as a cross-cutting contributor to the productive transformation of Loreto.

[19]Lists of these measures for each selected industry are found in Appendix 3.

Amazonian regions of Peru, Colombia and Brazil. [20] A higher score then implies greater viability. The presence of an industry in a region is established based on the existence of firms with at least one industry code in the Dun & Bradstreet database.

- **Ability to access intermediate inputs**. The availability of inputs required by an industry can be measured by the relative presence of firms that supply those inputs, or by the relative presence of other firms that also rely on those inputs. In the latter case, the presence of firms dependent on similar inputs suggests that, even if the firms that produce them are not present, it is possible to obtain them through imports or by using locally available substitutes. The inputs required by each industry are estimated using the United States Input-Output table, which reports the expenditure of each industry in each of the other industries in the American economy. The presence of industries that provide intermediate inputs is determined based on the information available in the Dun & Bradstreet database. The list of intermediate inputs needed by the identified potential diversification opportunities, and the list of missing inputs in the region, gives us an approximate list of the required inputs that are *not* available in the region for every industry listed as a potential diversification opportunity. Therefore, if a diversification opportunity requires a relatively high quantity of inputs that are not available in the region, it can be said that this diversification opportunity is less viable.
- **Propensity to export by air**. Given that Loreto's lack of transport connectivity has been identified as a binding constraint to sustainable growth, and that air transport can be used to circumvent the limitations of river transport, we use propensity to an industry to export by air as a viability indicator. This transportation alternative has significant costs that only make sense for industries that produce goods with high value-added. The propensity of an industry to export by air, is estimated using customs data from the United States. The measure calculate the proportion of US imports by industry that exported through air. Due to the size of that market and its relative importance in global air trade, US imports are a good approximation of world air exports. [21]
- **The intensity of electricity consumption**. Finally, given that electricity has been identified as a binding constraint to sustainable growth and, in particular, to the appearance of industries whose firms tend to organize themselves into larger units, [22] it is suggested, to prioritize diversification opportunities that are less intensive in the use of electricity, at least in the short term. The intensity of industries in the use of electricity is estimated using the United States Input-Output table. For each industry, we calculate the ratio of spending on electricity to the relative size of that industry in the US economy. This indicator of intensity in the use of electricity thus approximates the expected consumption of an industry according to its size.

[20] The regions considered are the following: Amazonas, Madre de Dios, San Martín, Ucayali (in Peru); Pará, Acre, Amazonas (in Brazil); Amazonas, Putumayo, Vaupés, Vichada (in Colombia).

[21] This measure is only relevant for the 27 products on the list and not for the industries that correspond to the services sector. For services, we assigned the highest score since it is not a relevant issue.

[22] For further information, please refer to the report Growth Diagnostic of Loreto (Hausmann et al., 2020a).

The four proposed attractiveness indicators are as follows:

- **Ability to attract Foreign Direct Investment (FDI) at the regional level**. FDI has direct and indirect benefits. The direct ones are the incorporation of additional productive knowledge, and the indirect ones are the set of complementary activities that can arise from the new investments. In this sense, FDI attraction could help strengthen the stock of productive knowledge in Loreto and boost other sectors of the economy. Not all the industries that we have identified as having potential in Loreto have the same capacity to attract foreign investment. For this reason, the indicator prioritizes those industries that can attract the largest amounts of FDI from Latin America. Performance on this factor can be approximated by the total value of FDI that has been generated in Latin America for each identified industry since 2003. The Financial Times fDi Markets database (for investment figures) and the Dun & Bradstreet (for employment figures) database were used to construct this indicator [23].
- **Ability to attract Foreign Direct Investment globally**. This factor extends the analysis of the previous indicator to include the amount of global FDI mobilized for each identified industry.
- **Propensity to export**. A central element of this development strategy is to strengthen Loreto's export profile. Industries that tend to be organized around exporting firms are less vulnerable to shocks in the domestic economy. The performance in this indicator is estimated by calculating the proportion of total employment in the industry that is found in exporting firms worldwide, based on from the Dun & Bradstreet database.
- **Capacity to generate employment**: One of the most important objectives for Loreto's development strategy is its potential to create formal jobs. Using information from Dun & Bradstreet, the average size of firms in the US economy is calculated for each industry by dividing the total number of employees by the total number of firms. Though using US data assumes that firms in an industry would tend to organize similarly in Loreto, which might not be true, it is a more reliable alternative from the point of view of the data representativeness and allows us to evaluate performance based on the efficient production possibility frontier.

Environmental sustainability, the last axis, is one of the most important dimensions to narrow down the list of industries for the productive diversification in the region. To incorporate the environmental sustainability criteria at the industry level, we use the US Environmentally-Extended Input-Output (USEEIO) matrix, which identifies 19 environmental impact metrics at the industry level. From these 19 metrics, 5 were selected as the most relevant for Loreto.

However, the data is based on information on emissions of toxic substances and use of resources specific to the production process of US industries, which presents limitations in

[23]The fDi markets data is available for the period January 2003 - May 2019.

their extrapolation to the context of Loreto. Still, the information necessary to recreate a matrix based on the specific production process used by firms in Loreto is not available at the country level, and would require a data collection process and local expertise that go beyond the scope of this study. Given these constraints, the US data represents what these industries could become at their most efficient state.

Further, the data is informative insofar as it reveals the effect of each industry per dollar of product produced. But an additional complication is that the environmental impact of an industry depends largely on its scale. Therefore, when working per unit value metrics, issues of scale are not considered. In any case, the analysis presented below is still informative and can be taken as an efficiency measure of the environmental impact of each industry.

The **five environmental sustainability metrics** proposed by industry are:

- **Detriment to water quality and aquatic biodiversity (EUTR**). Aquatic life is often affected by exposure to certain components found in fertilizers and sewage. When these contaminate natural water resources, they can cause massive algae growth, which harms other aquatic life by hogging oxygen, blocking sunlight from the water surface, or even emitting toxins. As the algae die, they leave behind a deteriorated ecosystem. This process is called eutrophication. For Loreto, the protection of rivers –which are not only vital to the subsistence of the population, but also as a habitat for a wide-ranging animal and plant biodiversity— is particularly relevant. In this category, industry emissions are measured primarily in kg of nitrogen, one of the major components that cause eutrophication.
- **Deforestation potential by land use intensity (LAND).** Most production processes require some degree of land use, such as factories, offices, roads, and warehouses. These are typically the result of the conversion of natural habitats that support the local flora and fauna. In Loreto, high intensity of land use could lead to deforestation, which should be mitigated. The performance in this factor is measured by the total area occupied on average to carry out the production process of the firms in an industry.
- **Ecological contamination by toxic substances (ETOX).** The United States Environmental Protection Agency (EPA) maintains a list of common toxic substances that have been rated as prone to pollution when in contact with air, soil, or water. In this indicator, the emission of these toxic substances is considered in terms of the impact they cause by industry, using a standardized unit of comparative toxicity. This measure was chosen for its local impact relevance compared to other measures.

  Air pollution by toxic substances (HAPS). EPA also maintains a list of the most polluting substances released into the atmosphere. In addition to the relevance of local impacts, air emissions of pollutants increase the risk of damaging regional ecosystems, particularly when complemented by other forms of water pollution. Performance on this factor is measured by the quantity of emissions of these substances.

  Emission of greenhouse gases (GCC). Greenhouse gas emissions are the main cause of global

warming. These types of gases absorb the sun's rays at a higher rate than other atmospheric gases, leading to the warming of the atmosphere. This category measures emissions of one of the most common greenhouse gases: carbon dioxide equivalent (CO_2e) at the industry level.

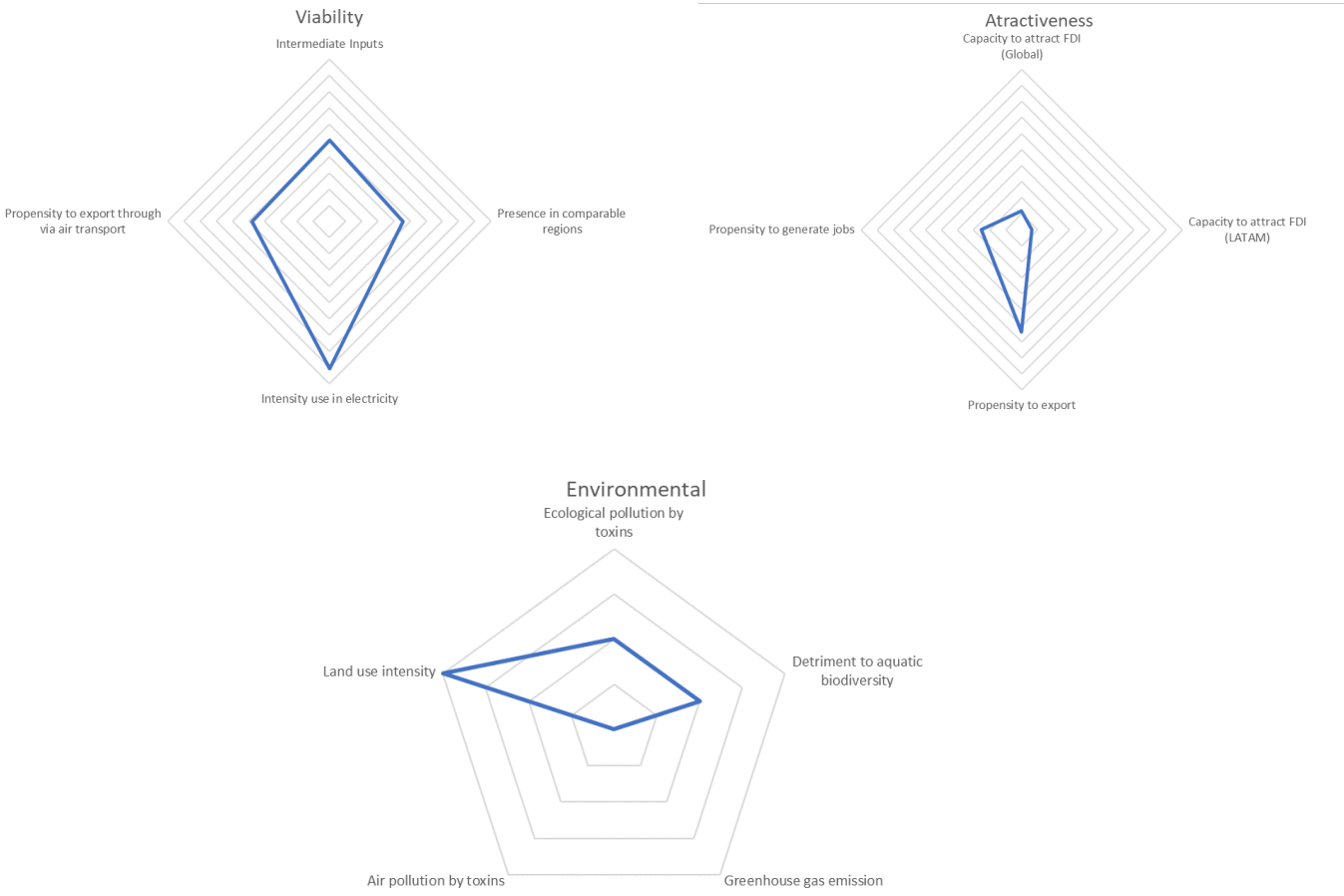
Each of these factors is standardized to make them comparable in terms of unit and scale. The viability and attractiveness factors are normalized and adjusted to form a scale from 0 to 10. This procedure was carried out according to the following formula, where x_i represents the measure for a particular industry, X_i this same normalized measure, and *i* identifies the industry in particular:

$$X_i = 10 \left[\frac{x_i - min\,(x_i)}{max\,(x_i) - min\,(x_i)}\right]$$

Thus, the best-performing industry receives a score of 10, the least-performing industry receives 0, and intermediate values remain within this scale according to their relative position. The specific distribution of environmental indicators- concentrated mostly around zero with some extreme factors several orders of magnitude higher - can be better visualized through the use of base 10 logarithms for each factor. From these distributions, the extreme values were estimated as very problematic, and high, and high, but not extreme, values as moderately problematic. The logic behind this procedure is that values around zero represent industries that have minimal impact on the environment according to the environmental metrics considered. In this way, a value of 0 is assigned to the most extreme values, 1 to high non-extreme values, and 2 to the other values, creating a metric that takes a higher value for industries that harm environmental sustainability the least, and vice versa. Cut-offs for the HAPS and GCC measures were estimated given their distributions, so these metrics should be interpreted with caution.

The performance of each industry along the three prioritization dimensions - viability, attractiveness, and environmental sustainability - can be visualized in Figure 28. Each vertex represents the industry's score for one of the indicators. The following is an example from industry NAICS 325411, "Manufacture of Medicinal and Botanical Products". The farther away from the center each vertex is on the diagram, the 'better' the industry performs on that metric. In other words, a larger area of the figure corresponds to industries that perform better on more indicators of viability, attractiveness, and environmental sustainability.

Figure 28. Relative Performance of Viability, Attractiveness, and Environmental Dimensions, Manufacture of Medicinal and Botanical Products



Source: Own calculations. The values to construct these figures can be found in Appendix 3.

Using these values, we then propose a four-step prioritization strategy involving the various industry groups. Standardization allows us to obtain a final score for each identified industry in each of the three dimensions by summing the scores for the factors on each axis. Based on the final viability, attractiveness, and environmental sustainability scores, the four prioritization phases are defined. In the case of the axes of viability and attractiveness, this sum gives the same weight to all the factors considered. In the case of the environmental sustainability axis, the following weights were used: EUTR (0.35), LAND (0.35), ETOX (0.15), HAPS (0.10), GCC (0.05). These weights were determined based on what we considered most important for Loreto's specific environmental context. Thus, more weight was given to essential measures, such as protecting rivers and avoiding deforestation, to the

detriment of other global measures such as greenhouse gas emissions[24]. Using these criteria we suggest industry prioritization according to the following sequential phases (Figure 29):

- **Phase 0 (short-term):** Among the 55 industries with high potential, industries with the highest priority are those that already existing in Loreto (intensive margin), with above-median performance in terms of both the viability and the attractiveness dimensions[25]. In addition, these industries must also have a high score in environmental sustainability (represented in green and light green in the *circles* in the upper right quadrant - number I - of Figure 29).

- **Phase 1 (short-term**): Activities with the same characteristics described in Phase 0 but that are not in Loreto (extensive margin). Most of these activities also score high on environmental sustainability (represented in green and light green in the *triangles* of the upper right quadrant in Figure 29).

- **Phase 2 (medium-term):** Activities with above-median performance, either in the viability or in the attractiveness dimension, with a high environmental sustainability score (represented in green and light green in *triangles and circles* in the upper quadrant left - number II - and lower right - number III - in Figure 29).

- **Phase 3 (long-term):** Activities below the median in both the viability and the attractiveness dimension, as well as activities that perform above the median in one of these two axes but register a median environmental sustainability score (located in the lower left quadrant - number IV - in Figure 29, or in yellow in quadrants number II and III).

For industries with low environmental sustainability scores, regardless of the quadrant where they are located (orange and red colors - 9 industries in total), we recommend additional evaluations to determine possibilities of implementation and mitigation strategies for potential negative impacts.

