MEXICO SOUTHERN STATES STUDY

SECTOR ASSESSMENT: FORESTRY SECTOR

WORLD BANK GROUP
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Mexico Southern States Study

Sector Assessment: Forestry Sector

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A forthcoming Country Private Sector Diagnostic (CPSD) will provide a broader view on the main challenges and opportunities for private sector development in Mexico, complementing the findings of these Deep Dives at the regional level. The CPSD and the Deep Dives will be mutually reinforcing, as the national coverage of the former will offer a more comprehensive view of the economic structure, constraints and opportunities for private sector investment in the country while the latter offers more granular analytics on the state of the economy and the private sector in Mexico's poorest region.

Abbreviations

Bancomext	*Banco Nacional de Comercio Exterior* (National Exterior Commerce Bank)
Banobras	*Banco Nacional de Obras y Servicios Públicos*
Banxico	*Banco de México* (Bank of Mexico)
CFEs	community forestry enterprises
CNBV	*Comisión Nacional Bancaria y de Valores*
CONAFOR	*Comisión Nacional Forestal* (National Forestry Commission)
DENUE	*Directorio Estadístico Nacional de Unidades Económicas*
EBITDA	earnings before interest, tax, depreciation, and amortization
EDUTIH	*Encuesta Nacional sobre Disponibilidad y Uso de Tecnologías de la Información en los Hogares*
ENCRIGE	*Encuesta Nacional de Calidad Regulatoria e Impacto Gubernamental en Empresas*
EU	European Union
FDI	foreign direct investment
FSC	Forest Stewardship Council
GDP	gross domestic product
HS	Harmonized System
ICT	information and communication technology
IMT	*Instituto Mexicano del Transporte*
IMTA	*Instituto Mexicano de Tecnología del Agua*
INEGI	*Instituto Nacional de Estadistica y Geografia*
km	kilometer
m^3r	cubic meters of roundwood
m	meter
mm	millimeter
MMcf/d	million cubic feet per day
Nafin	Nacional Financiera
NAICS	North American Industry Classification System
RCA	revealed comparative advantage
SEMARNAT	*Secretaría del Medio Ambiente y Recursos Naturales* (Secretariat of Environment and Natural Resources)
SENER	*Secretaría de Energía* (Secretariat of Energy)
SIE	*Sistema de Información Energética* (Energy Information System)
SMAPE	symmetric mean absolute percentage error
SNIARN	*Sistema Nacional de Información Ambiental y de Recursos Naturales*
TFP	total factor productivity

PIGOO	*Programa de Indicadores de Gestión de Organismos Operadores*
PRONAFOR	Programa Nacional Forestal
VPA	voluntary partnership agreement

Overview

Mexico has important opportunities to develop its forestry sector. Although the global market for forestry products is relatively small, Mexico has started to position itself as a significant player, and its share of global forestry exports is now the third largest in Latin America behind Brazil and Chile.

Mexico stands out among the 10 largest exporters of chairs and wooden seats, furniture, and wooden parts and pieces for furniture. The country also has enormous potential for substituting paper and paperboard imports—goods whose commercial deficit has almost quadrupled in recent decades—with domestic production. States like Chiapas, Guerrero, Oaxaca, and Yucatán (the selected states) have considerable scope to develop their local forestry industries, promoting the sustainable production of wood materials, and progressively upgrading to higher stages of the furniture value chain. These states have untapped industrial potential in the furniture, pulp, and paper and paperboard subsectors, with the greatest potential concentrated in the areas of Comitán and Palenque in Chiapas; along the Federal Highway (Fed.) 95D corridor that connects Acapulco with Mexico City, Tierra Caliente, and the coastal region in Guerrero; the areas along the Fed. 185 (*Transístmica*) and along the Fed. 190 (from Juchitán to Arriaga) in Oaxaca; and around the city of Mérida, the Mérida-Progreso corridor, and the Mérida-Valladolid corridor in Yucatán. However, to reverse the loss of thousands of hectares of forest because of illegal logging and burning and restore damaged and degraded forest areas, expansion of the forestry sector must be complemented by the adoption and enforcement of sustainable forestry practices and regulations.

MARKET ANALYSIS

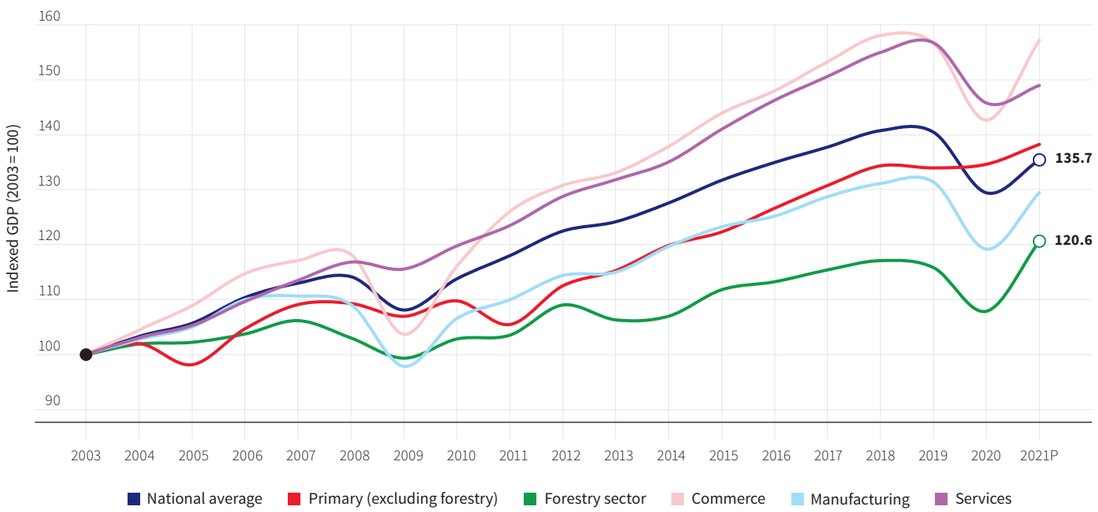
The forest sector makes up a small share of Mexico's gross domestic product (GDP), characterized by poor growth performance. The share of value added by the forest sector in Mexico expanded at an average annual rate of 1.1 percent between 2003 to 2021, yet it reached just 0.8 percent of the country's GDP. The growth of the forest sector was also more volatile than those observed in other sectors during the period (figure O.1). The forest sector accounts for 1.5 percent of total employment and 1.4 percent of all firms in the country, with an average of six workers per firm.

Although forestry products form a relatively small global market, they open up a significant opportunity for Mexico. In 2021, the forestry sector accounted for just 2.2 percent of global merchandise exports, but in absolute terms that represented a global market valued at US$482.2 billion. Between 1995 and 2021, global forestry exports grew at an average rate of 3.4 percent per year. The growth of Mexican forestry exports significantly exceeded the global average, expanding at an average rate of 4.4 percent per year over the period, and the country's global market share increased from 0.6 to 0.8 percent, or US$3.8 billion in nominal terms. However, over 60 percent of those exports and exporting firms were concentrated in just five states in northern and central Mexico: Baja California, Chihuahua, Querétaro, the State of México, and Tamaulipas. Moreover, three products represent more than 85 percent of Mexico's forestry exports: paper, paperboard, and by-products (48.8 percent), wood and articles of wood (22.8 percent), and other wooden furniture[1] (14.7 percent).

Despite the growth of forestry exports, imports continue to satisfy much of Mexico's demand for forestry products. Although the forestry sector's share in Mexico's total imports fell from 4.3 percent in 1995 to 2 percent in 2021, the

FIGURE O.1

Growth of the Mexican Forestry Sector



Source: Based on data from INEGI's National Accounts (various years).
Note: GDP = gross domestic product; P = preliminary. Forestry sector includes forestry and logging (North American Industry Classification System [NAICS] code 113), support activities for forestry (NAICS 1153), wood product manufacturing (NAICS 321), paper manufacturing (NAICS 322), household and institutional furniture and kitchen cabinet manufacturing (NAICS 3371), and office furniture (including fixtures) manufacturing (NAICS 3372).

country's share in global forestry imports increased from 1.4 to 1.9 percent. In 2021, Mexico's forestry sector imports totaled US$10.6 billion, highlighting the country's potential to develop domestic sources of production that can compete with imports. The Mexican furniture market is estimated at US$2.5 billion, and high domestic furniture prices reflect an important market opportunity that has been identified by key players such as Ikea, which recently launched operations in Mexico.

ECONOMIC POTENTIAL

The selected states can significantly increase their participation in local and international forestry markets and value chains, especially as suppliers of intermediate goods. Together, the selected states accounted for 13.2 percent of Mexico's timber production in 2018, and Oaxaca was the country's third-largest producer of timber after Chihuahua and Durango. Oaxaca also has the third-largest area certified by the Forest Stewardship Council. Timber production in Chiapas occupies a middle position in the national range, but the state has suffered vast deforestation over the last decade, while Yucatán has experienced a shortage of raw materials combined with deforestation. Both states could acquire raw materials from other states while they address deforestation and boost sustainable local timber supplies. Baja California, which is a leader in furniture production despite having the second-lowest timber production in the country, highlights the feasibility of this approach. Between 2000 and 2018, overall production of

nontimber products increased by 553 percent in the selected states. Guerrero accounts for more than 40 percent of Mexico's fiber production.