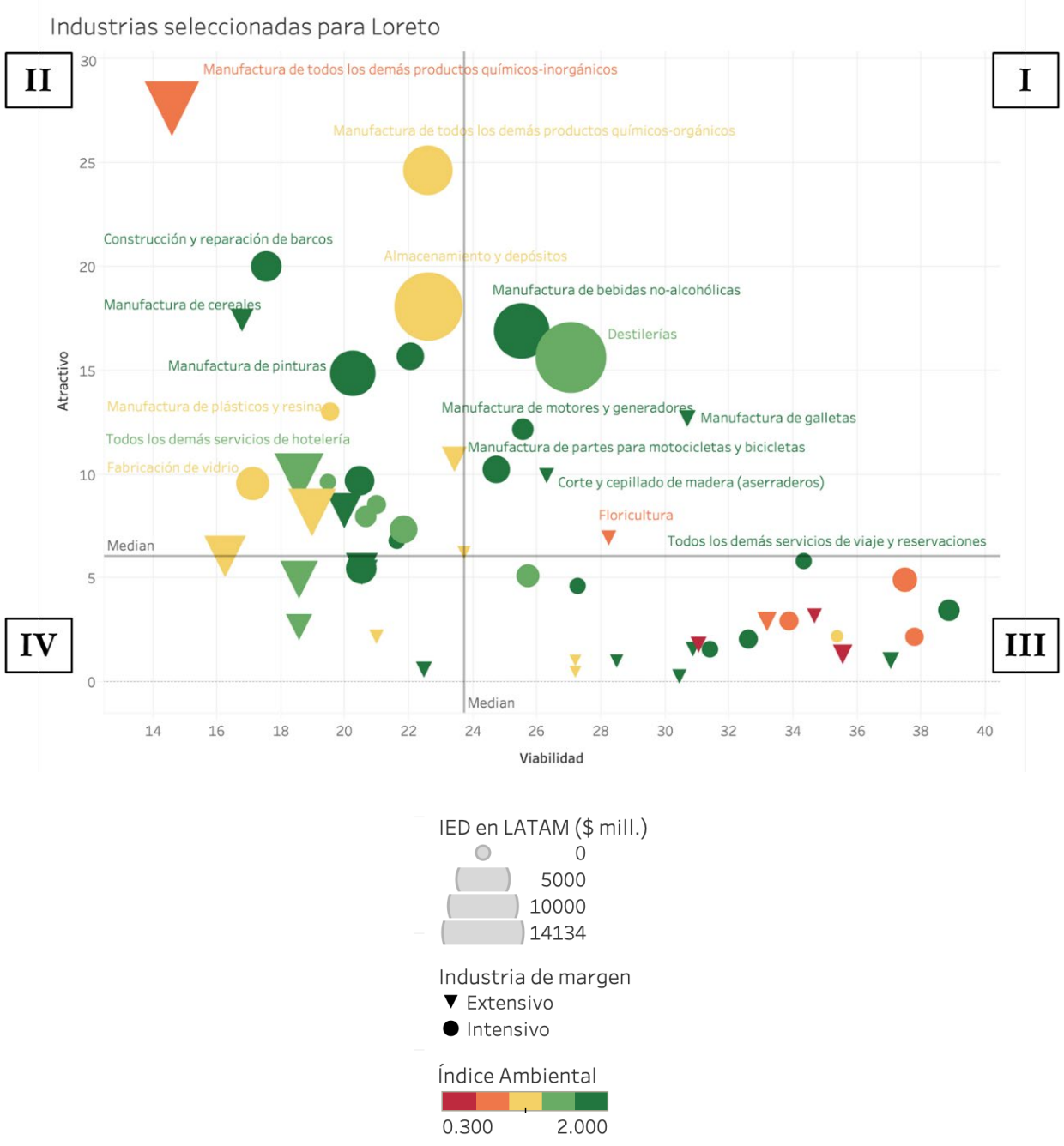
This exercise seeks to establish a roadmap on the type of factors that policymakers might consider and the type of process that they could follow when prioritizing diversification opportunities. The indicators chosen within each prioritization dimension and their respective weights can be redefined by the entities responsible for productive development policies based on their greater knowledge of the local context. This study attempts to provide a reference framework to prioritize industries with potential to promote productive diversification and structural transformation

[24]Although this would ideally be done based on the opinions of local experts, or by formulating a study that identifies a matrix relevant to Loreto's specific production process, both strategies require a level of deep and detailed analysis that is beyond the scope and resources of this report. The best possible approximation was made based on the available data and information.

[25] Its current presence in the region allows these activities to be designated as "Phase 0", with the idea of advancing in the interaction with private actors and industrial experts even before any other diversification initiative.

of Loreto's economy, while maintaining the environmental equilibrium. Ultimately, the prioritized sectors must emerge from an iterative and dynamic process, in which the available productive knowhow and the identified constraints to growth in the region, are taken into consideration.

***Figure 28.** Prioritization of diversification opportunities in stages, according to relative performance in viability, attractiveness and environmental sustainability, besides FDI*



5. STRATEGIES TO REDUCE BARRIERS TO SUSTAINABLE DEVELOPMENT

The following section aims to provide a roadmap to reduce barriers to sustainable development in Loreto. In particular, the analysis made in Section 3 of this document is complemented here with public policy proposals to address he binding constraints related to transportation, self-discovery, and energy. Each of these proposals was formulated considering Loreto's context and capabilities, not only in terms of its productive opportunities but also its institutional set up. We hope these policy recommendations contribute to mitigating the impacts of the barriers that isolation has imposed on the region and to promoting its sustainable development.

5.1 Transport Connectivity

Loreto's geographical remoteness presents significant barriers that have differential impacts on the movement of people, goods, and services. Most of the region is not connected by land transportation to the rest of the country, thus trade is limited to air and river transport. In the production of goods and services, the costs associated with local transportation and logistics act as a protective barrier for certain local industries. Thus, a productive ecosystem has been developed aimed at meeting domestic demand with less efficiency than its potential competition outside the region, at a margin equal to transportation costs. This explains both the development of a productive ecosystem that is more complex than expected given the remoteness of the region and the fact that this ecosystem has not been able to evolve into more sophisticated industries with the capacity to compete outside of Loreto and sustain higher wages. The reduction of these barriers and their associated costs through the provision of a more efficient transport alternative – less expensive, more predictable, and with greater capacity – emerges as a strategy to reduce the protection imposed by geography and promote greater efficiency and competitiveness in Loreto's economy.

Solutions to solve the transport connectivity problem include removing obstacles associated with river transport given the high environmental and economic costs of other alternatives. In terms of air transport, Loreto has relatively good connections with the rest of the country and limited connections between urban centers. However, moving cargo by air from Loreto has high costs and only makes economic sense for high-value merchandise[26]. By land, there have been various projects and initiatives to connect Iquitos with the National Highway System, without any concrete results to

[26] The cost of air cargo in Loreto is between 3 and 5 dollars per kilo, within the standard ranges for the industry of 1.50 and 4.50 dollars per kilo (Source: "Air freight: a market study with implications for landlocked countries", 2009).

date[27]. Although a highway would reduce the barriers connecting Iquitos with the rest of Peru – similar to the Lima-Pucallpa highway built around 1940 (Santos and Barclay, 2002) – the environmental and social damage of such a project could be significant. The most visible example is the construction of the interoceanic highway between Peru and Brazil. There, the materialization of the projected economic benefits is uncertain, but there are already observable significant environmental and social damages, including as the opening of roads to illegal activities such as illegal mining and deforestation. [28]

The existing Amazon Waterway project seeks to reduce the costs of fluvial transport of goods, reducing transfer times and the associated time uncertainty, and increasing the presence of the State along the rivers. The Waterway has the potential to improve navigability conditions along 2,687 km of the Marañón, Ucayali, Huallaga, and Amazonas rivers and thus contribute to the development of commercial exchange in the North Interoceanic Corridor that integrates the port of Paita with the Peruvian Amazonia. The project is estimated to reduce transportation times (measured in days rather than hours) by 20% and increase cargo transport by 3.5 times (Source: MEF). Currently, the river presents limitations around its depth, morphological changes, and the presence of palisades, which impose additional costs to river transport, added inefficiencies, and disorganized traffic due to the lack of a controlled and monitored system that allows safe navigation 365 days a year, both for passengers and cargo.

However, the current formulation of the project – due to the lack of associated studies – leaves many questions regarding the possible environmental impacts of the proposed Waterway. In general terms, the studies carried out to date (Environmental Impact Study and Feasibility Analysis) lack sufficient information to establish the environmental impacts of the project and its relationship with other aspects of the socioeconomic development in Loreto and surrounding areas. In addition, the environmental considerations are not in tune with comparable analyses that have been carried out in other regional projects – see for example the Paraguay-Paraná Waterway[29,30], - and do not incorporate the current state of knowledge in terms of environmental impact assessment included in the guidelines of international organizations such as the World Bank and the OAS.[31,32]

The following section analyses the environmental aspects of the Peruvian Amazon Waterway project based on the Environmental Impact Study (EIA) and the project's Feasibility Study.

[27] In 2016, there was an initiative to connect Iquitos with Saramiriza and even an Iquitos-Yurimaguas commuter train. To date, the Loreto Regional Government is carrying out pre-investment studies with the support of the Ministry of Transportation and Communications (MTC). Sources: Alayo Orbegozo (2016); Priale (2019).

[28] Vilela et al. (2020); Wagner (2017); Perz et al. (2013); Redwood (2012); Dourojeanni et al. (2009).

[29] Hamilton (1999).

[30] Baigún (2019).

[31] "Southern Cone Inland Waterways Transportation Study" (2010).

[32] "Capítulo VIII. Proyecto hidrovía Paraguay-Paraná" (n.d.)

Thus, opportunities for improvement in the implementation of environmental actions relevant to Loreto are identified, which is expected to support public policy makers in its decision-making.

5.1.1 Analysis of Waterway Environmental Aspects

As part of the Waterway project process, an Environmental Impact Assessment (EIA) [33] **and a Feasibility Study**[34] **were carried out**. Both documents cover the traditional aspects of engineering projects and river navigation infrastructure, and in the particular case of the Amazonia Waterway, they present a large amount of information on the navigability and characterization of the physical-environmental setting of the river channel, but without an adequate analysis of the environmental impacts that the project may generate by its construction and operation.

There are important information gaps related to the effects of shipping and associated port infrastructure on the social environment and biological communities. In its current formulation, the project not only fails to consider the impact on the effects induced outside the river channel, but also fails to integrate the ecosystem of the rivers and related wetlands, including of the overall landscape. To date, the research team has not identified any study that contemplates a dimensioning of the magnitude or durability of the possible environmental impacts, for which it would be necessary to make projections through simulation models or from trends observed from the environmental variables stated in both documents.

The information presented so far is static and mainly reflects a diagnosis of the current situation (without project), rather than an evaluation of future environmental impacts (with project). Appropriate monitoring has not been carried out to identify synergies and cumulative effects on river ecosystems, prerequisite conditions in the context of environmental studies. In this sense, it seems necessary to generate additional information specifically aimed at evaluating impacts (for example, effects derived from dredging and waves caused by navigation on different coastal organisms or communities) with a quantitative and prospective approach.

Although the environmental impacts of the Amazonian Waterway project are listed qualitatively, they are not yet subject to an economic evaluation[35]. This means that the environmental impacts described in the EIA do not affect and are not tied to the cost-benefit analysis presented in the Feasibility Study. In other words, the cost-benefit analysis of the project does not consider the environmental impacts contemplated in the EIA. The only exception to this evaluation is the economic assessment of an environmental impact ("Decrease in coastal fishing activity") in 3 of the 4 basins analysed (Huallaga, Marañón, Ucayali). This observation highlights that the economic benefits of the Waterway are concentrated in a relatively small number of actors such as dredging

[33] "Estudio de Impacto Ambiental detallado del Proyecto HIDROVÍA AMAZÓNICA" (2017).
[34] "Estudio de Factibilidad – Mejoramiento y Mantenimiento de las Condiciones de Navegabilidad en los Ríos Huallaga, Ucayali, Marañón y Amazonas" (n.d.).
[35] See for example Table 12.5-1 on page 9, and others similar to EIA tables.

companies, barge companies, and shippers that will immediately obtain greater profits from the construction of the project, while the environmental costs potentially will become more visible in the future and will be distributed among the most vulnerable local population in Loreto.

In addition to not considering environmental variables in the cost-benefit analysis of the project, the EIA does not present an economic valuation of the ecosystemic (or environmental) services. [36] The study only contains a list of the types of ecosystem services that appear in the local legislation, [37] but in none of these cases–regulation of water flow, regulation of erosion–(benefits) is valued in economic terms.

Finally, in addition to the lack of economic valuation and any effective influence on evaluations related to this project's ecosystemic services or environmental impacts, there are concerns about the credibility of the environmental analysis itself. For example, the 2019 WCS[38] review notes that while the different types of environmental impacts are listed in the EIA, their relative weights are questionable. There is no sensitivity analysis as these weights are not well justified. There is an agreement that the analysis carried out by WCS in that the EIA presents "*incomplete and inaccurate information on the conditions of the physical, biological and social environment, the identification of impacts is not solid and requires technical support, research results, representative information and other elements that provide support and credibility to the impact analysis and that contribute to an accurate/adequate assessment of the impacts that the project could cause*" (WCS, 2019).

5.1.2 Policy Recommendations

Combining the need to promote more efficient river connection alternatives in Loreto with the insufficiencies shown by the environmental impact analysis, a set of main recommendations are derived aimed at contributing to the decision-making process regarding the current project:

(1) **Carry out an environmental baseline study for the Amazonian Waterway project**. The information contained at the baseline must help in understanding the functional relationships between natural processes and ecosystem components and propose an ecological characterization of the areas to be intervened, highlighting their structure and functioning, and considering the severity of the impacts, the risks, and the vulnerability of these areas. From this, simulation models or projections of observed trends can be used to predict potential impacts.

[36] Ecosystem or environmental services represent socioeconomic benefits provided by the environment, for example, the provision of clean water, protection against floods, and erosion control, among many others. They should not be confused with environmental impacts, which refer more to the deterioration of the environment due to the project.

[37] See Table 12.3-1 Types of ecosystem services of the EIA

[38] WCS (2019). Own translation.

(2) **Guarantee the generation and accessibility of up-to-date, high-quality information.** There is a need to fill in the information gaps identified in the EIA, especially when projecting future environmental impacts and valuing ecosystem services. For example, the characterization and projections of environmental impacts to be carried out must be enough for the planning and establishment of mitigation measures and must include the aquatic habitats and the floodplain in each of the pathways identified in the river sections. This updated information is expected to lead to improvement in the characterization and quantification of the surfaces to be affected by the project works, and in the analysis of its impacts on ecosystems and species.

(3) **Generate studies and models to evaluate the extension, permanence, synergies, and accumulation of the different types of potential impacts of the Waterway on the ecosystems of the river corridor and the corresponding ecosystemic services**. In this sense, the need to complement the information contained in the EIA with future scenarios should be emphasized again. For example, interventions such as dredgings are performed periodically after the initial one. For this reason, it is essential to develop prospective scenarios for the occurrence of cumulative and synergistic impacts over the project implementation period. These scenarios must cover aspects such as the effects of dredging on the breeding and feeding areas of fish and other aquatic organisms, the quality of water for organisms or human consumption, and the stability of river channels. Another example is the detailed analysis of canalizations, rectifications, and other types of works that may cause habitat fragmentation and alter the connectivity of the wetland system.

(4) **Consider climate change as a priority variable in the development plans for waterway-related infrastructure works at the regional level**. At this point, it is worth noting that the studies carried (out to date) do not consider any impact of climate change. This is mainly due to the static nature of the diagnosis presented in the EIA. In particular, the WCS4 analysis notes that in the EIA "climate is used and confused with atmospheric conditions and seasonality".

Other recommendations that are derived as a corollary of the main ones are:

(1) **Analyse the environmental impacts in view of other existing or scheduled projects under study**. Thus, cumulative impacts or synergies could be identified, such as those that may be occurring with oil and forest exploitation. It is important to understand that environmental systems are inherently connected due to the nature's own processes (the hydrological cycle, mainly in this case). For this reason, the implementation of a project like the Amazonian Waterway implies physical and biological impacts on the surrounding environment (aquatic, soil, vegetation) that translate into impacts on other activities or projects and vice versa. Therefore, an updated EIA is necessary with these environmental impacts quantified in more detail.

(2) **Develop a protocol for continuous monitoring and evaluation of environmental impacts, which includes the state of water quality, the riparian coasts, and the wetlands throughout the entire fluvial corridor**. This can be done by combining in-situ monitoring and the use of remote sensing techniques to obtain data on environmental variables (water quality, fluvial geomorphology, vegetation cover) that provide inputs for adaptive management of the Waterway transportation system.

(3) **Consider and develop appropriate measures and mechanisms for the management of waste and discharges from activities related to the operation of the Waterway**. River transport generates solid waste and liquid discharges that must be properly managed following international standards of the river navigation industry. These variables are not considered in the existing EIA and must be analyzed especially from a cost-benefit perspective.

A new tender for the EIA of the Amazonian Waterway has recently been opened. COHIDRO has circulated a Terms of Reference document (TOR) to carry out a new EIA[39]. This document establishes that the previous EIA[40] has been withdrawn in 2019 due to the lack of eco-toxicological studies. After reviewing the content of this document, it was concluded that the new TOR reflect a more detailed analysis of the navigability of rivers, through the application of numerical hydrological and hydrodynamic models.

However, the study specifications still lack relevant considerations. The TOR has shortcomings in aspects of environmental impact mentioned above. For example, the new TORs include conducting an environmental baseline study (the first of our recommendations), but do not specify its minimum content or mention the assessment of the ecosystem services of river channels (second and third) or the climate change (fourth), key elements to establish the environmental viability of the Amazon Waterway as a whole. [41]

[39] COHIDRO (2020) - Detailed Environmental Impact Study of the "HIDROVÍA AMAZÓNICA: Ríos Marañón y Amazonas, tramo Saramiriza-Iquitos-Santa Rosa; río Huallaga, tramo Yurimaguas- Confluencia con el río Marañón; río Ucayali, tramo Pucallpa- confluencia con el río Marañón".

[40] COHIDRO (2017) – Detailed Environmental Impact Study of the Project "HIDROVÍA AMAZÓNICA: Ríos Marañón y Amazonas, tramo Saramiriza-Iquitos-Santa Rosa; río Huallaga, tramo Yurimaguas- Confluencia con el río Marañón; río Ucayali, tramo Pucallpa- confluencia con el río Marañón".

[41] It is not within the scope of this study to determine the extent to which they can improve river navigation and connectivity through interventions such as port and wharf refurbishment or ship condition checks.

Box 1: The effects of the Interoceanic Highway in Madre de Dios

In December 2010, the last phase of the Interoceanic Highway that connects Brazil with the Pacific Ocean and crosses Madre de Dios was completed. Using a difference-in-differences specification, we evaluate the causal impact of this highway on average wages, the rate of unemployment, and the labor participation rates in the department. The difficulty of estimating the impact lies in the fact that it is not possible to observe the economic performance of the region with the highway and without the highway at the same time. This is not possible since we only have the data of the departments *with* the interventions, and it is not possible to observe a counterfactual world where it was not built.

To estimate the impact of the highway, a counterfactual scenario must be constructed that contemplates how the relevant variables would have behaved in the absence of the intervention. In this case, it is assumed that these variables would have behaved in the same way as the national average. For this assumption to be reasonable, these variables should move in parallel in the department and the rest of Peru before the construction of the highway.

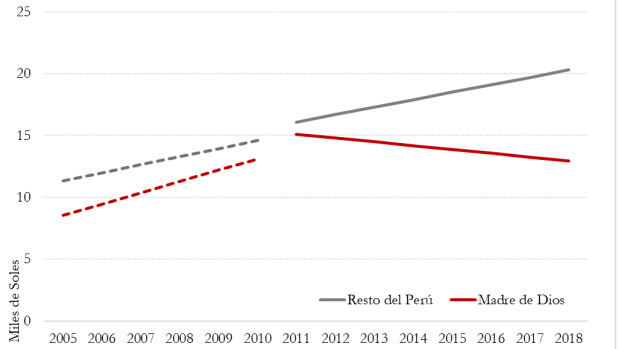
Regressions were carried out to specify the impact of road and electricity connections on changes in wages, unemployment, and labor participation rates (as well as the levels of these variables), using two different specifications – one without fixed effects and one with fixed effects for each department and each year. This second specification controls the idiosyncratic aspects of each region of the country and each year in the study, allowing the identification of variations that occurred in specific years in specific regions.

What do the results of the regressions indicate?

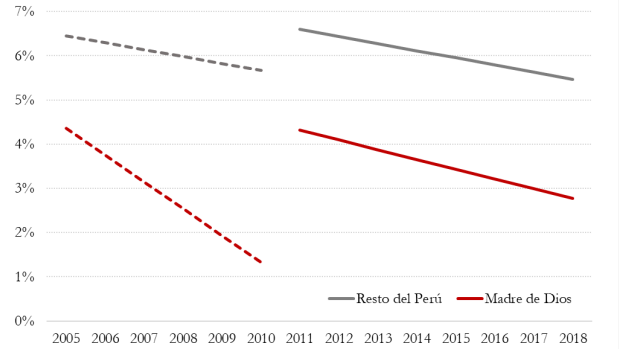
In the case of Madre de Dios, the analysis does not yield definitive results on the causal impact of the interoceanic highway, since it does not meet the econometric requirement that there be parallel trends conditions . Specifically, the differential trend coefficient for Madre de Dios is statistically significant and also relevant in practical terms.

However, some tentative conclusions can be drawn from the regression coefficients. In particular, after the inauguration of the highway, average wages in Madre de Dios decreased almost by 500 Soles more per year than in the rest of the country, after accounting for the impacts of fixed effects by state and year. Similarly, after the inauguration of the highway, the unemployment rate rose 0.23% more per year and the labor participation rate fell 1.47% more per year in Madre de Dios than in the rest of the country. Consequently, although we cannot attribute these causal effects to it the highway, it is possible to conclude that it is relatively unlikely that the interoceanic highway had positive effects on these variables. In any case, there is no significant evidence of a positive before-and-after impact on the economy of Madre de Dios.

Box 1 – Regression Results



Fuente: ENAHO



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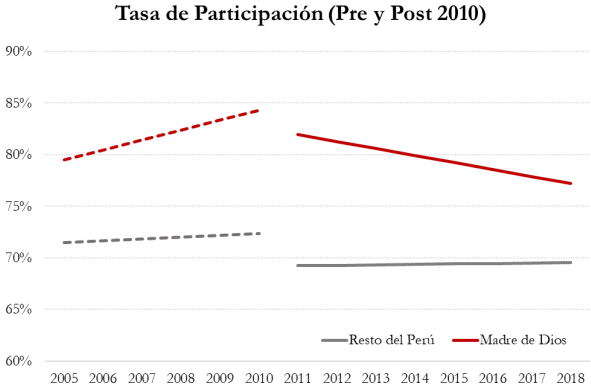


Fuente: ENAHO

5.2 Self-Discovery

The process of identifying which industries have potential in Loreto and coordinating the public and private inputs needed for their development is subject to information and coordination failures. Hence, public-public and public-private interaction mechanisms should be strengthened. Information failures are related to the costs of discovering whether a new economic activity can be profitable in a place, while coordination failures appear because the provision of inputs for a new industry tends to occur within the public sector, between its different instances, and between private actors.

Loreto's economic trajectory reveals that the department is less likely to diversify towards similar industries in terms of productive knowledge, which suggests that it has a differential lower capacity to resolve market failures related to the self-discovery process. Although Loreto has higher productive capabilities than its Amazonian counterparts in Peru and, as indicated by patent registrations, it has innovation capacity and an important stock of know-how in its native communities, it has not been able to coordinate the action of different public and private actors to capitalize on these benefits. Except for a few cases – which illustrate the potential of the region when it manages to combine efforts of different levels of government and private actors to jump into more sophisticated industries – the department has found it difficult to overcome the market failures associated with the self-discovery process.

The following policy recommendations are intended to enhance Loreto's capacity to resolve these market failures and provide incentives to overcome the information and coordination failures associated with the self-discovery process. These recommendations have been formulated taking into account the particular characteristics of Loreto, in addition to its institutional strengths and weaknesses, and can be implemented independently. However, there are synergies in implementing them together.

5.2.1 Regional Executive Tables for Public-Public and Public-Private Coordination

Loreto lacks formal coordination mechanisms between public and private actors for the design and execution of its Productive Development Policies (PDP). Although the Regional Government - through the Economic Development department - frequently meets with different Ministries to coordinate and implement productive development programs, the policy approach does not formally, dynamically, and iteratively involve representatives from the private sector in solving specific problems of their sectors.

Although Peru is a pioneer in the successful implementation of the Executive Tables to resolve failures associated with the process of self-discovery, differences in the agglomerations of knowledge, occupations, and sectors between departments make it essential to extend the initiative to the subnational level. The Executive Tables are temporary

public-private working groups that seek to resolve coordination failures between the different actors around a specific sector or factor of production. [42] They go beyond consulting the private sector about its main bottlenecks; they seek, through a dynamic and iterative process, specific solutions to sectoral problems. They are also a prioritization mechanism which helps the public sector to define its public policy agenda according to the expected impact of their policies on the economy and employment at the sector level. An emblematic case is the Forestry Executive Table, active since 2015, which began under the supervision of the Ministry of Production and currently continues under the Ministry of Economics and Finance. This Table has addressed various issues related to the sector's productivity problems, such as the size of the plantations, access to finance, and technology transfers. The issues that the Table addresses are mostly related to missing inputs that the public sector must provide for a sector to develop, including adequate regulation. However, the Tables lose impact when it comes to resolving coordination and information failures at the sub-national level since restrictions and bottlenecks are evaluated at the national level (for the average industry) and lose strength when it comes to considering particular characteristics and evaluate the needs of the sectors within each region.

For the industries suggested in this report, we propose implementing regional Executive Tables; the institutional framework and its actors are vital to its success. It is recommended to start with two industries: food and chemical industries, and tourism. Both sectors meet several prioritization criteria[43] and are part of the set of strategic industries derived from our complexity analysis. They share characteristics of vital importance for a Table to be successful: i) a certain degree of organization of its private sector (for example, some entrepreneurs in the tourism sector are associated with each other), ii) actors who already work with the State (for example, AJE), and iii) have potential to export (goods and services). In any case, the selection of the sectors with which to start an Executive Table must be a decision of the competent government authorities.

[42] For futher information, see "Mesas Ejecutivas, Nueva Herramienta para la diversificación productiva en el Perú" (2016).
[43] This is within the regulatory framework and existing initiatives in the region and not implying a reform of the state.

The Executive Tables have three types of participants:

Private Sector Representatives	Firm leaders, responsible for the decision-making of their respective companies, who know, first-handed, the bottlenecks of their sector and have convening power
Public Sector Representatives	Representatives of the State agencies and Ministries that have a direct relationship with the respective sectors. Includes the different relevant levels o government (national and regional).
Entity Responsible for the Executive Table	Technical Secretariat: Responsible for the meeting logistics, moderating the sessions, and leading the work.
	Technical Advisors: Highly qualified public servants, responsible for providing the Tables with sectorial studies, and monitoring public policy inputs provided by the different stakeholders.

It is recommended that the institution is operationally and administratively affiliated to the Vice Ministry for Territorial Governance, in Office of the President of the Council of Ministers, and jointly designed with the local government of Loreto. In this way, the Table is linked to the highest levels of the administration that has decision-making power in the country and the capacity to resolve the identified bottlenecks. It is also recommended that the meetings take place in Loreto, or a combination between Lima and Loreto, at the decision of the Technical Secretariat and the Table members. It thus aims to involve the different levels of government (national and regional) and businessmen in the sector, both from Loreto and from the rest of the country, in the study of opportunities in the region. In addition to the regular sessions of the board (normally weekly or biweekly), the Technical Secretariat must hold bilateral meetings with representatives of the public and private sectors of each sector to follow up on the agreements and resolve of public-public coordination problems (both between different levels of government as well as different instances that must concur to resolve bottlenecks within the same level of government). Ultimately, the political viability and commitment of various actors will depend on the initial success of the boards. The public sector must demonstrate its commitment to this mechanism through its work and willingness to mobilize resources to resolve bottlenecks, thus generating and strengthening private sector confidence. For this reason, it is recommended to start the process with two sectors, and only open successive tables to the extent that these two have demonstrated their ability to coordinate and resolve productivity constraints.

5.2.2 Competitions for Sustainable Business Plans to Solve Information Failures

Doing business using Loreto's current productive knowledge is expensive. The existence of information failures could explain why Loreto's current set of productive capabilities, including the patents and collective knowledge described here, have not yet been capitalized on a large scale. In the current situation, the private sector seems to invest less than it would in an optimal scenario when looking for new business models that could be profitable in Loreto, given the high costs of discovery and the low appropriability of profits. This can be a restriction not only for the appearance of new companies but also for existing companies that want to invest to expand their portfolio. The AJE case demonstrates the need for cooperation and coordination with various levels of government to materialize business models that exploit Loreto's comparative advantages.

To facilitate the emergence of new business models and products, public-private collaboration is essential, as is done through a series of funds and competitions under the *Innóvate Peru* Program. *Innóvate Perú* is a Government's program created in 2014 that seeks to increase firm's productivity by strengthening their innovative and agglomeration capacity. [44] Under the Framework Fund for Innovation, Science and Technology (Fondo Marco para la Innovación, Ciencia y Tecnología – FOMITEC in Spanish), programs are finance to support business growth, such as 'Start-up Peru', a a contest to encourage business growth and high-impact ventures, and 'Bio Challenge', with which the State co-finances companies and entrepreneurs to invest in natural resources, mainly associated with technologies for biological systems, efficiency and sustainable use of natural resources, supply and distribution chains, cleaning and sustainable conservation of rivers, lagoons, and oceans, among others. [45]

It is key to give the existing funds a regional character to amplify their impact. Innóvate Peru already has funds and institutions to implement programs aimed at resolving information failures. These initiatives should be adapted to the challenges of Loreto, which are significantly different from the average region of the country. It is necessary to consider that the national programs could underestimate the additional costs of self-discovery associated with the department and that the particular impact of Loreto's economic and environmental restrictions implies modifying the conditions of these support programs.

The expansion or creation of a program similar to the *Reto Bio (Bio Challenge)* exclusive for the department of Loreto (or the Amazon regions) is proposed, focused not only on the enhancement of natural resources but also on their productive capacities in general. This opens up possibilities for business models and products for any project that is profitable and environmentally sustainable. A focus on natural resources may limit Loreto's ability to innovate in other areas that can contribute to its sustainable development. The specific conditions could be

[44] "Historia – Innóvate Perú" (n.d.).

[45] "Concurso Reto Bio 2019 - Innóvate Perú" (n.d.).

defined by the Ministry of Production together with the Regional Government of Loreto and the Ministry of the Environment, given the experience they have with other companies.

The organization and the financing of this initiative could involve environmental organizations that work in the Amazon. This initiative, in addition to helping to resolve the information gaps that are inhibiting the emergence of new business models in Loreto, could further involve local environmental organizations, which could be further associated not only with the prevention and remediation of environmental damage but also with the promotion of new sustainable activities that generate wealth and productive jobs.