The pulp, paper, and paperboard industries have the greatest potential for import substitution. Mexico imported US$6.21 billion in paper and paperboard and exported US$1.87 billion in 2021. This trade deficit has nearly quadrupled since 1995. Globally, efforts to develop this industry tend to focus on recycled raw materials rather than on virgin tree fiber. If Mexico continues to increase its recycling rate, it could significantly reduce the environmental impact of this industry while generating efficiency gains and economies of scale required for further expansion.

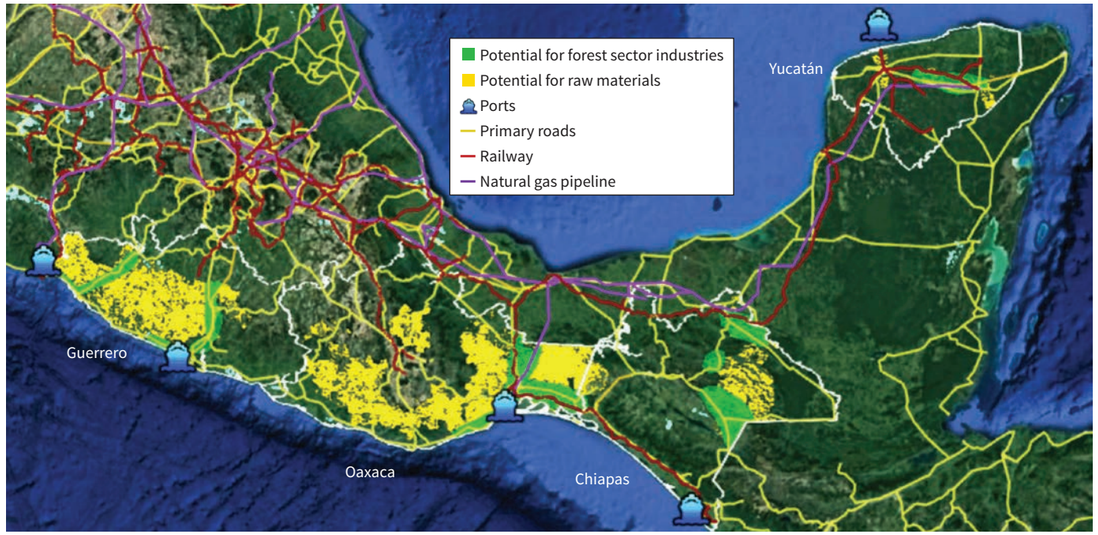
The forestry sector's employment-to-output ratio is about three times the national average and forestry is an important engine of job creation in rural areas. Subsectors like furniture, pulp, and paper production have a strong potential to generate employment because they are reliant on labor-intensive processes. Additionally, many of the jobs within these industries only require technical training. The forestry sector accounts for about 2.4 percent of total sales but just 1.8 percent of total purchases, indicating a strong potential for forward links.[2] Adopting sustainable forestry production practices and regulations backed by appropriate enforcement mechanisms can mitigate and reverse the damage caused by illegal logging and burning while also improving air and water quality, enabling greater carbon storage, supporting biodiversity, and creating opportunities for renewable energy.

Out of 23 individual forestry activities, Oaxaca has three with productivity levels higher than the national average, Yucatán has two, and Chiapas and Guerrero have none. In terms of value added, Guerrero, Oaxaca, and Yucatán each have a comparative advantage in five forestry activities, while Chiapas in only three. Oaxaca and Yucatán each have two activities with higher-than-average productivity levels and a comparative advantage. For Oaxaca, these activities are related to sawn boards and planks, and wood containers and pallets. For Yucatán, these activities are wood containers and pallets and fitted kitchen and modular bathroom furniture. Of 57 forestry exports, Yucatán has a comparative advantage in four products, Guerrero in two, Oaxaca in one, and Chiapas in none. Further developing these products could have multiplier effects because of the upstream and downstream links in their value chains. Key forestry products in each state include pine and scantling in Chiapas, Guerrero, and Oaxaca, and tropical comuna and charcoal, posts, piles, and andirons in Yucatán. Nontimber raw materials include resins in Chiapas and Oaxaca and fibers in Guerrero.

Multiple locations could support the sustainable production of raw materials from the forestry sector (map O.1). These include the areas surrounding the Selva Lacandona and Meseta Comiteca–Tojolabal in eastern Chiapas; the Costa Grande, Tierra Caliente, and Centro regions in western and southern Guerrero; Istmo, Sierra Sur, and Valles Centrales in Oaxaca; and Centro, Noreste, and parts of Oriente close to Mérida and Valladolid in Yucatán. These locations have active and potential producers with the capacity for raw materials production and manufacturing, and they exclude protected areas. The distribution of utilities and transportation infrastructure indicates that the areas with the greatest manufacturing potential are the regions near Comitán and

MAP O.1

Potential Regions for Developing Forest Sector Activities Based on Products and Inputs Availability and Existing Transportation and Logistics Infrastructure in the Selected States



Source: Elaborated using Google Earth with information from INEGI 2017; CONANP 2019; CONAFOR 2019; SCT 2019; SENER 2018.
Note: The symbols are only indicative and are not meant to reflect exact locations, except for potential for raw materials.

Palenque in Chiapas; the corridor along the Fed. 95D, which connects Acapulco with Mexico City, Tierra Caliente, and the coastal region in Guerrero; the areas along the Fed. 185 (or *Transístmica*) and Fed. 190 (from Juchitán to Arriaga) in Oaxaca; and the area around the city of Mérida and along the Mérida-Progreso and Mérida-Valladolid corridors in Yucatán.

BINDING CONSTRAINTS FACED BY THE SECTOR

In Mexico and the selected states, the forestry sector is performing well below its potential. In 2021, the wood, paper, pulp, and furniture industries represented only 0.3 percent of the combined GDP of the selected states and 3.9 percent of their manufacturing output. Moreover, the value added of the forestry industry shrank by 21 percent between 2003 and 2021. At the same time, the forestry sector received a mere 0.01 percent of the combined total FDI of the selected states, which represented 0.02 percent of the FDI in Mexico's forestry sector. Furthermore, the combined share of the selected states in the national forestry exports is estimated at 1.2 percent, which is similar to their share of exporting firms (1.1 percent).

Limited human capital constrains the development of paper, furniture, and related products manufacturing in Guerrero and Oaxaca. However, for Chiapas and especially Yucatán human capital does not appear to be a binding constraint to support increased wood-product manufacturing.

Inadequate infrastructure is a key constraint for the development of the forestry sector in the selected states. Logistics and transportation infrastructure are deficient in all selected states, especially Guerrero. Energy is a key constraint mainly in Guerrero and Oaxaca, as is the absence of natural-gas distribution infrastructure in Chiapas and Guerrero. Water availability (superficial and underground) is broadly adequate in the selected states, except for some parts of northern Guerrero, but all four states are at high or very high risk of forest fires. Pulp, paper, and paperboard mills are most affected by infrastructure constraints, as they are intensive users of energy, water, and fuel.

Burdensome regulations, loose enforcement, and inadequate government support programs undermine the development of the forestry sector. The difficulty of obtaining the necessary permits for forest harvesting and transportation is a major obstacle. For a local community, acquiring a forest-harvesting permit requires about 44 steps and can take up to 195 days.[3] This long and burdensome process, together with loose oversight, has resulted in a thriving illegal market that accounts for an estimated 70 percent of all wood sales. The prevalence of illegal burning for land clearance, particularly in Chiapas and Oaxaca, is another issue that constrains the development of the industry.

Limited access to finance further inhibits the development of forestry-related manufacturing. The evidence is insufficient to determine whether financing is a constraint for the production of primary forestry products. However, a small number of actors who seek financing for primary production indicate that financial incentives or dedicated credit lines could encourage new entrants to participate or grow small producers into larger firms or cooperatives.

Figure O.2 summarizes the binding constraints for developing the forestry sector in the selected states.