5.2.3 Decentralized Office for Productive Development

Productive development policies in Loreto are well established in various plans and actions prepared by the public sector; the challenge is in its articulation. The region has plans at the regional and national levels that define its productive development objectives, as well as related projects, progress indicators, and responsible entities. Efforts to define the future of regional economic policy in the short and medium term have not been scarce, as can be seen in the Concerted Regional Development Plan "Loreto 2021" (PDRC), [46] the Institutional Strategic Plan 2019-2022 (PEI), [47] and the Loreto Regional Export Plan (PEXL), [48] among others. The Ministry of Production, as the governing entity in the matter, has various programs and activities in Loreto that include the implementation of the CITEs, innovation and technology transfer services, among others. [49]

However, given the multiplicity of stakeholders and government agencies involved in each of them, coordinated implementation and oversight is difficult. In some cases, programs are implemented in a limited manner, occurring in isolation, and ultimately diminishing their impact. For example, PEXL has established 34 specific actions for 4 production-export chains, each with a direct responsible in charge, ranging from specific directorates of the Regional Government to ministries, and various public, private, and academic actors involved. The PEI, in turn, establishes 6 general guidelines to achieve its institutional strategic objective #8 ("increase the productive competitiveness of the department"), which would have to be articulated with the regional strategic objectives of the PDRC, which in turn establish new responsible and strategic actions. The stakeholders and those responsible ends up being the same. The 'GORE- Ejecutivo', a space where ministers of the National Government meet with the Regional Governors–is a major step forward in the coordination and alignment of public policies. However, more fluid and constant meetings, organized around the sectors that have potential, are necessary.

The public sector must also coordinate further with the private and entrepreneur sectors. To capitalize on its know-how, the State must be able to articulate the private sector with the different

[46] "Plan de Desarrollo Regional Concertado 'Loreto Al 2021'" (2015).
[47] Prialé (2019).
[48] "Plan Regional Exportador de Loreto" (n.d.).
[49] "Ministerio de la Producción promoverá el desarrollo productivo de la región Loreto" (2020).

government programs and its innovative capacities. The productive potential and the possibilities of the productive ecosystem of the region are already documented[50]. The key is to coordinate the different plans and efforts to make coherent and implementable programs, without duplicating efforts and starting from the main bottlenecks that need to be resolved. According to the observations and interviews carried out for this research, the degree of coordination and organization capacities among the private sector is heterogeneous: sectors with a high level of organization coexist with others that may be more dispersed.

For these reasons, we propose the creation of a Decentralized Office for Productive Development in Loreto. Its main objective would be to lead public-public and public-private coordination and integrate existing plans and programs. The Office would also assume the role of promoting and attracting investment to the region and would be an integral part in the organization of the regional executive boards and competitions for sustainable business plans that have been proposed in this report. The Office could be under the Ministry of Production, the President of the Council of Minister's Office, or the Regional Government, subject to where it can have the most impact given its potential.

Since 2018, there has been an initiative to implement Regional Development Agencies (ADR by its acronym in Spanish). The general objective of the Agencies is to "*Promote sustainable and inclusive growth and investment to improve levels of competitiveness*", acting as instances of intersectoral and intergovernmental coordination and articulation (Decentralization Secretariat, Government of Peru). According to the 2019 Annual Decentralization Report of the Presidency of the Council of Ministers of Peru (PCM), in that year, six Regional Governments formalized the creation of the ADRs. In Loreto, this has not yet happened. The Office proposed here can complement this initiative, expanding its powers with the principles suggested for Loreto or evaluating which of the frameworks is more convenient for the region.

The Office must assume certain roles and characteristics in terms of its mandate:

i. Public-public coordination: Articulate existing plans and programs in the Public Sector for productive development policies, avoiding the overlapping of responsibilities, facilitating their implementation, and maximizing their impact.
ii. Public-private coordination: Being the articulating agency and strengthening relations with the regional and national private sector, identifying its sectoral needs, and involving these actors in the identification of joint solution for the restrictions that inhibit its development in Loreto. The public sector has only part of the information necessary to carry out productive

[50]The analysis made in the Economic Complexity Report of Loreto shows that the region has a level of productive skills and knowledge that is close to the median of the other Peruvian regions, above most of its Colombian peers, and below of the Brazilians.

development policies based on the identification of market failures. To promote this interaction in a productive way (and reducing the risks that they become instances of rent capture), the Office must have specialized technical personnel, with knowledge of the sectors of the region and their potential in global markets. Whether large or small, the identification of barriers and public inputs necessary for the success of a sector is essential. When identifying them, the Office must work to secure their provision with the corresponding State agencies, both at the national and regional levels. In addition, it plays a role in grouping the less organized sectors. For example, in cases where there is dispersion in local companies because they are very small, the Office will be able to create spaces for joint work, identifying their main bottlenecks and promoting increased productivity.

iii. Investment Promotion: An important role that the Office can play is to promote Loreto as an investment location, be it through contests, directed visits, or other mechanisms. The sectors to start with could be associated with those identified in the phases of this report, given their proximity to Loreto's productive capacities, their viability, attractiveness, and environmental sustainability. Productive development policy agendas are usually monopolized by local agents, but since a significant fraction of Loreto's productive diversification possibilities is found in the extensive margin, it is important to establish communication with potential entrepreneurs and innovators outside of Loreto, who can provide information and inputs regarding constraints, and bottlenecks, contributing with possible measures to resolve or mitigate them.

iv. Flexibility and dynamism: A key aspect for the Office should be its flexibility to adapt to a changing public sector, a dynamic private sector, and an environment that demands constant learning to quickly evaluate and implement new ideas or adapt initiatives. This is also important for the private sector to gain confidence in the institution and maintain its willingness to work together.

Finally, the Office must learn how to distinguish the problems where it can play a primary role to increase productivity, and those that are specific to the private sector. Ultimately, it is the private sector that must design which are the best products for the market, define their prices, and obtain the necessary private inputs for production and sales when these are available in the private sector (Stein Crespi, Fernández-Arias and Stein, 2014) [51]; Produce, 2016) [52] – on their profitability. The public sector, in turn, is responsible for supporting increased productivity and providing the required *public* goods, within the established rules of the game. To resolve information and coordination failures in Loreto, the challenge is mainly institutional - the ideas, and know-how already exist.

[51] Crespi et al. (2015)

[52] "Mesas Ejecutivas, Nueva Herramienta para la diversificación productiva en el Perú" (2016).

5.3 Energy

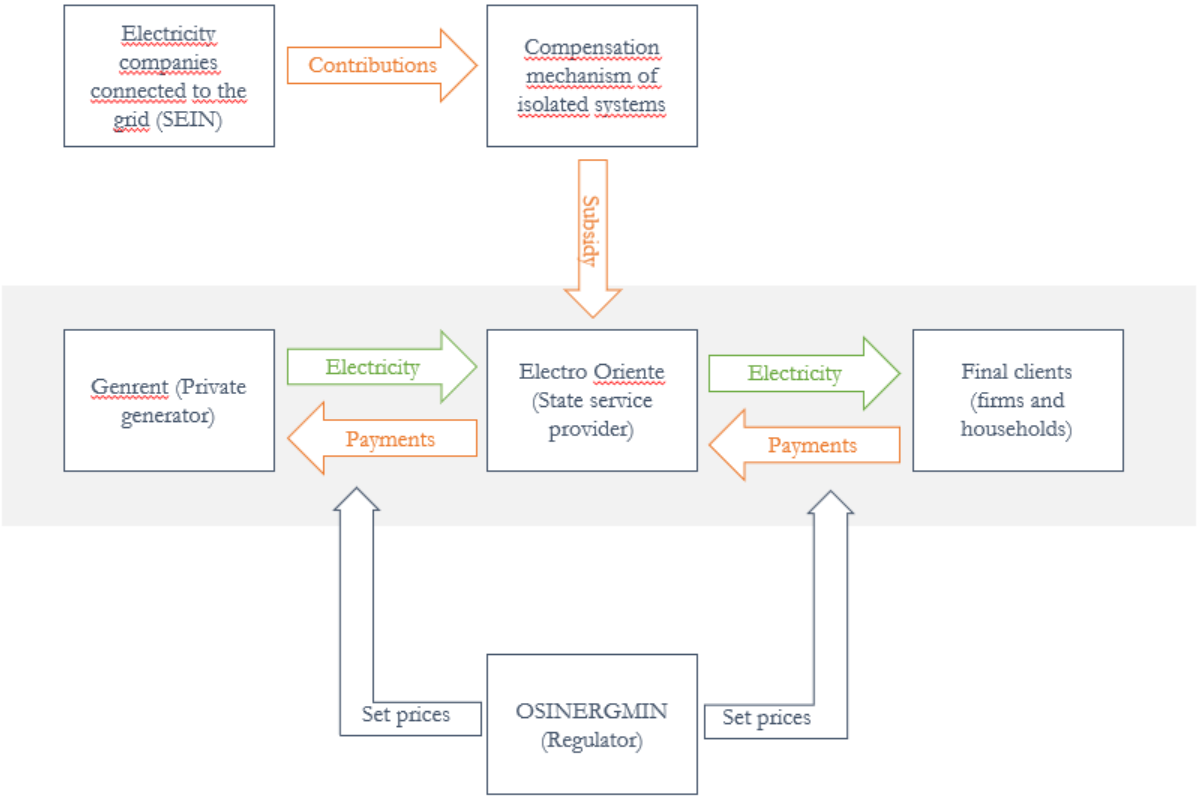
Loreto is not connected to the national interconnected electrical system (SEIN, by its acronym in Spanish) and uses isolated electrical generation and distribution systems. Electricity is generated locally in thermal plants that consume residual fuel and diesel, produced at the Iquitos refinery with local crude oil and transported by river. The variable costs associated with this type of generation are very high; thus, Loreto receives a subsidy from the rest of the country to keep electricity rates in line with the rest of the regions.

A private company generates electricity in Iquitos with modern thermal generators that cover current demand. In 2013, the Peruvian State, represented by the Ministry of Energy and Mines (MINEM), signed a twenty-year generation contract with a private company from Brazil, Genrent, which invested around 110 million dollars over five years to build a modern thermal plant based on residual fuel and diesel. The contract contemplates a first stage of an isolated system and then the second stage of the cold reserve. In the first stage – which works while Iquitos is not connected to the SEIN – Genrent plants operate permanently and supply the city with electricity. In the second stage, which would come into effect if Iquitos becomes connected to the SEIN, Genrent's generators become a cold reserve that is only activated if there is an interruption in the normal electricity supply. Genrent uses seven MAN brand generating units of German origin with an installed capacity of 11.6 MW each, for a total of 81.2 MW of installed capacity and ~78 MW of effective power. Currently, Genrent plants cover the peak demand of Iquitos, of 60 MW.

In addition to Genrent's generators, Electro Oriente has generators that operate as a cold reserve. Before the activation of the Genrent plants, the local service provider company (EPS, by its acronym in Spanish), Electro Oriente, acted as the main electricity provider with seven Finnish Wartsila generators with an installed capacity of ~65 MW and an effective power of ~47 MW. Upon completion of the first and second expansion of Genrent's investment, these Electro Oriente generators ceased to be cold reserves that are only used in emergencies.

OSINERGMIN, Peru's electricity regulator, plays an important role in the Loreto and Iquitos electricity market. On the one hand, it sets the price at which the EPS sells electricity to final customers, households and businesses. On the other hand, according to the terms established in the contract between the Peruvian State and Genrent, OSINERGMIN sets the fixed payment that Genrent receives for the effective contracted power (measured in MW) and for the associated energy (the amount of MWh generated and sold). Finally, as Iquitos is not connected to the SEIN, the EPS receives a monthly transfer through a compensation mechanism for isolated systems, which in 2018 reached approximately 34 million dollars.

Figure 29. Structure of Power System in Iquitos



Source: Own elaboration, MINEM.

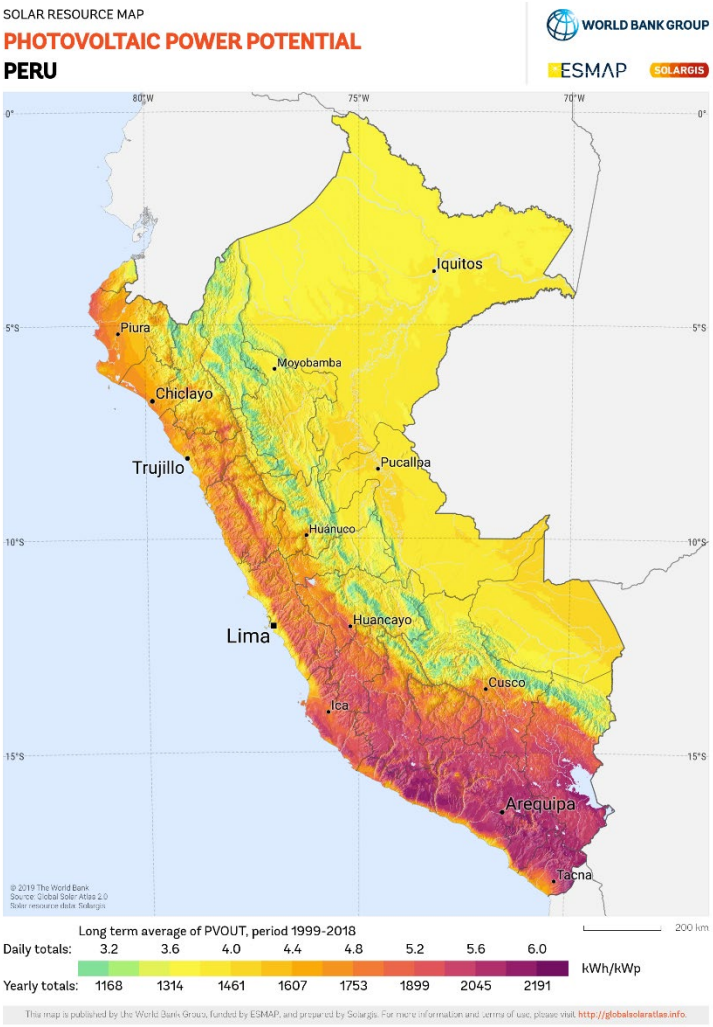
Despite the efficiency of Genrent's MAN thermal generators, generation is still expensive. Our calculations–based on MINEM and OSINERGMIN statistics–indicate that to produce 317 GWh for Iquitos in 2018, Genrent's thermal power plant consumed 18.3 million gallons of residual fuel with a market value of approximately 35.7 million dollars and 417 thousand gallons of diesel with an approximate value of 971 thousand dollars. This implies that, on average, each MWh of energy used 57.6 gallons of residual fuel and 1.3 gallons of diesel, representing a total cost of US$115 per MWh.

Given the high cost of thermal generation, other less expensive alternatives should be explored. Unfortunately, there is not enough wind in Loreto to generate large-scale wind power generators. [53] Likewise, alternatives for hydroelectric generation such as the Mazán hydroelectric plant, which was initially designed to generate 240 MW and was later redesigned to generate 544 MW, only make economic sense if Loreto is connected to the SEIN and excess generation can be sold to the rest of Peru. Still, the department does have the potential for solar energy production. Although there are regions of Peru that receive more solar irradiation than Loreto (such as the in coast and the south

[53] Brancucci et al. (2020).

of the country, see Figure 32), solar energy in Loreto is technically feasible[54] and could reduce fuel consumption in thermal generation plants and produce savings in the electricity system.

Figure 30. Peru's Photovoltaic Power Potential



Fuente: 2019 The World Bank, Source: Global Solar Atlas 2.0, Solar resource data: Solargis.

Solar energy could bring not only environmental benefits but also economic ones. Electricity is a transversal production input that affects all economic sectors. Solar energy could reduce the average cost of electricity and thereby overcome potential constraints on the appearance of more energy-intensive industries. To estimate the magnitude of this potential effect, one must first consider

[54] Ibid.

the savings to the electrical system that solar technology could generate, and then how these savings could be distributed among different participants in the electricity market.

5.3.1 Estimate of Solar Energy Savings

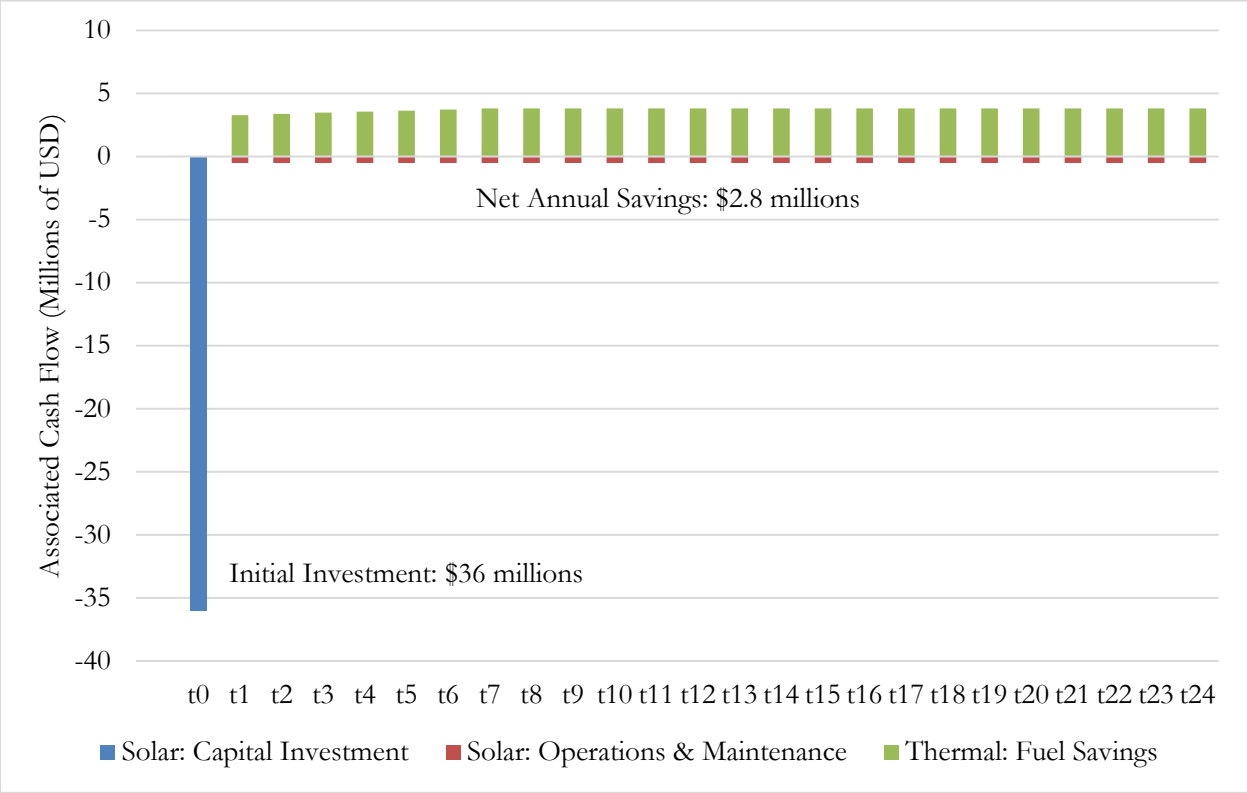
To generate savings in the electrical system, the Net Present Value (NPV) of the benefits associated with solar energy must be greater than the fixed costs of the initial investment. The fixed cost of the initial investment is essentially given by the capital required to purchase and install the solar plants and equipment. The benefits of solar energy occur over time and come from the savings associated with the net reduction in fuel consumption in thermal plants (after the resulting efficiency losses in the system, and the costs of operations and maintenance of the solar technology). Broadly speaking, the NPV of the benefits should be greater than the cost of the investment, given that today solar energy can be generated at a cost of between 35 and 71 dollars per MWh, [55] which is less than 115 dollars per MWh. that thermal generation costs in 2018.

Quantifying the potential savings in the system from the introduction of solar technology requires a series of assumptions. First, according to the latest NREL[56] study, the installed capacity is assumed to be 40 MW with an efficiency of 16.0%, giving an effective capacity of 6.4 MW. Large PV systems were not considered due to potential curtailment and loss of thermal efficiency. Second, it is assumed that the capital investment associated with solar energy is $900 per kWh and that the annual operations and maintenance cost is $13 per kW per year, based on the references and projections indicated on the website of the NREL[57] for large-scale solar power. Third, it is assumed that the Iquitos electrical system uses all solar energy (that is, that the panels are integrated with 0% curtailment or waste), but that they do generate thermal efficiency losses in the Genrent plant. These losses are related to the fact that Genrent's generators would have to increase or decrease their power more frequently to adapt to fluctuations in solar generation, which is a variable energy source. In the base scenario, the efficiency losses are 5%,[58] which means that each MWh of energy that Genrent generates would use 5% more fuel. Implicit in this assumption is the adoption of technologies to mitigate thermal efficiency losses, such as dynamic optimization systems or batteries, which we discuss in greater detail in this section. Finally, the prices per barrel of Brent oil were obtained according to the futures curve of the Chicago Mercantile Exchange (then it remains fixed in real terms), which increases from its current level to $43.35/bbl in 2021 and $52.67/bbl in 2027. In addition, two additional scenarios were considered in which the oil price rises or fall $15 per barrel above or below the base case.

[55] This data refers to the 5th and 95th percentile of the solar energy generation auctions and database of "Renewable Power Generation Costs in 2019" (2020).
[56] Brancucci et al. (2020).
[57] "Utility-Scale PV" (n.d.).
[58] Based on consultations with energy experts from the Growth Lab.

The introduction of solar energy generates an initial fixed cost and then a series of savings over time. These flows can be summarized by calculating their net present value (NPV) and internal rate of return (IRR). The base scenario of thermal efficiency losses (5%) and with the projection of oil prices implicit in the futures curve can be seen in Figure 33.

Figure 31. Net Flow of Solar Power Installation (base scenario)



The alternative scenarios of efficiency losses and oil prices generate a cash flow schedule that follow the same logic. The NPV and IRR of the cash flows associated with each scenario are summarized in Figure 34 and Figure 35, respectively. In line with the cost of capital for energy projects in Peru, [59] a discount rate of 8% was used for the NPV calculation.

[59] "El Costo Promedio Ponderado del Capital (WACC): Una estimación para los sectores de Minería, Electricidad, Hidrocarburos Líquidos y Gas Natural en el Perú", 2017.

Figure 32. NPV of solar integration according to scenario (discounted at 8%)

Efficiency Loss (%)	Oil Prices (US$ / barrel)		
	Base -$15/bbl	Base	Base +$15/bbl
0.0%	(2,349,397)	8,830,266	20,009,929
2.5%	(6,554,301)	3,324,015	13,202,331
5.0%	(10,759,204)	(2,182,236)	6,394,733
7.5%	(14,964,108)	(7,688,486)	(412,865)
10.0%	(19,169,011)	(13,194,737)	(7,220,463)
12.5%	(23,373,915)	(18,700,988)	(14,028,061)

Figure 33. IRR of solar integration according to scenario

Efficiency Loss (%)	Oil Prices (US$ / barrel)		
	Base -$15/bbl	Base	Base +$15/bbl
0.0%	7%	11%	14%
2.5%	6%	9%	12%
5.0%	4%	7%	10%
7.5%	2%	5%	8%
10.0%	0%	3%	5%
12.5%	-2%	0%	3%

With the current projections of oil prices, the base scenario produces savings with an IRR of 7%, one percentage point below the discount rate of 8%, and therefore has a slightly negative NPV. Several conclusions are derived from this information. First, in the baseline scenario of efficiency losses, solar energy is only profitable if oil prices exceed current projections. Second, it is important to adopt technologies to limit curtailment and thermal efficiency losses, such as systems that optimize thermal production based on weather forecasts or batteries to store solar energy. The introduction of these technologies makes sense from the point of view of the electrical system as long as the net savings they generate (via reductions in fuel consumption) are greater than their costs. If a discount rate of 4% is used, consistent with the MEF recommendation for environmental sustainability projects, the project has an NPV of US$13 million in the base scenario, a difference of US$15 million with the discount rate of 8 %.

The cost of technologies to mitigate curtailment and thermal efficiency losses have been falling. Chemical batteries, for example, are useful for storing electricity when there is a surplus of solar generation and reducing curtailment and have shown potential in rural areas. However, batteries are prohibitively expensive at present, priced at $175 per kWh, although their price has fallen in recent years and the expectation is for that pattern to continue. [60] Although large-scale use of batteries does

[60] For further details, see study of the Massachusetts Institute of Technology (Ziegler et al, 2019).

not make economic sense currently, it could in the medium and long term. In addition, there is a wide range of technologies to limit the electrical oversupply in the system. For Loreto, those that allow dynamic adjustment of thermal generation are relevant to minimize total curtailment losses and thermal efficiency losses. This technology needs to consider both the solar supply and the demand forecasts.

The calculations made here only take into account the private economic benefits of solar energy. Investments could become socially profitable when environmental benefits are considered. Calculations suggest that residual fuel consumption in Iquitos could be reduced by about 2.5 million gallons per year (or 6,800 gallons per day) in the baseline scenario, with a 40 MW photovoltaic system with average thermal efficiency losses of 5%. Iquitos' air quality will be improved by reducing the emissions that must be net-estimated considering the carbon and energy required to manufacture the panels. Taking this into account, even if the NPV of solar integration is negative, it could be socially profitable given the environmental benefits, which opens the possibility for the government, civil society organizations, and environmental organizations to participate in subsidizing the investment. Furthermore, the calculations do not take into account second-round effects such as fuel savings due to changes in the destination and place of oil consumption that would stop using Genrent's generators.

5.3.2 Economic Impact, Savings Split, and Adoption Incentives

The economic impact of incorporating solar energy in Loreto depends on how the savings are divided among the key players. Under certain institutional arrangements where solar energy savings are captured by the Peruvian treasury (or public entities outside of Loreto), there would be no positive economic impact for Loreto beyond the environmental benefit. In other arrangements that allow electricity rates to be lowered or the GOREL budget to be increased, the private or public sector would capture most of the economic benefits. Some stylized scenarios are summarized below, discussing which is the most likely under the current legal framework and what would be needed to promote the most favourable one.

- ***Pro-treasury* scenario**: In this scenario, Electro Oriente captures the savings generated in the electrical system by solar energy, which improves its financial position. However, the off-grid compensation mechanism reduces the monthly transfer to Electro Oriente by an equivalent amount so that Electro Oriente's financial position ends up the same as in the status quo. In net terms, beyond the environmental impact, there is no financial-economic impact for Loreto. Companies and households face the same electricity rates, and GOREL does not have a larger budget to cover current expenses or investments. Only the contributions made by the other electricity companies in the country to the compensation system for isolated systems are

reduced. That being the case, the savings from solar energy are captured by the National Peruvian public sector and not by Loreto directly.

- ***Pro-private*** **scenario**: In this scenario, Electro Oriente captures the savings from solar energy and passes them on to businesses and homes in Loreto through lower electricity rates. In addition, the subsidy of the isolated systems' mechanism does not change, so the net financial position of Electro Oriente remains the same as in the status quo. In the short term, the competitiveness of Loreto companies increases, and Loreto becomes a more attractive place to operate. In the medium term, it could stimulate investment in the region and also the development of new, more energy-intensive economic activities.
- ***Pro-public*** **scenario**: In this scenario, GOREL captures the savings generated in the electrical system from solar energy, which increases its budget to invest or fund current spending. The isolated system mechanism subsidy is unchanged, and the solar energy savings are transferred to GOREL, so Electro Oriente's net financial position remains the same as in the status quo. As discussed in the previous subsection, the NPV of savings is in the order of ~10 million dollars under the set of technical assumptions used, which would increase if oil prices exceed current projections. In any case, although the NPV of savings is modest compared to GOREL's annual budget, it is still a significant amount. In this scenario, the impact on the economic development of Loreto would be limited by the efficiency of spending and investments that GOREL can make.

For Loreto to capture the benefits of solar energy in a scenario such as "pro-private" or "pro-public", GOREL and Electro Oriente will probably have to coordinate with OSINERGMIN and MINEM to modify regulations of the electricity sector. It is convenient to move forward these conversations to understand how feasible each scenario is. A detailed study of the regulation of the Peruvian electricity sector is beyond the scope of this study, but from the regulations, we can observe that the "pro-treasury" scenario is the most likely if a solar energy company were to be installed in Loreto, and probably without major changes to the current legal framework. To prevent this from happening, it will mostly be necessary to modify regulations including the one that governs the compensation mechanism of isolated systems. For this reason, it is convenient to initiate a dialogue with the Ministry and the regulatory agency to understand what legal and contractual arrangements would allow the Loreto private sector or GOREL to benefit from the savings of solar energy. Coordination with key stakeholders in the central government is critical as amending any regulation can follow a slow and complex process.

Regardless of the scenario, Genrent, Electro Oriente, and GOREL must have enough incentives to cooperate for the success of solar energy. For Genrent, integrating solar energy into the energy matrix represents a technical challenge and fixed and variable costs associated with systems to dynamically optimize thermal production and save fuel. Therefore, if the contract with the Peruvian government does not contemplate the contingency of introducing new energy sources into the energy matrix, the company may have to be compensated for changes in the status quo. The integration of

solar energy also represents a technical challenge, investments, and coordination works for Electro Oriente and GOREL. Each entity has its own institutional logic and utility function; however, both have to perceive that the benefits of participating outweigh the costs for solar power to have a better chance of success.

In the medium to long term, savings from installing solar power in Loreto could increase significantly. On the one hand, due to the COVID-19 pandemic, oil prices are below their 20-year average. If oil prices return to their historical averages, fuel savings will become more attractive. Additionally, technological advances are driving down the cost of solar panels and batteries, both of which may become a smaller fraction over time than previous estimates suggested.

5.3.3 Solar Energy in the context of Peru and Loreto

The proposal to integrate solar energy into Loreto's energy matrix would achieve many of the objectives that the Iquitos-Moyobamba transmission line project had without the associated economic and environmental costs. It is estimated that the Iquitos-Moyobamba transmission line, which would connect the regional capital with the SEIN, would cost between 500 and 600 million dollars and would extend for 588 km through primary forests in the Amazon [61] [62]. The line, if built, would supply Iquitos (which already has thermal electricity from Genrent generators) and would have a limited impact on the rest of the department's urban agglomerations that are disconnected and isolated from the capital. The benefits of the line would be received mainly by Iquitos, as pollution from Genrent generators will reduce, which would become a cold reserve, and possibly due to reduced electricity rates (although they are already quite in line with the rest of the country, thanks to the subsidy). Most likely, the reduction in subsidies to the EPS Electro Oriente (~US$30 million per year, at 2018 fuel prices) would not compensate for the economic cost of the investment (and even less so with the recent drop in fuel prices), nor because of the enormous environmental costs. The proposal to add solar energy to the Iquitos energy matrix fulfils the same objective of reducing pollution from Genrent's thermal generators (although to a lesser extent) and also has the potential to reduce the subsidy, lower the cost of electricity for households and businesses or create fiscal space for GOREL, as long as the savings from the new technology are distributed accordingly.

A series of practical details remain to be fine-tuned to develop the proposal. For example, the proposal to install solar energy in an isolated system would have to be grounded in the country's electrical legal and regulatory framework, which is not covered in the report. The roles of the various levels of national, regional, and municipal government, and the various agencies and institutions involved, would also need to be clarified.