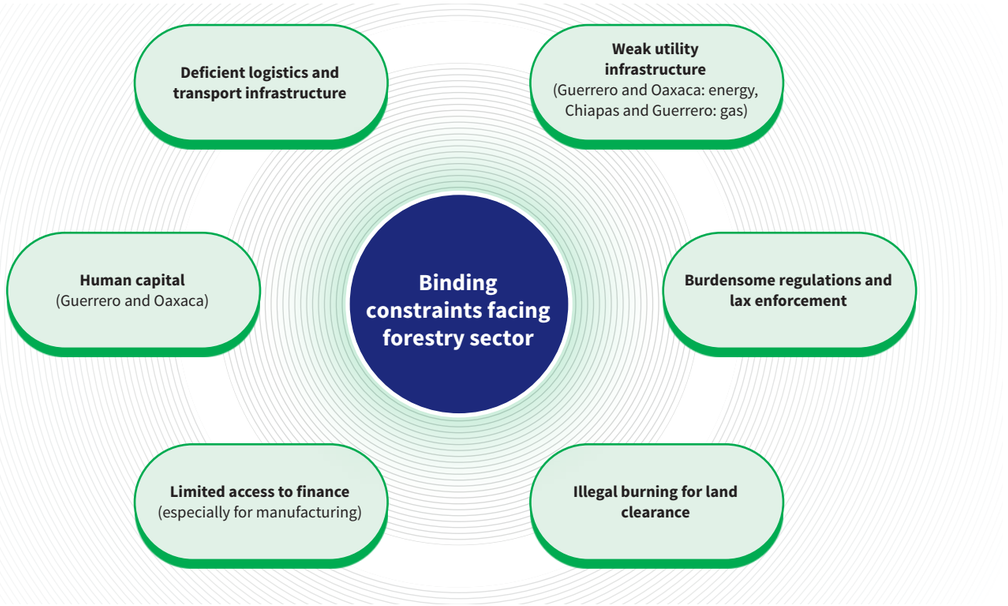
OPPORTUNITIES FOR GROWTH: WHAT WOULD IT TAKE TO DEVELOP THE SECTOR?

Supporting the development of sustainable forestry in the selected states will involve a mix of investments and policy reforms. Improving road and railroad infrastructure is necessary to connect forestry manufacturers with primary producers and final markets, reducing logistics costs and increasing productivity. Establishing and strengthening forestry clusters in strategic areas close to the required inputs would further reduce costs, increase productivity, and create synergies. Offering well-designed incentives could attract anchor firms to the clusters and encourage links, technology transfer, and investment in sustainable forestry practices.

Strengthening regulations and enforcement mechanisms at the federal and local levels is crucial to stopping illegal logging and burning. To effectively protect forest resources will require strengthening the government's monitoring capacity, increasing penalties, and simplifying agrarian and environmental regulations without weakening them. Expanding and enhancing federal and state programs dedicated to reforestation and the preservation of forest health is also vital. These programs should incentivize producers and local communities to plant endemic species, identify arboreal diseases and other risks to forest

FIGURE O.2

High-Level Overview of Binding Constraints Facing the Forestry Sector in the Selected States



health, and actively participate in forest protection. Furthermore, expanding government recycling programs for paper and paperboard could provide a sustainable way to increase fiber supply, thereby easing pressure on forest resources. Consolidation of collection systems could make recycling more feasible, even in remote or rural areas.

The authorities could help increase the productivity of communal forests. Supporting the development and training of community forestry enterprises could improve forest management, production systems, and business practices. Establishing joint ventures, long-term production-sharing contracts, or unified negotiations could facilitate collaboration with manufacturers and investors, and the strict enforcement of these agreements is crucial to their success.

Table O.1 summarizes the policy recommendations for developing the forestry sector in the selected states.

TABLE O.1

Matrix of Policy Recommendations

	Infrastructure
	➜ Improve road and railroad infrastructures to connect forest industries to the main sources of primary production (which tend to be in remote regions) and final markets to reduce logistics costs and increase productivity. ➜ Develop infrastructure to access natural gas in Guerrero at the coastal region by connecting from the pipeline in Michoacán, and Chiapas at the coastal region to potentially connect and provide natural gas to Central America by connecting from the pipeline in the Isthmus of Tehuantepec in Oaxaca. ➜ Increase investments in infrastructure for the production and storage of germplasm and seed banks for native timber plants and new plants that can be produced in the selected states.
	Support for producers
	➜ Foster community production systems in regions where land is mainly social property and explore arrangement mechanisms to reach production with adequate volume and quality levels (joint-ventures, long-term production sharing contracts, unified negotiations, among others). ➜ Establish training programs for community forestry enterprises and other primary producers to improve their forest management, harvesting and production systems, and business management practices, and connect them with potential manufacturing investors. ➜ Expand public programs dedicated to reforesting, recovering, and preserving the health of forests, partnering with local communities and existing producers of the sector. ➜ Create research and development centers to encourage innovation in the design of affordable and multifunctional (home and office) products in partnership with academic institutions and the private sector. ➜ Create a platform or generate partnerships with financial technology (fintech) and delivery firms to promote online selling of furniture products from local producers, leveraging existing logistics routes and the option of getting credit for these purchases. ➜ Create a financing and technical support program, with support from organizations with the know-how for innovating and improving practices along the forest sector's value chain while observing social and environmental best practices.
	Investment climate, competition, and government interventions
	➜ Improve the legal frameworks and enforceability mechanisms at the federal and state levels to increase the costs for illegal producers, increase economic returns from authorized activities, and protect the environment. Some actions in this direction include: • Enhance the government's capacities for monitoring the conservation of forests and protected areas • Increase penalties (and enforcement) for illegal logging and arson of forest lands • Create an awareness campaign for consumers to increase their knowledge of the environmental damages from consuming wood products from illegal logging • Streamline agrarian and environmental regulations (number of procedures, time, and costs) • Implement a program to support and enforce the use of the Chain of Custody Certification of the Forest Stewardship Council for forest products • Sign a Voluntary Partnership Agreement with the European Union to reduce illegal logging while incentivizing legal timber exports into Europe, the leading wood importing continent • Establish a platform similar to those used by the Open Timber Portal and the Forest Transparency Initiative to incentivize legal timber production • Launch public-private collection programs to boost paper and paperboard recycling ➜ Support the establishment or strengthening of forest clusters to reduce transportation costs, increase productivity, facilitate the dissemination of knowledge, and create synergies.
	Access to finance
	➜ Consolidate financial resources from development banking institutions (including Bancomext when imports and exports are considered) to design tailor-made products to support the development of the forest sector in the selected states. ➜ Assess the impact of existing financing instruments aimed at developing the forest sector, to determine whether these instruments should be modified, replaced, or continue as they are.

1

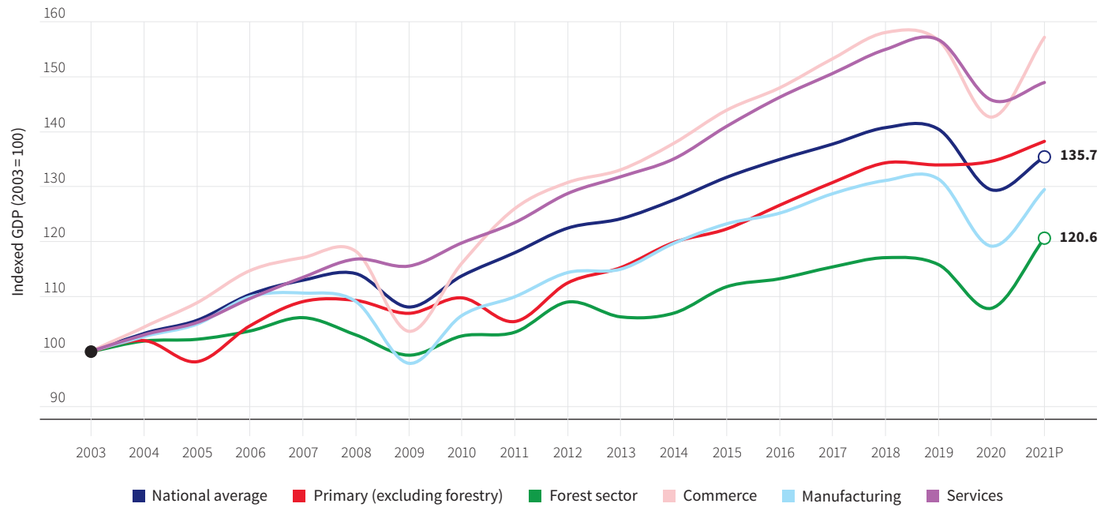
The Forest Sector in Mexico and in the Selected States

The forest sector makes up a small share in Mexico's gross domestic product (GDP). Although Mexico's value added in the forestry sector expanded at an average annual rate of 1.1 percent between 2003 to 2021, the sector's share in GDP reached just 0.8 percent in 2021. The sector's growth was also more volatile than those observed in other sectors during this period (figure 1.1). By 2018, the forest sector accounted for 1.5 percent of total employment and 1.4 percent of all firms in the country, with an average of six workers per firm.[4]

Throughout this assessment, The forestry sector includes all economic activities that depend on goods and services from forests and forest-related products such as commercial production and processing of wood and nonwood products (for example, paper and pulp). Unless specified, throughout this assessment, the term forest sector or forest industry refers to forestry, wood-related activities, and paper and pulp industry.

FIGURE 1.1

Growth of the Mexican Forestry Sector



Source: Based on data from INEGI's National Accounts (various years).
Note: Forest sector includes forestry and logging (North American Industry Classification System [NAICS] code 113), support activities for forestry (NAICS 1153), wood product manufacturing (NAICS 321), paper manufacturing (NAICS 322), household and institutional furniture and kitchen cabinet manufacturing (NAICS 3371), and office furniture (including fixtures) manufacturing (NAICS 3372). Data for 2021 are preliminary.

Whereas Mexico's forestry sector has vast untapped investment opportunities, the actual investment levels are modest. Indeed, the sector received only around 1.1 percent of Mexico's foreign direct investment (FDI) inflows between 2003 and 2021. Of these, 78 percent went to the pulp, paper, and cardboard industries, 16.9 percent to furniture manufacturing, 5.1 percent to the wood industry, and the remaining part to forestry. In 2018, the sector represented about 1.3 percent of gross capital formation (GCF) in Mexico.[5]

The development of the forestry sector in Chiapas, Guerrero, Oaxaca, and Yucatán mirrors national trends. In 2021, the wood, paper, and pulp and furniture industries represented 0.3 percent of the combined GDP of the selected states and around 3.9 percent of their manufacturing output. However, during 2003–21, the aggregate value added by the forest sector contracted by 21 percent, whereas the total value added in the selected states expanded by 26.3 percent. Investment levels have also been low. The forest sector accounted for just 0.01 percent of the total FDI of these states (0.02 percent of Mexico's total forest sector FDI) over the period. The share of forest sector investment in the aggregate GCF of the selected states, increased from 0.2 percent in 2004 to 0.4 percent in 2018. In 2018, the forest sector (excluding the primary components, that is, forestry) accounted for around 1.2 percent of employment and 1.6 percent of all firms in these states, with an average firm size of 2.4 workers (table 1.1). The selected states represent 6.1 percent of total sectoral employment and 15.7 percent of all firms in the country's forest sector.

TABLE 1.1

Forestry Sector Firms and Employment in the Selected States, 2018

NAICS code	Description	Number of firms	Number of workers
1153	Support activities for forestry	5	n.a.
321	Wood product manufacturing	5,278	12,745
3211	Sawmills and wood preservation	98	213
3212	Veneer, plywood, and engineered wood product manufacturing	7	60
3219	Other wood product manufacturing	5,173	11,354
	Not reported*	n.a.	1,118
322	Paper manufacturing	1,040	3,121
3221	Pulp, paper, and paperboard mills	4	13
3222	Converted paper product manufacturing	1,036	2,159
	Not reported*	n.a.	949
3371	Household and institutional furniture and kitchen cabinet manufacturing	4,463	9,485
3372	Office furniture (including fixtures) manufacturing	61	330
	Total of the forest sector in the selected states	10,847	25,681
Total in the selected states		667,789	2,057,630
Share of the forest sector (%)		1.6	1.2

Source: Based on data from INEGI 2019.
Note: The data for workers correspond to those reported by established economic units and may differ from those estimated by the ENOE (representative survey applied to households). No data for NAICS 113 (forestry and logging) as well as for its disaggregated sectors were reported. ENOE = *Encuesta Nacional de Ocupación y Empleo* (National Survey of Occupation and Employment); NAICS = North American Industry Classification System; n.a. = not available.
*Indicates that the missing values could be attributed to data not accessible because of confidentiality. Values were calculated as the difference between the NAICS three-digit sector and the sum of the NAICS four-digit subsectors.

By 2018, the selected states produced 13.2 percent of Mexico's timber production (1.1 million roundwood cubic meters). Pine was the most abundant forest-based raw material in these states, accounting for 89.7 percent of their combined production and 16.8 percent of national production. Meanwhile, scantling is the most popular forest-based product, constituting 90.8 percent of their combined production and 18.6 percent of national production. The selected states also produce 3.9 percent of Mexico's nontimber forest production (6,780 tons), with fibers produced in Guerrero (Agave lechuguilla, Sabal mexicana, and Tillandsia usneoides) being the main nontimber product (22.3 percent of their combined production and 40.7 percent of national production) (table 1.2). Between 2000 and 2018, total timber production in Mexico fell by 11.6 percent whereas in the selected states it grew by 8.8 percent. Nontimber production increased in the selected states by 553 percent despite a 27 percent decline at the national level. In 2018, there were 2,025 firms dedicated to timber products in Mexico, with an installed annual capacity of 11.7 million cubic meters of roundwood (m^3r). However, they used around 63.6 percent of their installed annual capacity (7.4 million m^3r). Oaxaca had the highest installed capacity among the selected states (1.8 million m^3r), but it used only 40.8 percent of it.[6]

The forestry sector could be an important engine of job creation and income growth in the selected states, especially in rural areas where few other industries are viable.[7] The employment-to-output ratio[8] of the forest sector in the selected states is 10.4, about three times the national average (3.4).[9] Forest sector

TABLE 1.2

Forest Production in the Selected States, 2018

	Chiapas	Guerrero	Oaxaca	Yucatán	Total for the selected states	*National average*
Timber by type (m^3 of roundwood)						
Pine	102,411	149,452	735,613	0	987,476	5,875,686
Sacred fir	–	624	0	0	624	214,873
Other conifers	3,262	–	0	0	3,262	35,962
Oak	10,677	3,310	33,946	0	47,933	1,210,740
Other broadleaved species	482	134	2,124	0	2,740	220,634
Precious species	109	–	0	0	109	15,961
Tropical comuna	20,705	4,297	23,325	10,142	58,469	761,239
Total	137,646	157,817	795,007	10,142	1,100,612	8,335,095
Timber by product (m^3 of roundwood)						
Scantling	135,623	145,045	719,103	65	999,836	5,389,162
Cellulosic	–	8,446	31,350	0	39,796	835,554
Wood veneer or plywood	–	–	0	0	–	446,095
Post, piles, and andirons	–	–	215	1,671	1,886	144,409
Firewood	–	355	44,339	128	44,822	449,185
Charcoal	2,023	3,971	0	8,278	14,272	620,195
Crossties (sleeper)	–	–	0	0	–	450,495
Total	137,646	157,817	795,007	10,142	1,100,612	8,335,095
Nontimber output by product (tons)						
Resins	70	–	301	–	371	24,205
Fibers	–	1,510	–	–	1,510	3,709
Rubbers	–	–	–	–	–	24
Tree wax	–	–	–	–	–	2,313
Rhizomes or rootstock	–	–	–	–	–	–
Others	–	4,394	387	38	4,819	78,051
Tierra de Monte	–	80	–	–	80	64,701
Total	70	5,984	688	38	6,780	173,002

Source: Based on data from CONAFOR 2021.
Note: The others category include mushrooms or fungi, seeds, leaves, nopal, stems, and hay. m^3 = cubic meters.

industries tend to be labor intensive,[10] and many jobs can be done by workers with limited formal education. Today, even in regions where logging is not feasible for social, environmental, or legal reasons, forests can still generate revenue from ecotourism or through carbon-credit programs.[11]

The forestry sector plays a modest role in the production processes of other sectors, but pulp and paper production and furniture manufacturing have strong potential for forward linkages.[12] The forestry sector's sales to other sectors represent 2.4 percent of economywide sales, while its purchases from other sectors correspond to 1.8 percent of economywide purchases: for every one monetary unit of forestry products sold to other sectors, the forestry sector purchases up to 0.76 monetary unit from other sectors.[13] The major domestic purchasers of forestry products

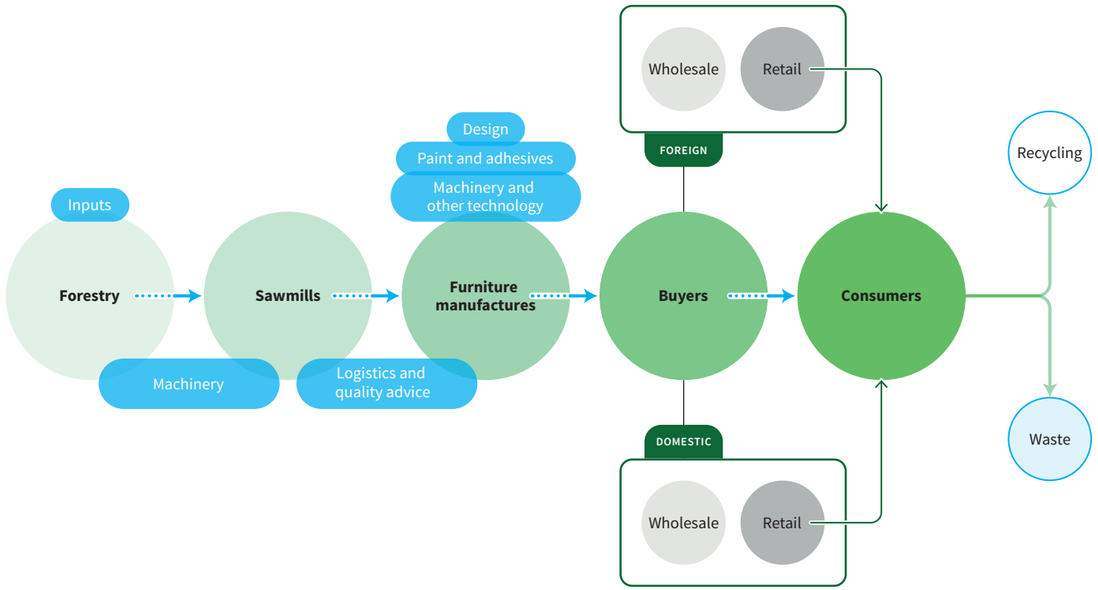
are converted paper manufacturers (38.1 percent); pulp, paper, and paperboard mills (26.4 percent); and sawmills and wood preservation industries (14.7 percent).