[61] https://www.osinergmin.gob.pe/seccion/centro_documental/electricidad/Documentos/PROYECTOS%20GFE/Acorde%C3%B3n/Transmisi%C3%B3n/2.2.2.pdf

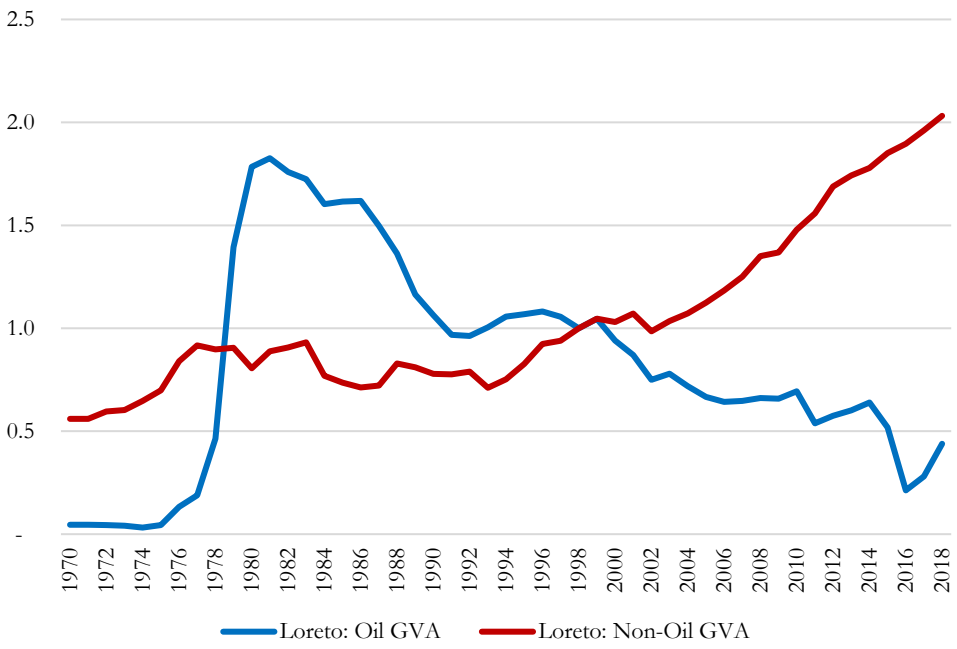
[62] https://www.proyectosapp.pe/modulos/JER/PlantillaProyecto.aspx?ARE=0&PFL=2&JER=5583

6. LORETO'S OIL SECTOR

The oil sector has played a central role in Loreto's economic history and should be considered in any discussion of the region's development. By the end of the1970s, Loreto's economic structure changed dramatically, triggered by a boom in oil extraction. The sector went from being a relatively small activity to representing more than 70% of the region's gross value added, bringing with it a wave of companies and workers, changing the region's power relations. After this initial acceleration, oil production continuously fell during the 1980s, giving way to other economic activities in the region. However, although the role of oil has been dramatically reduced, its extraction continues to be part of the region's future and its imaginary.

Since the production boom of the late 1970s, Loreto's oil activity has declined steadily. According to INEI statistics, activity in this sector surged sharply in the late 1970s, from representing 6% of total GVA in 1970 to 62% in 1980. Since then, it has been falling steadily for almost four decades, reducing its contribution to GVA both in absolute and relative terms (Figure 36). For 2018, the last year with complete data, oil represents just 18% of GVA at current prices.

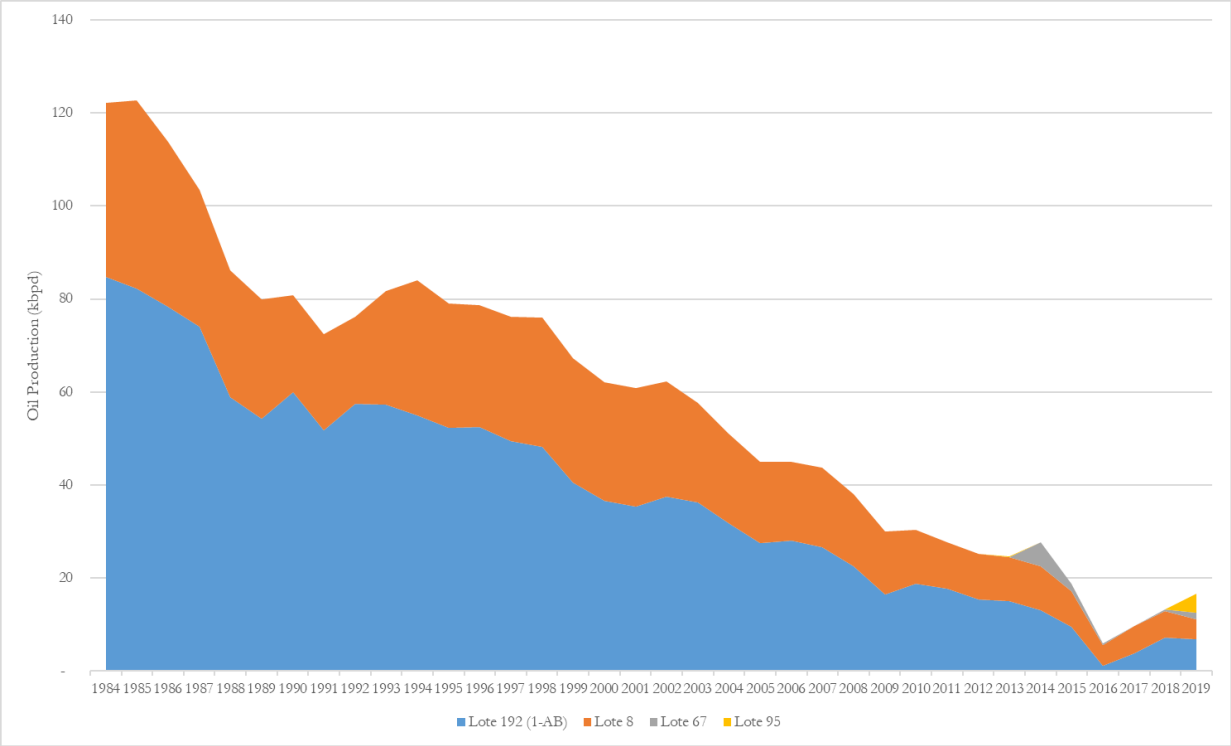
Figure 34.Growth of the oil sector and non-oil economy (1998=1)



Source: INEI, prepared by the authors.

Oil production per well data shows an even more dramatic drop than the GVA data. According to disaggregated figures from PeruPetro, [63] total production has fallen from more than 120,000 barrels per day (kbpd) in 1984 to less than 20,000 in 2019. As Figure 37 highlights, the production of lot 192, [64] the flagship lot of Loreto, has fallen from 85 kbpd in 1984 to just 7 kbpd in 2019; a drop of 92% in 35 years. In that same period, lot 8 production declined by a similar magnitude (88%), going from producing 38 kbpd in 1984 to just 4 kbpd in 2019. The increase in production in lots 67 and 95 has been minuscule in contrast with these colossal falls, with which the whole of total production has collapsed.

Figure 35.Oil production per oil well (Lote) in Loreto



Source: PeruPetro, prepared by the authors

Loreto's particular characteristics makes oil production very expensive. To extract and transport crude oil, operators must transport equipment and personnel to Iquitos and from there to their lots. This takes a few days by boat from the city and a few hours by helicopter. The different lots must transfer the production to the stations of the North Peruvian pipeline, which covers the distance of 1,106 kilometers to the Bayóvar terminal in Piura. These transfers can be more or less precarious depending on the location of the lot, and in most cases require the use of barges. Operations are subject to disruptions due to a number of "force majeure" events such as the National Emergency

[63] Only available from 1984.
[64] Previously known as lot 1-AB.

Order (Covid19 case), climate change, sabotage of operations, and disruption of pipeline services. During the stoppage of pipeline operations that occurred between 2016 and 2017, the crude that was produced had to be transferred by barge and truck to the Bayóvar station, which made production significantly more expensive and reduced it by an average of between 6 and 10 kbpd in both years. Production costs have also increased due to the modernization of environmental standards, which are now stricter than in the 1970s when Loreto's oil exploitation began. To the extent that some negative externalities of production have been internalized and mechanisms have been implemented to mitigate the risks associated with production and transportation, production in the forest has become more risky and costly. This means that oil extraction in Loreto has characteristics and costs more similar to those of offshore production than traditional extraction.

In addition to geographic challenges, the Loreto operation is subject to various coordination failures. These alignment errors occur in situations where multiple inputs are required at the same time, leading to a kind of chicken-and-egg dilemma. Take, for example, the North Peruvian pipeline. Built between 1972 and 1976, this massive infrastructure can move over 100,000 barrels per hour. It has nine pumping stations scattered along its 1,106 kilometers, which require a significant amount of labor for its operation. Since 2015, Loreto has failed to produce more than twenty thousand barrels per day. These volumes can be handled using the pipeline just 2-3 days a month, which is why it has been necessary to raise rates – which can reach up to 7 dollars per barrel – to cover the fixed costs of the operation. Thus, declining production combined with high fixed costs in pipelines has created a vicious circle of increasingly higher rates per barrel transported, resulting in less profitable oil extraction.

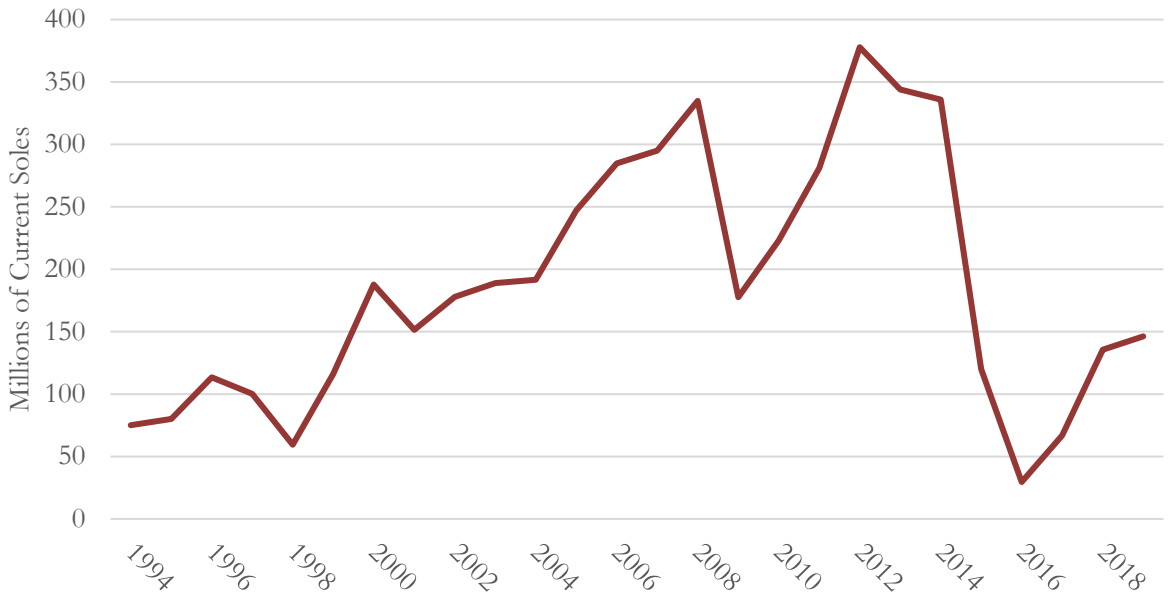
There are also synergies and complementarities – subject to coordination failures – between the production of different types of crude in Loreto. Light and medium crudes are used as diluents to facilitate the transport of heavy and extra-heavy crudes. In the absence of light production, heavy lots need to import and transfer to Loreto other diluents, which also makes the operation more expensive. At Loreto, specifically, the inability to produce light crudes from lot 67 has harmed the production of heavier crudes in lot 192.

The existence of negative externalities associated with environmental risks and the prevalence of coordination failures require a more active participation of the State to promote the sustainable development of the oil sector in Loreto. Institutional weakness in the area of intervention, regulation, and supervision of the oil industry were the main restriction to investment and growth that emerged in our interviews with concessionaires in the region. The 35-year decline in production suggests that there are other structural factors constraining these capacities. The institutional inertia, in addition to a more and more complex environment, seem to have contributed to this decline.

Oil activity has the potential to provide the financial resources required to improve the provision of public goods, and actively contribute to the development of new industries and structural transformation. The oil royalty and *sobre-canon* royalty are the main links between the oil

sector and the rest of the Loreto economy since they allow Loreto to retain 50% of the income tax and 18.75% of the value of the production of the oil companies that operate in the region. The royalty is a mechanism used in Peru to allows departments with extractive activities (mainly mining and oil) to benefit directly from the exploitation of these resources. In Loreto, the proceeds must be used for investment and are divided between the regional government (52% of total resources), local governments (42% of total), national universities (5%), and the Amazonian research institute (3%).[65] As Figure 38 shows, a combination of sustained drops in production and falling prices that have occurred since 2014 have reduced the income from royalties that Loreto receives Total transfers reached a maximum of 377 million Soles in 2012, and the part corresponding to GOREL represented more than 16% of its budget of 1,285 million Soles. For 2019, the total transfer was less than 150 million soles, just 5% of its annual budget (1,594 million soles).

Figure 36.Transfers of oil canon and oil sobre-canon



Source: PeruPetro, prepared by the authors

The low equilibrium levels reached by current production contrast with Loreto's oil potential. The drop in oil production in Loreto is a consequence of the aforementioned institutional factors; it does not result from the depletion of reserves. According to MINEM estimates in lots 8, 64, 67, 95, and 192, there are 74 million barrels of developed reserves (ten years of production at 20 kbpd) and another 87 million barrels of proven undeveloped reserves (twelve years at 20 kbpd). Additionally, there are 42 million barrels of probable reserves and 208 million barrels of possible reserves. Thus,

[65] "Transferencias por Tipo de Canon, Regalías, Participaciones y Otros" (2019).

data suggest that there are reserves to sustain PeruPetro's plans, which contemplate production levels in the medium term between two and three times higher than the current ones. The challenge is to develop the institutional capacity required to resolve coordination failures, promote an agreement that benefits the sectors involved (concessionaires, native communities, environmental organizations, and different levels of government), regulate and supervise in a way that guarantees that the operation will be carried out within the agreed conditions and limits.

The extraction of natural gas in Camisea shows that the Peruvian government can manage hydrocarbon operations in the jungle with relative success. The Camisea deposits, in the department of Cusco, have several trillion cubic feet of natural gas and were discovered in 1986 by the Dutch company Shell. The deposits are in the heart of the Amazon, near several native communities, in an area of enormous biodiversity. In 2004, they began production with a Pluspetrol consortium and five other oil companies, with investments totaling at least four billion dollars to date. The gas they produce is used for 40% of the country's electricity[66]. Although the extraction of natural gas in Cusco has brought frequent social and environmental problems, [67,68] these are less intense than those registered in Loreto.

Although Camisea is an example of the results that can be obtained in the hydrocarbon sector when there is institutional will and capacity, the challenges of the oil operation in Loreto are more complex. Loreto drags a legacy of environmental damage and deteriorating relations with native communities, which contributes in preventing the longer-term agreements. In addition, the profitability of the exploitation of the resource in Loreto is lower. The deposits contain smaller volumes of hydrocarbons and are in more remote places, which makes the state's task as a governing and regulatory entity more complex. Finally, there are environmental risks derived from the exploitation of the resource that bring with them many negative externalities. The environmental services of the Amazon rainforest are very significant and attract a lot of international attention, resulting in greater involvement of environmental organizations in the area. All of this introduces greater complexities and challenges when it comes to resolving coordination failures and promoting an agreement that protects the interests of a broader and more active range of stakeholders.

[66] Fernandez (2019).

[67] "Camisea: Comunidades indígenas rompen diálogo con TGP y amenazan con bloqueos" (2018).

[68] "Pluspetrol afronta quejas de indígenas ante el gobierno de Holanda" (2020).