Adopting sustainable forestry practices and regulations can generate additional benefits. Sustainable forestry can help stop and reverse the damages caused by illegal logging, burning of forested land for agricultural purposes, urbanization, and other factors that are responsible for the loss of thousands of forest hectares each year. Other benefits include more resilient rural development, cleaner air and water, improved carbon storage, greater biodiversity, and even renewable energy.[14]

VALUE-CHAIN ANALYSIS

The two main value chains in the forestry sector are wood furniture and paper and pulp. Figure 1.2 shows the structure of the wood furniture value chain. The first stage of the wood furniture value chain is forestry, which refers to the sustainable management of forests. Key inputs used in the forestry sector include seed, fertilizers, pesticides, equipment, and water. Harvested timber is processed in sawmills and then manufactured into furniture. Sawmills use simple machinery to process large volumes of timber into highly standardized intermediate products. Furniture manufacturers use more specialized machinery to produce finished products,[15] and they engage firms in the service sector to assist with design and branding.[16] The second stage, industry processing, adds value to the products processed in the primary stage. Some furniture manufacturers sell directly to consumers, while others sell to wholesalers or other intermediaries.

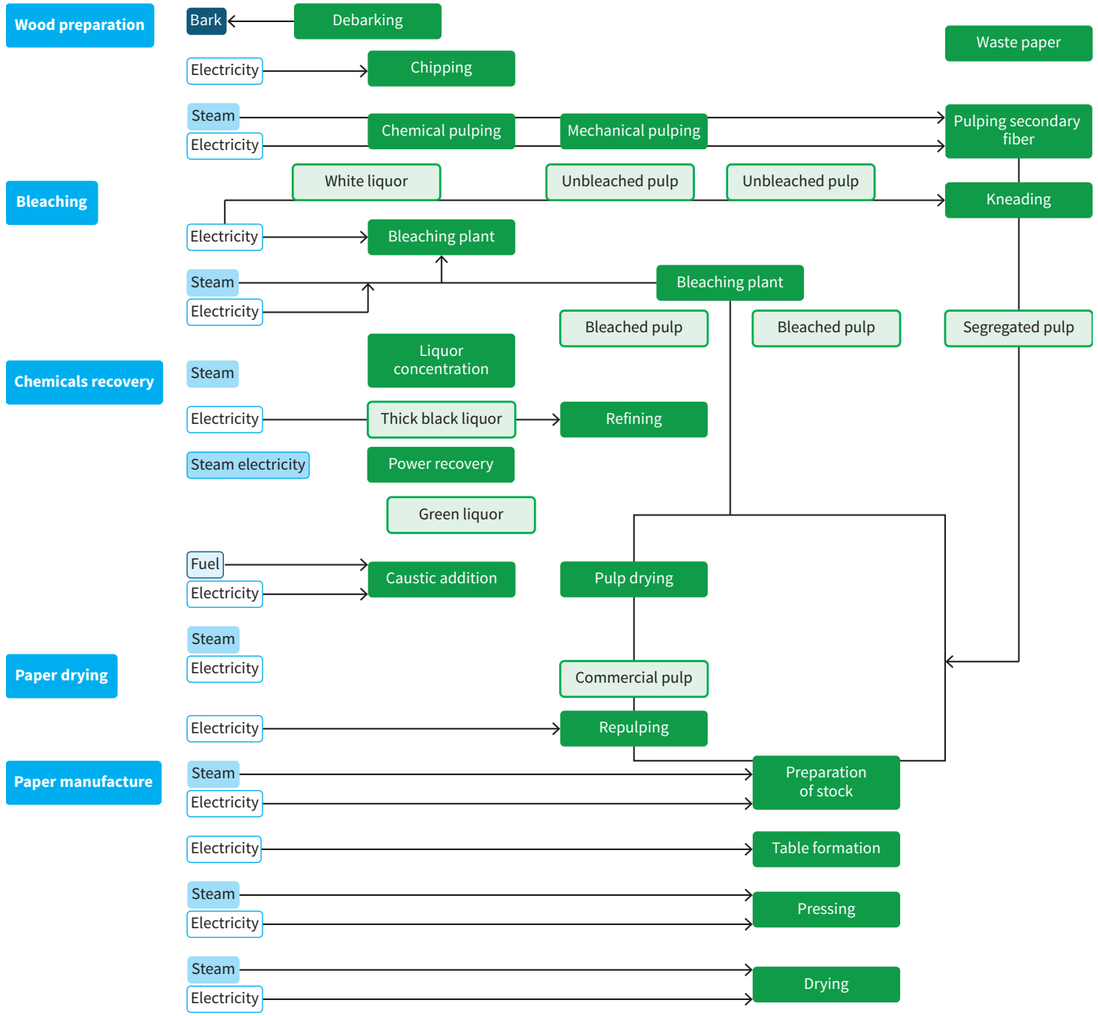
FIGURE 1.2
The Wood Furniture Value Chain



Source: Adapted from Kaplinsky, Readman, and Memedovic 2008.

Figure 1.3 presents the structure of the pulp and paper value chain. The first segment of this value chain is pulp manufacturing, in which wood is transformed into pulp though a mechanical process, a chemical process, or a chemical thermo-mechanical process (combination of the two). The process of transforming pulp into paper is mainly mechanical: the pulp is refined into paste, formed into sheets, and dried into paper using specialized machinery. The drying stage is relatively energy-intensive and involves both electricity and steam.[17] It is important to remark that recent trends in the sector point at the use of recycled raw inputs for pulp and paper production, as well as obtaining wood from sustainable forestry practices.

FIGURE 1.3
The Pulp and Paper Value Chain



Source: Adapted from FUMEC/USMFS 2006.

LEGAL FRAMEWORK[18]

MEXICAN FORESTRY LAWS

By law, the forest communities and *ejidos* play a key role in the development of the forestry sector. In 1986, Mexico returned the ownership of forest resources to the communities and ejidos,[19] granting them the right to define whether and how much of their forestry they want to allocate to the production of timber. The 1992 Agrarian Law amended the Mexican Constitution and established the right of the ejidos and other indigenous landholders to lease their properties. These reforms enabled the establishment of community forestry enterprises (CFEs), or organized groups of ejidos and indigenous landholders that sell their timber and other forest products in broader markets. A growing number of CFEs have also developed relationships with private industries, including land-use agreements requiring community-based processing.

The main legislation governing Mexico's forest sector is the 2003 General Law for Sustainable Forest Development, which covers the conservation, protection, restoration, production, organization, and management of the country's forests. The law also establishes the competencies of local, regional, and national authorities over forest management. All matters not directly addressed by the General Law for Sustainable Forest Development are regulated by the 1998 Law for the Ecological Balance and Environmental Protection.

PROCESSING, MANUFACTURING, AND TRANSPORT LAWS

Processing and storage facilities require authorization from the *Secretaría del Medio Ambiente y Recursos Naturales* (Secretariat of Environment and Natural Resources; SEMARNAT). Such facilities are also required to keep a detailed log of all incoming and outgoing timber and timber products. SEMARNAT requires two different permits for commercial timber transportation: one for moving timber from forests to processing facilities (remisión forestal) and a second for moving timber from processing facilities to other locations (reembarque forestal). Table 1.3 lists several of Mexico's *Normas Oficiales Mexicanas* (Official Mexican Standards), which provide guidelines, criteria, and specifications, for producing timber and nontimber materials.

TABLE 1.3

Official Mexican Standards Related to Forest Management

Standard	Description
NOM-152-SEMARNAT-2006	Establishes the guidelines and criteria of the contents of all programs for forest management.
NOM-059-SEMARNAT-2001	Protects the native species of plants and wildlife including species at risk.
NOM-019-SEMARNAT-1999	Establishes the guidelines for fumigating and controlling insect infestations in forests.
NOM-015-SEMARNAT/SAGARPA-2007	Establishes the guidelines for the use of fire in forest and agricultural regions.
NOM-060-SEMARNAT-1994	Establishes the specifications for mitigating the impact of forest materials' production to soil and bodies of water.

Source: SE 2020.

TRADE REGULATIONS

Mexico has no specific legislation regulating the trade of timber or timber products. Exporters must only comply with general requirements for customs approval, including a phytosanitary permit and an invoice demonstrating the exporter's timber purchase. Depending on the export destination, compliance with international guidelines or other bilateral or multilateral agreements may be required.