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APPENDIX

1. Phases of Prioritization by Thematic Area and Industry

***Figure 37.** Thematic and sub-thematic prioritization activities, by phases*

Área temática	Sub-área temática	Industria	Fase 0	Fase 1	Fase 2	Fase 3
Actividades forestales, ambientales, flora y fauna	Industrias Maderera y de Papel	Manufactura de todos los demás productos de papel			X	
		Viveros				
		Corte y cepillado de madera (aserraderos)		X		
		Armarios, gabinetes y mostradores de cocina (madera)				X
		Actividades de soporte al sector forestal				
	Actividades Piscícolas	Acuicultura				
		Pesca			X	
		Piscicultura y crianza de peces				
	Floricultura y cultivo de frutos	Floricultura				
		Cultivo de frutas y frutos secos				
	Servicios de soporte Ambiental	Topografía y servicios de cartografía			X	
		Consultoría ambiental			X	
Industrias alimentarias y químicas	Manufactura de materiales	Manufactura de plásticos y resina				X
		Manufactura de pinturas			X	
		Manufactura de jabones y otros detergentes			X	
	Industrias alimentarias	Manufactura de bebidas no-alcohólicas	X			
		Enlatados de frutas y verduras			X	
		Manufactura de pasta y derivados de harina			X	
		Refinación de aceites vegetales			X	
		Manufactura de galletas		X		
		Destilerías	X			
		Manufactura de cereales			X	
	Industrias químicas	Manufactura de todos los demás productos químicos-orgánicos				X
		Manufactura de productos medicinales y botánicos		X		
		Manufactura de todos los demás productos químicos-inorgánicos				

Área temática	Sub-área temática	Industria	Fase 0	Fase 1	Fase 2	Fase 3
Manufactura y servicios de transporte	Servicios de almacenamiento	Almacenamiento y depósitos				X
		Almacenamiento y depósitos para productos agrícolas				X
		Otros tipos de almacenamiento y depósitos				X
	Manufactura y reparaciones del sector transporte	Manufactura de motores y generadores	X			
		Construcción y reparación de barcos			X	
		Manufactura de partes para motocicletas y bicicletas	X			
	Servicios de transporte	Servicios de carga marítima		X		
		Empacado y embalaje				X
		Navegación interna y transporte de pasajeros				
		Navegación interna y transporte de mercancías				
Manufactura para la construcción	Manufactura para la construcción	Fabricación de vidrio				X
		Concreto premezclado			X	
		Manufactura de todos los demás productos minerales no-metálicos			X	
		Fabricación de arcilla refractaria			X	
		Fabricación de accesorios de cerámica, porcelana, y plomería			X	
		Manufactura de otros productos de concreto			X	
		Bloques de concreto y ladrillos			X	
Turismo e industrias creativas	Servicios Turísticos	Todos los demás servicios de hotelería			X	
		Operadores turísticos			X	
		Restaurantes			X	
		Todos los demás servicios de viaje y reservaciones	X			
		Agencias de viaje			X	
		Hostales y/o Posadas				X
	Atracciones Turísticas	Parques naturales y similares				X
		Campamentos recreacionales y de vacación				X
		Servicios de paisajismo			X	
		Sitios históricos				X
		Zoológicos y jardines botánicos				X
	Industrias Creativas	Fotografía comercial			X	
		Producción de cinematografía y video			X	

2. Environmental Analysis of Forest Legislation in Loreto

Peru has developed a legal and regulatory framework in environmental matters that considers aspects of natural resource management and sustainable development defined at various legislation levels. This framework is based on the Political Constitution of Peru (1993), [69] which promotes the sustainable use of its natural resources and indicates the obligation to conserve biological diversity and protected natural areas. In the forestry field, the National Environmental Policy (2009) [70] highlights the importance of forests in the country, including their role in mitigating and adapting to climate change. This policy contains specific guidelines referring to promoting the sustainable and integrated management of forests, preventing the reduction and degradation of forests and their resources, conserving and increasing forest areas considering aspects of biodiversity and environmental services, strengthening control and surveillance with the community and citizen participation, and preventing deforestation of natural forests.

The Law for the Sustainable Use of Natural Resources (1997) [71] defines the conditions for the sustainable use of natural resources, considering the renewal capacity of these resources and avoiding their overexploitation. This law derives in the Forest and Wildlife Law (2011, coming into force in 2015), [72] which aims to promote the conservation, protection, increase, and sustainable use of forest heritage and wildlife. This law is complemented by four regulations: (i) Forest Management Regulation, which establishes the provisions that regulate, promote, and supervise forestry activity in the country; (ii) the Regulations for the Management of Wild Fauna; (iii) the Regulation for the Management of Forest Plantations and Agroforestry Systems; and (iv) the Regulations for Forest and Wild Fauna Management in Native Communities and Peasant Communities. A detailed presentation of this legal and regulatory framework is included in the Forest and Wildlife Regulations (SERFOR, 2019). A report by Videnza Consultores (2019) [73] presents an account of this legislative and regulatory framework, highlighting that in practice it is the regulations contained in the Forestry and Wildlife Law (Law No. 29763) that defines operationally (through its regulations) the specific legal provisions that regulate, promote and supervise forestry activity.

From a conceptual point of view, the legal and regulatory framework that governs the forestry sector in Peru is adequately structured to include the relevant environmental aspects of the activity. There is a clear division of responsibilities at the three levels of government (national, departmental, and municipal). This goes hand in hand with a definition of the competencies of the different institutions, e.g., ministries, agencies, and public institutions of the three levels of

[69] "Constitución del Perú 1993" (n.d.), Arts. 66-69.
[70] "Política Nacional del Ambiente" (2009).
[71] "Ley Orgánica para el aprovechamiento sostenible de los recursos naturales" (n.d.).
[72] "Ley No. 29763: Ley Forestal y de Fauna Silvestre" (2015).
[73] "Asistencia técnica para el análisis del funcionamiento de las concesiones forestales maderables desde la perspectiva económica" (2019).

government, including the agencies attached to them with related competencies and the Forest and Wildlife Management Committees (CGFFS, by its acronym in Spanish). Among the members of the National Forest and Wildlife Management System (SINAFOR, by its acronym in Spanish), created in 2016, there are entities such as the Ministry of Agriculture and Irrigation (MINAGRI), the Ministry of Environment (MINAM), the Ministry of Economy and Finance (MEF), the Supervisory Board of Forest and Wildlife Resources (OSINFOR, by its acronym in Spanish), the Forest and Wildlife Service (SERFOR, by its acronym in Spanish), regional and local governments, among others.

However, the practical implementation of these laws and regulations largely depends on the capacity of the State. In particular, for the monitoring of environmental variables in the sector's activities, the collection and analysis of data related to these variables, and the establishment of adaptive management and planning mechanisms in the sector that respond to these analyses. Several observations are worth highlighting when evaluating national forest laws from an environmental perspective. These observations are based on the following forest management principles described in the SERFOR publication (2019): [74]

- *Forest governance*: harmonization of policies, institutional strengthening, regulations, participation of diverse actors, legal certainty, transparency and accountability. To satisfy this principle, it is necessary to obtain and analyze data on forest coverage, and its spatial and temporal changes, as well as its wide and transparent dissemination.

- *Intersectoral approach*: intersectoral, interinstitutional and interdisciplinary coordination and cooperation. To satisfy this principle, there must be tools for analysis and decision-making support that draw on the data and environmental analyzes described in the previous observation, and that incorporate this intersectoral aspect of forest management.

- *Sustainability in the use of forest heritage*: integrating the economic, social and environmental dimensions. To satisfy this principle, it is necessary to explicitly consider environmental variables in the analysis and decision-making processes in the economic and social spheres, particularly in terms of resource distribution and both public and private investments.

- *Ecosystem approach*: compatibility with the framework of the Convention on Biological Diversity understood as a strategy for the integrated management of land, water, and living resources, which promotes conservation and sustainable use in an equitable manner. To satisfy this principle, it is necessary to invest in science, technology, and knowledge to understand and manage forest ecosystems and other ecosystems of wild vegetation. For example, it is necessary to delve into obtaining and disseminating information about wild ecosystems as living space, wildlife habitat, and water source, as well as their contribution to the food security and well-being of the population that depends on them.

[74] "Normativa Forestal y de Fauna Silvestre" (2019).

- *Competitiveness and productivity*: promote the diversification of forest goods and services, through management, industrial transformation, conservation and ecotourism. It must tend to achieve greater profitability and benefit distribution, high productivity levels with high-quality values added in the national and international market. To satisfy this principle, emphasis should be placed on the development of environmentally sustainable production chains, from the forest to the final destination of the products. This can be achieved through the certification of good practices, such as tools that guarantee the origin of forest and wildlife products, as well as the sustainability of their use.

Policy Recommendations

For Loreto in particular, a series of policy recommendations can be derived by leveraging the existing legal and regulatory framework with opportunities for improvement in the implementation of environmental actions in the forestry sector in Peru.

(1) **Forest Management:** The development of forest production systems must be based on forest management based on orderly, transparent, and competitive access to forest resources through the modalities and mechanisms governed by existing laws, relying on state-of-the-art monitoring systems, such as remote sensing, using open data and platforms accessible to all stakeholders in the sector.

(2) **Investment in human capital**: The environmental management of forest resources at all levels of government must seek the institutional, professional, economic, and logistical conditions necessary to effectively fulfill the normative, regulatory, and supervisory functions contemplated in the current legal framework regulations. In particular, investment should be made in the training of professional personnel in environmental matters that form part of the public forestry career.

(3) **Compatibility with global processes focused on the environment and biodiversity**: The implementation of the criteria for the conservation of biodiversity, water resources and soils that already exist should be actively promoted in the current legal and regulatory framework in the management of the forestry sector, and its corresponding updates through new global knowledge trends such as the Convention on Biological Diversity (CBD 2.0[75] and Aichi targets) [76], climate change mitigation (REDD) [77], and Nature-based Solutions (NbS) [78]. This may lead to a diversification of economic opportunities for the sector beyond the production and marketing of wood products.

[75] CBD 2.0: https://www.cbd.int/forest/
[76] Aichi Targets: https://www.cbd.int/sp/targets/
[77] REDD: http://www.fao.org/redd/en/
[78] Cohen-Shacham et al. (2016).

(4) **Preventive and punitive role of the state**: To reduce the environmental degradation of Loreto's Forest ecosystems, the focus should be on preventive control and the sanction of illegal logging and trade, as well as the trafficking of flora and fauna species, paying attention to actors traditionally excluded from access to forest resources who are engaged in informal and/or illegal activities. To this end, methods of environmentally sustainable use must be created within their reach, traceability mechanisms for forest products to identify and sanction those of illegal origin, and control and surveillance systems with the participation of the same actors.

(5) **Innovation in business models**: The development of productive systems and environmentally sustainable forestry and agroforestry business models that are oriented towards increasing the value of ecosystem goods and services, with highly efficient production chains, should be encouraged and supported. These systems must guarantee the legal origin of the products and the best practices of sustainable forest management, for the supply of environmental products and services from the forests.

(6) **Technological development**: Research and technological development, management of scientific and traditional knowledge, innovation, extension, and education must be promoted as strategic supports to promote forestry development in Loreto in an environmentally sustainable way. To this end, industrial, academic and governmental actors should be involved in an integrated manner.

3. Standardized Metric for Prioritizing Industries

3.1. *Viability Axis*

Thematic Area	Industry	Missing inputs	Existence in comparable	Intensity in electricity	Propensity to export by air	Aggregate
Tourism and creative industries	Travel Agencies	10.00	9.09	9.79	10.00	38.88
Forestry, environmental, flora and fauna activities	Fruits and tree nut farming	8.89	10.00	9.04	10.00	37.93
Manufacturing and transportation services	Inland Water Freight Transportation	7.78	10.00	10.00	10.00	37.78
Tourism and creative industries	Tour operators	10.00	7.27	9.79	10.00	37.06
Forestry, environmental, flora and fauna activities	Support Activities for Forestry	7.78	8.18	9.88	10.00	35.84
Tourism and creative industries	Zoos and Botanical Gardens	8.89	8.18	8.47	10.00	35.54
Forestry, environmental, flora and fauna activities	Finfish Farming and Fish Hatcheries	8.89	6.36	9.56	10.00	34.81
Tourism and creative industries	All Other Travel Arrangement and Reservation Services	10.00	4.55	9.79	10.00	34.33
Manufacturing and transportation services	Inland Water Passenger Transportation	7.78	6.36	10.00	10.00	34.14
Forestry, environmental, flora and fauna activities	Nursery and Tree Production	7.78	6.36	9.85	9.46	33.45
Tourism and creative industries	Motion Picture and Video Production	7.78	5.45	9.67	10.00	32.90
Tourism and creative industries	Full-Service Restaurants	4.44	10.00	7.64	10.00	32.09
Forestry, environmental, flora and fauna activities	Other Aquaculture	8.89	2.73	9.56	10.00	31.18
Forestry, environmental, flora and fauna activities	Environmental Consulting Services	10.00	0.91	9.97	10.00	30.88
Food and chemical industries	Cookie and Cracker Manufacturing	8.89	2.73	9.21	10.00	30.83
Tourism and creative industries	Commercial Photography	7.78	3.64	9.31	10.00	30.73
Forestry, environmental, flora and fauna activities	Surveying and Mapping (except Geophysical) Services	3.33	6.36	9.64	10.00	29.33
Forestry, environmental, flora and fauna activities	Floriculture Production	7.78	0.91	9.85	10.00	28.54
Forestry, environmental, flora and fauna activities	Finfish Fishing	7.78	10.00	9.47	0.31	27.55
Tourism and creative industries	Historical Sites	8.89	0.00	8.47	10.00	27.36
Tourism and creative industries	Nature Parks and Other Similar Institutions	8.89	0.00	8.47	10.00	27.36

Food and chemical industries	Distilleries	10.00	7.27	9.70	0.11	27.08
Forestry, environmental, flora and fauna activities	Cut Stock, Resawing Lumber, and Planing	7.78	0.00	8.82	10.00	26.60
Construction manufacturing	All Other Miscellaneous Nonmetallic Mineral Product Manufacturing	8.89	6.36	9.03	1.59	25.88
Manufacturing and transportation services	Motor and Generator Manufacturing	7.78	6.36	9.72	1.99	25.85
Food and chemical industries	Soft Drinks Manufacturing	7.78	9.09	8.95	0.00	25.82
Manufacturing and transportation services	Motorcycle, Bicycle, and Parts Manufacturing	8.89	4.55	9.83	1.62	24.89
Manufacturing and transportation services	Marine Cargo Handling	2.22	2.73	9.74	10.00	24.69
Food and chemical industries	Medicinal and Botanical Manufacturing	5.56	4.55	9.09	4.80	23.99
Tourism and creative industries	Landscaping Services	1.11	2.73	9.76	10.00	23.60
Food and chemical industries	All Other Basic Organic Chemical Manufacturing	3.33	9.09	8.59	2.43	23.44
Manufacturing and transportation services	General Warehousing and Storage	6.67	6.36	0.00	10.00	23.03
Food and chemical industries	Fruit and Vegetable Canning	6.67	6.36	9.35	0.09	22.47
Food and chemical industries	Fats and Oils Refining and Blending	6.67	5.45	9.81	0.31	22.24
Manufacturing and transportation services	Packing and Crating	2.22	0.00	9.74	10.00	21.96
Forestry, environmental, flora and fauna activities	Lumber Industry	10.00	1.82	9.99	0.09	21.89
Food and chemical industries	Dry Pasta, Dough, and Flour Mixes Manufacturing from Purchased Flour	8.89	3.64	9.21	0.01	21.75
Construction manufacturing	Pottery, Ceramics, and Plumbing Fixture Manufacturing	5.56	6.36	8.11	1.52	21.55
Construction manufacturing	Clay Building Material and Refractories Manufacturing	5.56	7.27	8.11	0.28	21.22
Construction manufacturing	Concrete Block and Brick Manufacturing	5.56	6.36	9.07	0.07	21.06
Forestry, environmental, flora, and fauna activities	Wood Kitchen Cabinet and Countertop Manufacturing	8.89	2.73	9.21	0.10	20.92
Forestry, environmental, flora, and fauna activities	All Other Converted Paper Product Manufacturing	6.67	5.45	8.34	0.40	20.87
Construction Manufacturing	Ready-mix Concrete Manufacturing	7.78	3.64	9.38	0.02	20.82
Food and chemical industries	Paint and Coating Manufacturing	5.56	4.55	9.45	1.25	20.80
Food and chemical industries	Soap and Other Detergent Manufacturing	5.56	4.55	9.48	0.45	20.03
Food and chemical industries	Plastic Material and Resin Manufacturing	6.67	4.55	8.06	0.70	19.98
Construction Manufacturing	Other Concrete Product Manufacturing	5.00	5.45	9.31	0.21	19.97