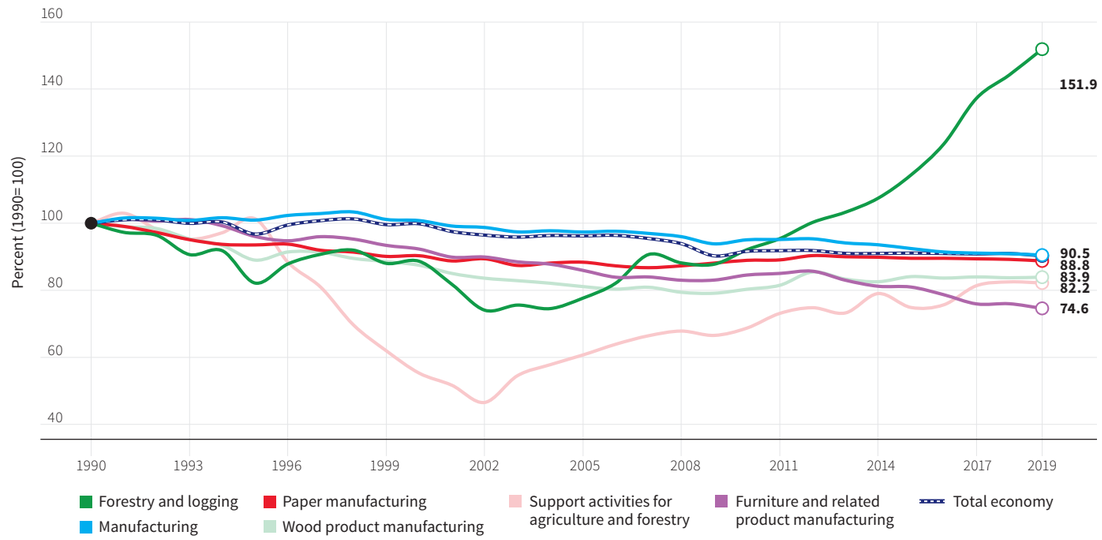
The Forest Stewardship Council's (FSC) Chain of Custody Certification is an increasingly important international certification in the forest sector. It provides credible assurance that forest products are obtained from environmentally and socially responsible sources. It also guarantees that the forest products used in industrial value chains are produced legally and meet established quality specifications. In Mexico, the FSC has granted 222 of these certificates.[20]

PRODUCTIVITY, LABOR AND CAPITAL INTENSIVENESS, AND WAGES

The forestry sector experienced a decline in productivity over the last decades for most of its subsectors. During 1991–2019, the total factor productivity (TFP) of forestry and logging (North American Industry Classification System [NAICS] three-digit code 113) increased annually by 1.6 percent, whereas support activities for agriculture and forestry (NAICS 115)[21] decreased by 0.42 percent, and the TFP of all related manufacturing activities also experienced a decrease: wood products (NAICS 321) at an annual average rate of 0.59 percent, paper (NAICS 322) at an average rate of 0.41 percent, and furniture, mattresses, and blinds (NAICS 337)[22] at a rate of 0.99 percent (figure 1.4).

FIGURE 1.4

Total Factor Productivity in the Selected Sectors

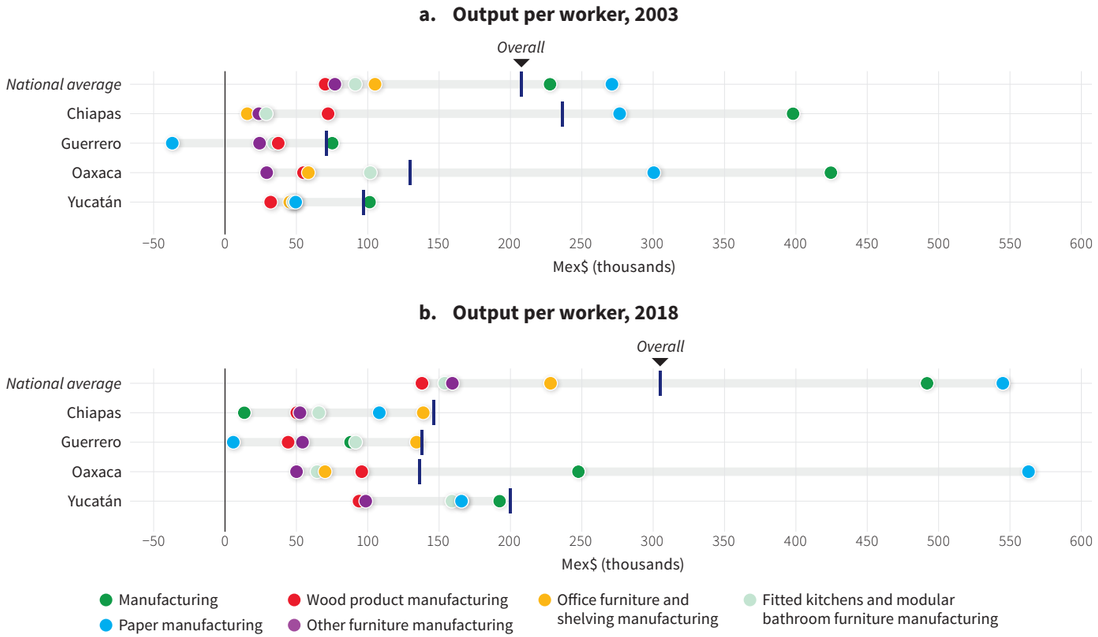


Source: INEGI.
Note: TFP = total factor productivity.

In 2018, labor productivity (measured as value added per worker) in the selected states was below the national level across most forest subsectors.[23] The only exceptions were paper manufacturing in Oaxaca and the manufacturing of fitted kitchens and modular bathroom furniture in Yucatán, which recorded the eighth- and seventh-highest productivity levels, respectively, among Mexico's 32 states. Oaxaca appears to have scope to expand in paper manufacturing, as its productivity in the subsector is higher compared to its manufacturing productivity and overall productivity at the state level and the national productivity in paper manufacturing. Chiapas is the only state in which the productivity of its forest subsectors exceeds the average of its manufacturing sector, though productivity levels in these subsectors are not higher than the average for the state economy (figure 1.5).

An analysis of 23 forest activities[24] reveals that Oaxaca has three in which its productivity is higher than the national level, while Yucatán has two, and Chiapas and Guerrero have none. Guerrero, Oaxaca, and Yucatán each have five activities with a revealed comparative advantage[25] greater than one, indicating a share of value added greater than the national average, while Chiapas has three. Oaxaca and Yucatán each have two activities with higher-than-average productivity levels and a comparative advantage. For Oaxaca, these activities are related to sawn boards and planks, and wood containers and pallets. For Yucatán, these activities are wood containers and pallets and fitted kitchen and modular bathroom furniture. These subsectors have significant potential for further development, and their upstream and downstream linkages would yield positive spillovers on other subsectors.

FIGURE 1.5
Labor Productivity in the Forest Sector, Selected States



Source: INEGI 2014; 2019.

Paper manufacturing requires larger capital stocks per firm than the average for the manufacturing sector or the overall economy, as well as a higher capital-to-worker ratio. The subsector also has the highest number of workers per firm nationwide within the industry at an average of 24.2, more than twice the average for the manufacturing sector. This national trend is only observed in Oaxaca, although paper manufacturers have an average of just 3.5 workers per firm, reflecting the prevalence of small and medium enterprises in the state. The manufacturing of office furniture and shelving has the second-highest labor intensity within the industry, with an average of 22.7 workers per firm at the national level. Among the selected states, this higher worker per firm ratio is only seen in Yucatán (despite it being almost half the national level, 12.8). Regarding the manufacturing of fitted kitchens and modular bathroom furniture, Yucatán has an average of 23.1 workers per firm, a higher labor intensity than the state's manufacturing sector (4.1), the state economy overall (4.6), and the national average for the subsector (4.8). The state also has capital ratios above the national average.

Across all the selected states, hourly wages in the forest sector are below the national average, both for formal and informal workers.[26] According to Table 1.4, the only exception is the forestry and logging subsector in Guerrero and Oaxaca, where wages exceed the national average for the subsector. For all other subsectors, hourly wages are below the national average, and this is related to their lower labor productivity.

TABLE 1.4
Salaries and Education Levels Among Formal and Informal Forest Sector Workers in the Selected States, 2019

	National average		Chiapas		Guerrero		Oaxaca		Yucatán	
	Formal	Informal	Formal	Informal	Formal	Informal	Formal	Informal	Formal	Informal
Overall										
Average income per hour worked (Mex$)	48.5	34.2	36.5	21.5	41.3	28.9	49.8	27.0	48.5	31.2
Average years of education	12.0	8.5	11.0	7.4	12.3	7.6	12.4	7.3	12.1	8.1
Forestry and logging										
Average income per hour worked (Mex$)	32.7	21.4	26.7	21.9	51.6	19.0	67.8	16.2	17.5	15.2
Average years of education	6.9	4.7	7.8	5.5	8.1	4.3	3.5	4.6	4.0	3.7
Wood product manufacturing										
Average income per hour worked (Mex$)	28.5	23.6	20.0	16.3	39.5	21.2	24.7	17.6	18.6	20.9
Average years of education	8.3	7.0	2.8	4.4	7.1	5.6	8.4	6.8	6.0	6.7
Paper manufacturing										
Average income per hour worked (Mex$)	29.0	22.0	17.0	16.1	30.7	19.8	28.6	21.6	23.4	21.2
Average years of education	10.3	8.6	9.7	7.8	10.3	9.4	12.0	8.0	9.9	8.4
Furniture and related products										
Average income per hour worked (Mex$)	30.5	26.1	21.4	17.4	33.5	23.8	26.2	21.8	26.1	23.3
Average years of education	9.5	8.1	8.9	7.3	9.4	7.8	9.5	7.7	9.4	8.1

Source: Based on data from INEGI's ENOE database.

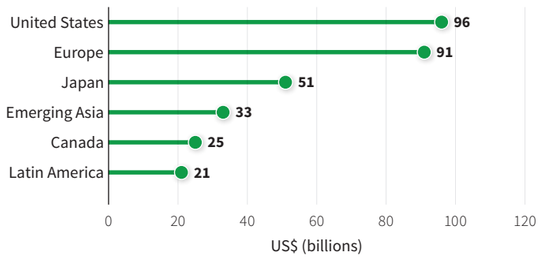
TYPICAL COST STRUCTURE AND PROFITABILITY INDICATORS

Raw materials dominate the cost structure of the forest industries, representing around 80 percent of total costs for cellulosic and paper industries and around 90 percent for furniture industries. The paper industry also uses a greater amount of electricity (9.4 percent) and fuel (7.1 percent) compared to furniture production (2.4 percent and 1.5 percent, respectively), while labor costs are a more important component of the latter (2 percent versus 4.5 percent), and water represents less than 1 percent of production costs for both industries.[27] The distribution of economic benefits varies across different stages of the value chain. In forest management, benefits tend to concentrate among a few agents, such as landowners.[28] In the globally competitive furniture industry, profitability depends on how efficient firms are in their use of resources.[29] Firms in the furniture sector registered annual earnings before interest, tax, depreciation, and amortization (EBITDA) margins of 11.5 to 12.1 percent in 2019, while annual net margins ranged from 5.8 to 6.0 percent. In the cellulosic and paper industries, annual EBITDA margins varied from 8.8 to 10.0 percent, with annual net margins between 6.2 and 7.0 percent. Firms producing other forest products had annual EBITDA margins between 10.3 and 12.3 percent and annual net margins between 5.3 to 6.8 percent.[30]

INDUSTRY LEADERS

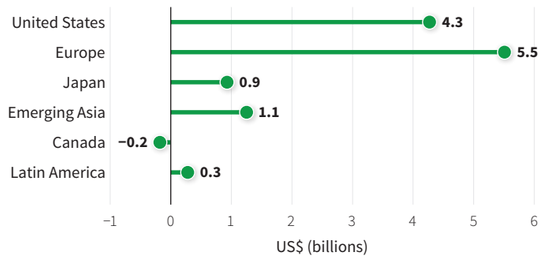
Measured in terms of sales, most of the key players in the global forest sector are firms based in Europe and the United States.[31] U.S. firms recorded US$96 billion in sales in 2015, followed by European firms with US$91 billion, Japanese firms with US$51 billion, and Latin American firms with US$21 billion (figure 1.6). European firms had US$5.51 billion in net income in 2015, followed by U.S. firms with US$4.27 billion, Asian firms with US$1.25 billion, and Latin American firms with US$0.28 billion, while Canadian firms recorded net losses (figure 1.7). In terms of production, in 2018, China was the largest producer of forest sector products by volume in cubic meters with 12.3 percent and the second-largest producer of forest sector products by weight in tons with 20.1 percent, only behind the United States (20.5 percent).[32]

FIGURE 1.6
Market Share by Sales and Region, 2015



Source: Based on data from PwC 2016.

FIGURE 1.7
Market Share by Net Income (Loss) and Region, 2015



Source: Based on data from PwC 2016.

In Mexico, the leading firms include large multinationals and domestic ones. For the paper and cellulosic industry, according to sales, the main companies are Kimberly-Clark México with US$2,051 million, Bio Pappel with US$1,868 million, Smurfit Kappa Mexico with US$901 million, Fábrica de Papel de San Francisco with US$313 million, and Resolute Forest Products with US$142 million in 2019. Regarding the national furniture industry, the leading firms by sales are El Puerto de Liverpool, D'Europe Muebles, Muebles Dico, Mueblería Tampico, and Muebles Troncoso, with sales of US$522 million, US$147 million, US$122 million, US$58 million, and US$31 million, respectively, which represented 39 percent of the national market share in 2018 (for details, see appendix H).

Figure 1.8 shows that Oaxaca and Guerrero are among the top 10 states with more plants for wood production. In terms of nontimber products, figure 1.9 reveals that there were 50 firms in the country with a total installed capacity of 118,507 tons in 2018. There were no firms in Chiapas, Guerrero, and Yucatán, while in Oaxaca there were two firms with an installed capacity of 388 tons.

FIGURE 1.8
Number of Plants and Installed and Used Capacity for Wood Products by State, 2018

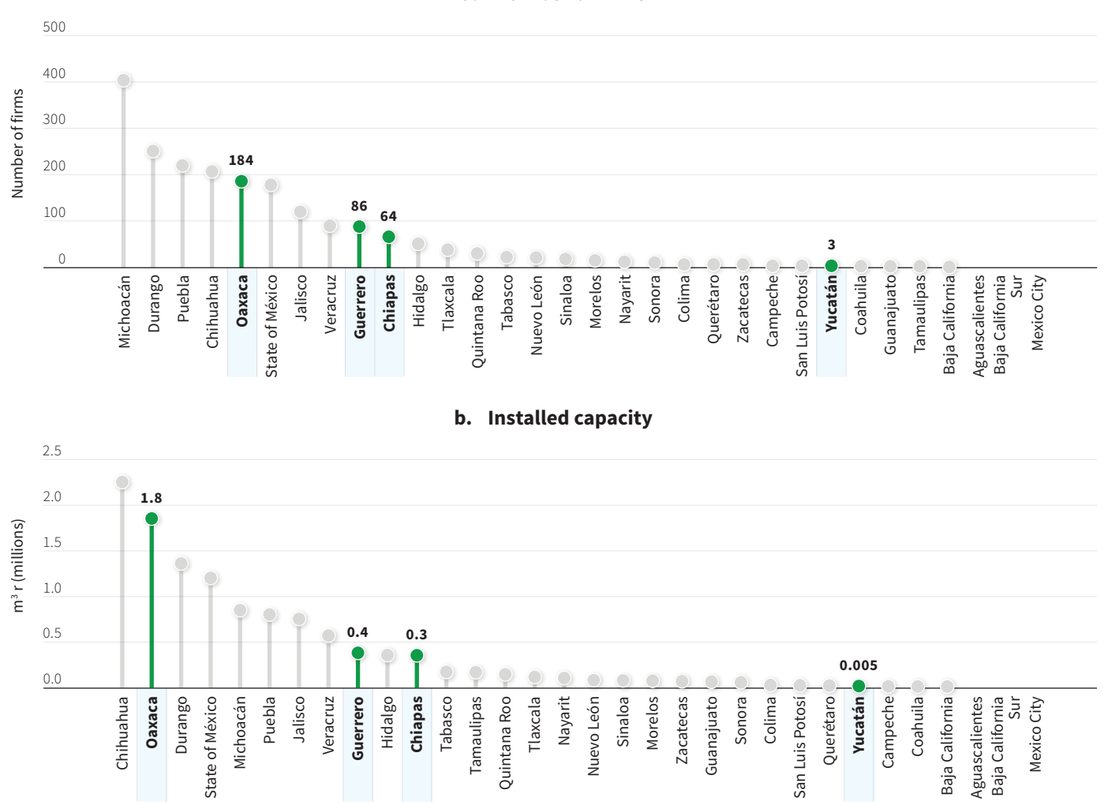


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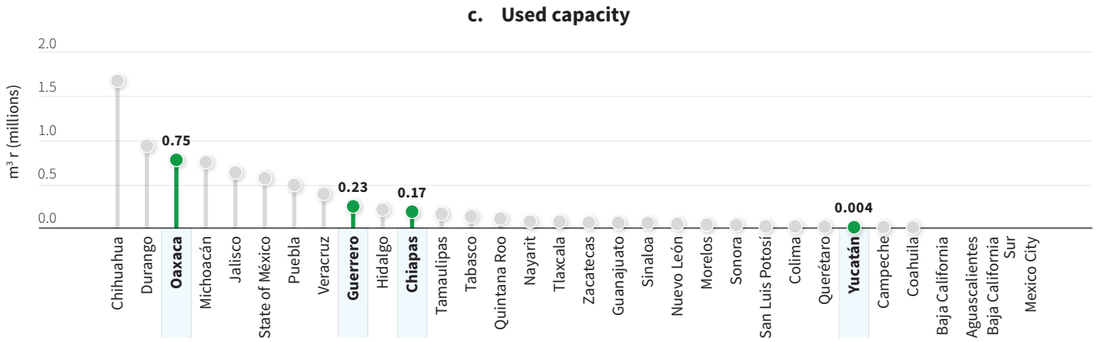
FIGURE 1.8