Tourism and creative industries	Bed-and-Breakfast Inns	2.22	0.00	7.31	10.00	19.53
Tourism and creative industries	All Other Traveler Accommodation	2.22	0.00	7.31	10.00	19.53
Tourism and creative industries	Recreational and Vacation Camps (except Campgrounds)	2.22	0.00	7.31	10.00	19.53
Manufacturing and transportation services	Other Warehousing and Storage	6.67	2.73	0.00	10.00	19.39
Manufacturing and transportation services	Ship Building and Repairing	4.44	3.64	9.47	0.70	18.25
Construction Manufacturing	Glass Product Manufacturing Made of Purchased Glass	4.44	3.64	6.18	3.56	17.82
Food and chemical industries	Breakfast Cereal Manufacturing	7.78	0.00	9.28	0.01	17.06
Manufacturing and transportation services	Farm Product Warehousing and Storage	6.67	0.00	0.00	10.00	16.67
Food and chemical industries	Other Basic Inorganic Chemical Manufacturing	7.78	1.82	3.99	1.27	14.86

3.2. *Attractiveness Axis*

Thematic Area	Industry	Potential to attract IED	Potential to attract IED in LATAM	Propensity o to export	Propensity to create jobs	Aggregate
Food and chemical industries	Other Basic Inorganic Chemical Manufacturing	10.00	6.18	5.88	5.51	27.56
Food and chemical industries	All Other Basic Organic Chemical Manufacturing	6.53	4.04	8.62	5.43	24.62
Manufacturing and transportation services	Ship Building and Repairing	1.18	0.96	7.85	10.00	19.99
Manufacturing and transportation services	General Warehousing and Storage	5.08	9.13	2.49	1.38	18.07
Food and chemical industries	Breakfast Cereal Manufacturing	0.21	0.43	7.78	8.99	17.42
Food and chemical industries	Soft Drinks Manufacturing	1.82	5.47	2.77	6.82	16.87
Food and chemical industries	Fruit and Vegetable Canning	0.47	0.66	10.00	4.54	15.67
Food and chemical industries	Distilleries	2.45	10.00	2.19	0.97	15.62
Food and chemical industries	Paint and Coating Manufacturing	5.43	3.21	3.56	2.63	14.82
Food and chemical industries	Plastic Material and Resin Manufacturing	0.26	0.11	5.56	7.04	12.97
Food and chemical industries	Cookie and Cracker Manufacturing	0.11	0.09	4.99	7.47	12.67
Manufacturing and transportation services	Motor and Generator Manufacturing	0.36	0.27	6.35	5.16	12.13

Food and chemical industries	Medicinal and Botanical Manufacturing	1.18	0.61	6.39	2.53	10.71
Manufacturing and transportation services	Motorcycle, Bicycle, and Parts Manufacturing	0.93	0.66	7.57	1.08	10.24
Forestry, environmental, flora, and fauna activities	Cut Stock, Resawing Lumber, and Planing	0.06	0.04	7.56	2.27	9.92
Tourism and creative industries	All Other Traveler Accommodation	4.41	4.75	0.09	0.54	9.80
Forestry, environmental, flora, and fauna activities	All Other Converted Paper Product Manufacturing	0.51	0.86	4.62	3.72	9.70
Food and chemical industries	Soap and Other Detergent Manufacturing	0.04	0.04	6.55	2.98	9.61
Construction Manufacturing	Glass Product Manufacturing Made of Purchased Glass	1.03	1.25	4.76	2.48	9.52
Construction manufacturing	Pottery, Ceramics, and Plumbing Fixture Manufacturing	0.21	0.12	6.58	1.60	8.52
Construction manufacturing	Other Concrete Product Manufacturing	1.91	1.88	1.83	2.61	8.22
Manufacturing and transportation services	Other Warehousing and Storage	2.41	4.34	0.72	0.70	8.16
Construction manufacturing	Clay Building Material and Refractories Manufacturing	0.42	0.24	4.21	3.11	7.98
Food and chemical industries	Fats and Oils Refining and Blending	0.34	0.69	4.60	1.73	7.36
Forestry, environmental, flora and fauna activities	Floriculture Production	0.01	0.04	6.11	0.76	6.92
Food and chemical industries	Dry Pasta, Dough, and Flour Mixes Manufacturing from Purchased Flour	0.09	0.07	4.52	2.13	6.81
Manufacturing and transportation services	Marine Cargo Handling	0.00	0.01	3.22	2.99	6.22
Manufacturing and transportation services	Farm Product Warehousing and Storage	1.65	2.99	0.35	1.06	6.05
Tourism and creative industries	All Other Travel Arrangement and Reservation Services	0.02	0.04	3.98	1.76	5.80
Forestry, environmental, flora and fauna activities	Wood Kitchen Cabinet and Countertop Manufacturing	0.08	0.07	4.63	0.71	5.50
Construction manufacturing	Concrete Block and Brick Manufacturing	0.93	0.92	1.04	2.60	5.49
Construction manufacturing	Ready-mix Concrete Manufacturing	1.41	1.38	0.51	2.15	5.46
Construction manufacturing	All Other Miscellaneous Nonmetallic Mineral Product Manufacturing	0.19	0.33	2.69	1.90	5.10
Manufacturing and transportation services	Inland Water Freight Transportation	0.78	0.42	1.74	1.99	4.93
Tourism and creative industries	Bed-and-Breakfast Inns	2.11	2.28	0.15	0.38	4.92
Forestry, environmental, flora and fauna activities	Finfish Fishing	0.00	0.03	4.13	0.46	4.63

Tourism and creative industries	Travel Agencies	0.18	0.24	2.64	0.37	3.44
Forestry, environmental, flora and fauna activities	Lumber Industry	0.10	0.39	2.51	0.41	3.42
Forestry, environmental, flora and fauna activities	Finfish Farming and Fish Hatcheries	0.02	0.03	2.63	0.52	3.20
Manufacturing and transportation services	Inland Water Passenger Transportation	0.29	0.16	0.75	1.76	2.96
Forestry, environmental, flora and fauna activities	Nursery and Tree Production	0.10	0.21	1.85	0.76	2.92
Tourism and creative industries	Recreational and Vacation Camps (except Campgrounds)	0.66	0.71	0.29	0.96	2.62
Tourism and creative industries	Zoos and Botanical Gardens	0.04	0.00	0.67	1.47	2.18
Forestry, environmental, flora and fauna activities	Fruit and Tree Nut Farming	0.03	0.09	1.95	0.10	2.17
Manufacturing and transportation services	Packing and Crating	0.01	0.01	0.39	1.75	2.16
Tourism and creative industries	Motion Picture and Video Production	0.24	0.13	1.31	0.38	2.05
Forestry, environmental, flora and fauna activities	Other Aquaculture	0.05	0.06	1.32	0.39	1.81
Tourism and creative industries	Full-Service Restaurants	0.09	0.05	0.00	1.44	1.58
Forestry, environmental, flora and fauna activities	Environmental Consulting Services	0.07	0.02	0.87	0.59	1.55
Forestry, environmental, flora and fauna activities	Support Activities for Forestry	0.10	0.21	0.60	0.45	1.35
Tourism and creative industries	Tour operators	0.06	0.09	0.57	0.34	1.05
Tourism and creative industries	Nature Parks and Other Similar Institutions	0.04	0.00	0.80	0.18	1.02
Forestry, environmental, flora and fauna activities	Surveying and Mapping (except Geophysical) Services	0.02	0.01	0.44	0.52	0.99
Tourism and creative industries	Landscaping Services	0.25	0.06	0.09	0.20	0.60
Tourism and creative industries	Historical Sites	0.04	0.00	0.06	0.38	0.48
Tourism and creative industries	Commercial Photography	0.06	0.02	0.21	0.00	0.28

3.3. *Environmental Axis*

Thematic Area	Industry	Ecological Pollution by toxins	Detriment to aquatic biodiversity	Greenhouse Gas Emission	Air Pollution by toxins	Intensity in the land use	Aggregate
Forestry, environmental, flora and fauna activities	Surveying and Mapping (except Geophysical) Services	2.00	2.00	2.00	2.00	2.00	2.00

Forestry, environmental, flora and fauna activities	Environmental Consulting Services	2.00	2.00	2.00	2.00	2.00	2.00
Food and chemical industries	Soft Drinks Manufacturing	2.00	2.00	2.00	2.00	2.00	2.00
Manufacturing and transportation services	Motorcycle, Bicycle, and Parts Manufacturing	2.00	2.00	2.00	2.00	2.00	2.00
Tourism and creative industries	Motion Picture and Video Production	2.00	2.00	2.00	2.00	2.00	2.00
Tourism and creative industries	Commercial Photography	2.00	2.00	2.00	2.00	2.00	2.00
Tourism and creative industries	Travel Agencies	2.00	2.00	2.00	2.00	2.00	2.00
Tourism and creative industries	Tour operators	2.00	2.00	2.00	2.00	2.00	2.00
Tourism and creative industries	All Other Travel Arrangement and Reservation Services	2.00	2.00	2.00	2.00	2.00	2.00
Tourism and creative industries	Landscaping Services	2.00	2.00	2.00	2.00	2.00	2.00
Tourism and creative industries	Full-Service Restaurants	2.00	2.00	2.00	2.00	2.00	2.00
Food and chemical industries	Breakfast Cereal Manufacturing	2.00	2.00	0.00	2.00	2.00	1.90
Food and chemical industries	Fruit and Vegetable Canning	2.00	2.00	0.00	2.00	2.00	1.90
Food and chemical industries	Cookie and Cracker Manufacturing	2.00	2.00	0.00	2.00	2.00	1.90
Food and chemical industries	Dry Pasta, Dough, and Flour Mixes Manufacturing from Purchased Flour	2.00	2.00	0.00	2.00	2.00	1.90
Construction manufacturing	Other Concrete Product Manufacturing	2.00	2.00	0.00	2.00	2.00	1.90
Construction manufacturing	Ready-Mix Concrete Manufacturing	2.00	2.00	0.00	2.00	2.00	1.90
Forestry, environmental, flora and fauna activities	Wood Kitchen Cabinet and Countertop Manufacturing	2.00	2.00	2.00	0.00	2.00	1.80
Manufacturing and transportation services	Motor and Generator Manufacturing	2.00	2.00	2.00	0.00	2.00	1.80
Manufacturing and transportation services	Ship Building and Repairing	2.00	2.00	2.00	0.00	2.00	1.80
Forestry, environmental, flora and fauna activities	Finfish Fishing	1.00	2.00	0.00	2.00	2.00	1.75
Forestry, environmental, flora and fauna activities	Cut Stock, Resawing Lumber, and Planing	2.00	2.00	0.00	0.00	2.00	1.70
Forestry, environmental, flora and fauna activities	All Other Converted Paper Product Manufacturing	2.00	2.00	0.00	0.00	2.00	1.70
Food and chemical industries	Paint and Coating Manufacturing	2.00	2.00	0.00	0.00	2.00	1.70
Construction manufacturing	Concrete Block and Brick Manufacturing	2.00	2.00	0.00	0.00	2.00	1.70

Tourism and creative industries	Bed-and-Breakfast Inns	2.00	1.00	2.00	2.00	2.00	1.65
Tourism and creative industries	All Other Traveler Accommodation	2.00	1.00	2.00	2.00	2.00	1.65
Tourism and creative industries	Recreational and Vacation Camps (except Campgrounds)	2.00	1.00	2.00	2.00	2.00	1.65
Food and chemical industries	Fats and Oils Refining and Blending	2.00	1.00	0.00	0.00	2.00	1.35
Food and chemical industries	Distilleries	2.00	1.00	0.00	0.00	2.00	1.35
Food and chemical industries	Soap and Other Detergent Manufacturing	2.00	1.00	0.00	0.00	2.00	1.35
Construction manufacturing	Pottery, Ceramics, and Plumbing Fixture Manufacturing	2.00	1.00	0.00	0.00	2.00	1.35
Construction manufacturing	Clay Building Material and Refractories Manufacturing	2.00	1.00	0.00	0.00	2.00	1.35
Construction manufacturing	All Other Miscellaneous Nonmetallic Mineral Product Manufacturing	2.00	1.00	0.00	0.00	2.00	1.35
Manufacturing and transportation services	Marine Cargo Handling	1.00	1.00	2.00	0.00	2.00	1.30
Manufacturing and transportation services	Packing and Crating	1.00	1.00	2.00	0.00	2.00	1.30
Manufacturing and transportation services	General Warehousing and Storage	2.00	1.00	2.00	2.00	1.00	1.30
Manufacturing and transportation services	Farm Product Warehousing and Storage	2.00	1.00	2.00	2.00	1.00	1.30
Manufacturing and transportation services	Other Warehousing and Storage	2.00	1.00	2.00	2.00	1.00	1.30
Tourism and creative industries	Historical Sites	1.00	1.00	2.00	0.00	2.00	1.30
Tourism and creative industries	Zoos and Botanical Gardens	1.00	1.00	2.00	0.00	2.00	1.30
Tourism and creative industries	Nature Parks and Other Similar Institutions	1.00	1.00	2.00	0.00	2.00	1.30
Food and chemical industries	Medicinal and Botanical Manufacturing	1.00	1.00	0.00	0.00	2.00	1.20
Food and chemical industries	All Other Basic Organic Chemical Manufacturing	1.00	1.00	0.00	0.00	2.00	1.20
Food and chemical industries	Plastic Material and Resin Manufacturing	1.00	1.00	0.00	0.00	2.00	1.20
Construction manufacturing	Glass Product Manufacturing Made of Purchased Glass	1.00	1.00	0.00	0.00	2.00	1.20
Forestry, environmental, flora and fauna activities	Nursery	1.00	1.00	0.00	0.00	1.00	0.85
Forestry, environmental, flora and fauna activities	Floriculture Production	1.00	1.00	0.00	0.00	1.00	0.85
Food and chemical industries	Other Basic Inorganic Chemical Manufacturing	1.00	0.00	0.00	0.00	2.00	0.85

Manufacturing and transportation services	Inland Water Freight Transportation	1.00	0.00	0.00	0.00	2.00	0.85
Manufacturing and transportation services	Inland Water Passengers Transportation	1.00	0.00	0.00	0.00	2.00	0.85
Forestry, environmental, flora and fauna activities	Fruit and Tree Nut Farming	0.00	1.00	0.00	0.00	1.00	0.70
Forestry, environmental, flora and fauna activities	Support Activities for Forestry	0.00	0.00	0.00	0.00	1.00	0.35
Forestry, environmental, flora and fauna activities	Finfish Farming and Fish Hatcheries	2.00	0.00	0.00	0.00	0.00	0.30
Forestry, environmental, flora and fauna activities	Other Aquaculture	2.00	0.00	0.00	0.00	0.00	0.30