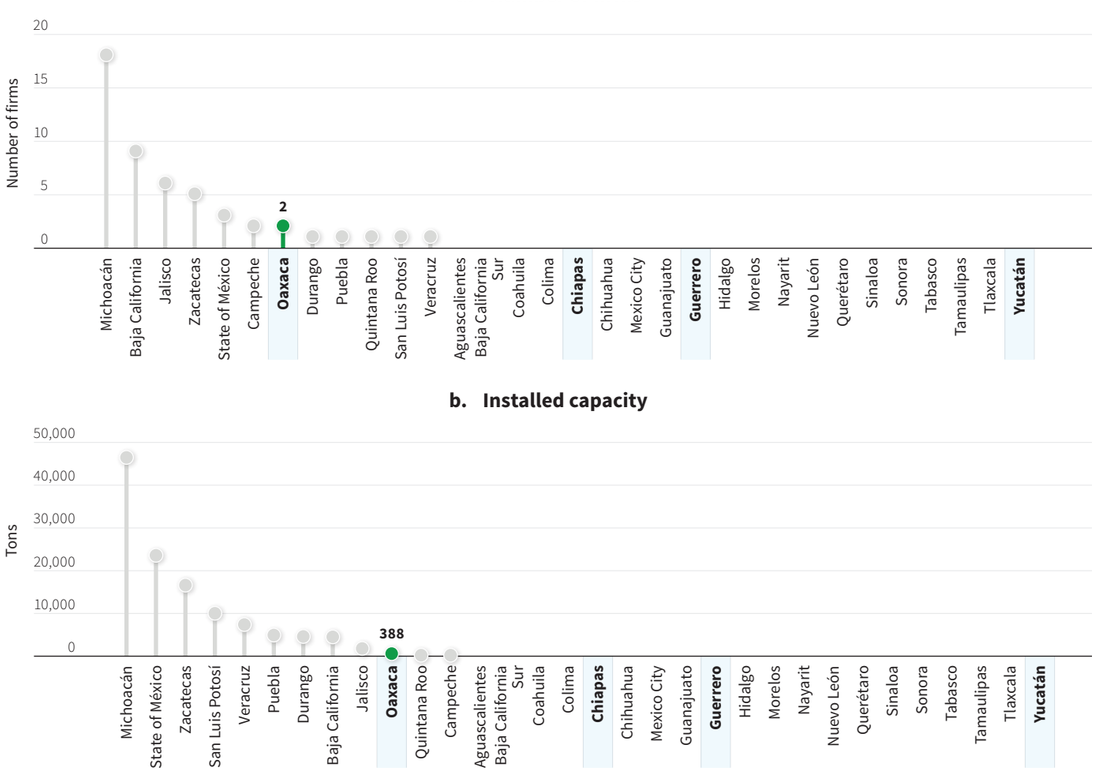
Number of Plants and Installed and Used Capacity for Wood Products by State, 2018 *(continued)*



Source: Based on data from CONAFOR 2021.
Note: m³r = cubic meters of roundwood.

FIGURE 1.9

Number of Firms and Installed Capacity for Nontimber Products by State, 2018



Source: Based on data from CONAFOR 2021.

Box 1.1 describes how a firm, operating in the Southern region, implemented sustainable practices and obtained certifications, thereby increasing its market access.

BOX 1.1

Proteak: An Example of Sustainable Forest Production

At just two decades old, Proteak has established itself as the biggest and most important forest firm in Mexico. It is the third-largest producer of teak (Tectona grandis)—wood with high resistance used for making high-value furniture—in the world and a leader in the production of medium-density fiberboard (MDF). It was founded in the state of Nayarit in 2000, because of the region's ideal climate conditions for cropping teak. It has since expanded its cultivations to the southern region of Mexico, and has extended operations to Colombia, Costa Rica, and Panama.

Proteak started with the vision of only cropping teak as a means to participate in the forest sector with a plant that was not only difficult to produce in Mexico, but also appreciated in the market. The first business model was simple: the partners were in charge of raising money, look for regions in Nayarit to crop teak (by renting the land), wait until the teak was mature (15–20 years), process the timber, sell them, distribute the profits, and use the money to crop more teak. It started with more than 284 hectares planted in 2006. The profit margins of the teak were ten times the value invested. The firm then decided to extend its operations. To do so, it started to implement more rigorous sustainable practices to achieve certifications from the Forest Stewardship Council (FSC), which made them the first Mexican firm to achieve FSC standards. This also allowed them to achieve financial subsidies from the *Comisión Nacional Forestal* (National Forestry Commission; CONAFOR) through the program ProÁrbol. By 2009, Proteak had achieved its area of planted teaks to 2,706 hectares, expanding beyond Nayarit to Tabasco. By that year, the firm achieved the *Premio Nacional al Mérito Forestal*, granted by CONAFOR. In 2010, to raise more funds, the firm decided to become public in the *Bolsa Mexicana de Valores* (Mexican Stock Exchange). It received funds from several stakeholders, including Afores that were looking for long-term investments. With those funds, Proteak expanded to mature teak regions in Latin America to reduce times for maturity of the crops, increasing its production considerably and acquiring experience in international markets. By 2011, the company had already founded its first germplasm center and a greenhouse to produce its own seeds.

Because the company had well certified sustainable practices, it received a loan from the International Finance Corporation in 2012, which allowed them to tap into the Asian market and started to crop Eucalyptus. By this time, the business model was different: they produced the teak in Mexico and Latin America, sent the raw material to workshops in Asia, received manufactured products, and sold those products to developed markets in Europe and the United States.

To reduce their dependence on Asian workshops, in 2013, the company developed a manufacturing timber plant to produce MDF, a board made of wood and synthetic fibers which is widely used for building furniture for offices and homes. The 30 hectares manufacturing plant was installed in Huimanguillo, Tabasco, where the firm had its crops of Eucalyptus, and represented an investment of around US$220 million. The project represented one of the highest forest-industrial complexes in Mexico for wooden products, with a capacity to produce 6 million boards per year (280,000 cubic meters of wood). The plant has cutting-edge technologies that enable it to be 100 percent sustainable, producing its own energy and disposing of its own residues.

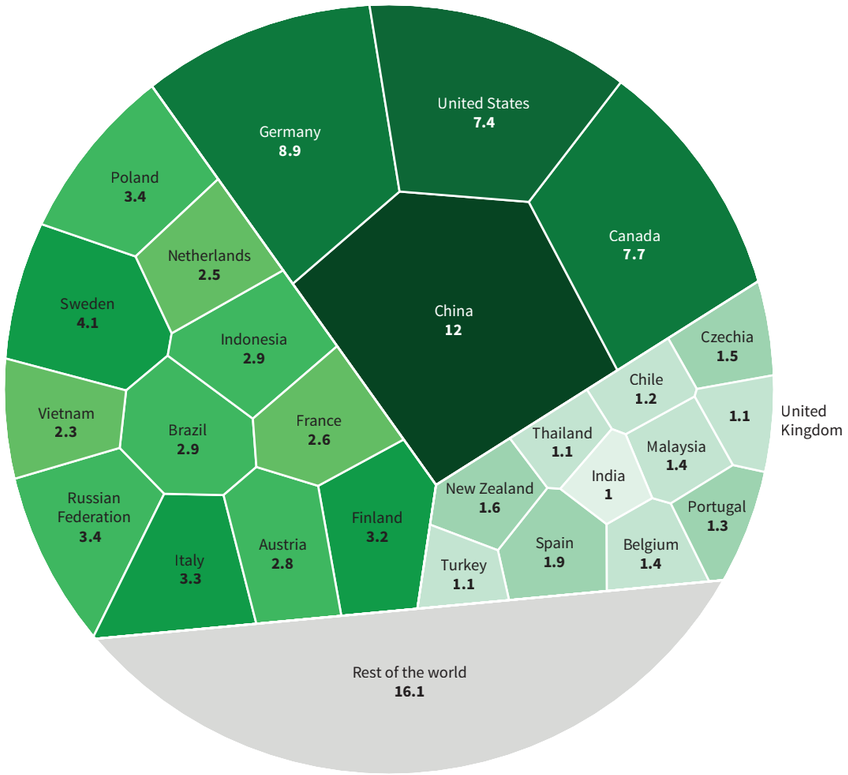
To date, the firm has achieved up to 19,000 hectares for the production of teak and Eucalyptus. It exports to various markets in Europe and North and South America. Furthermore, the firm holds environmental, sustainable, and social certifications throughout its entire value chain. It also seeks to provide improvements in the communities situated near its production areas.

2
Market Potential

EXPORTS

Between 1995 and 2021, Mexico's forest sector exports grew by 4.4 percent per year, above the global average of 3.4 percent. As a result, the country's global market share increased from 0.6 to 0.8 percent. Mexico is Latin America's third-largest exporter of forest products after Brazil and Chile, with annual exports of US$3.8 billion. Nevertheless, the sector's contribution to total merchandise exports fell from 1.6 to 0.8 percent over the period, reflecting a more accelerated growth of other Mexican exports. Close to 90 percent of global forest exports are paper, paperboard, and by-products (38.3 percent), wood and articles of wood (38.0 percent), and pulp of wood or other fibrous cellulosic material and recovered paper or paperboard (10.9 percent). Kitchen and bedroom furniture as well as other wooden furniture of Mexico presented higher average shares in global exports and growth rates. Yet, paper, paperboard, and by-products represented almost half of Mexico's forest sector exports in 2021 (figure 2.1 and table 2.1).

FIGURE 2.1
Share of Wood Industry Global Exports by Country, 2021



Source: Based on data from UN Comtrade.

TABLE 2.1

Key Indicators of Forestry Exports

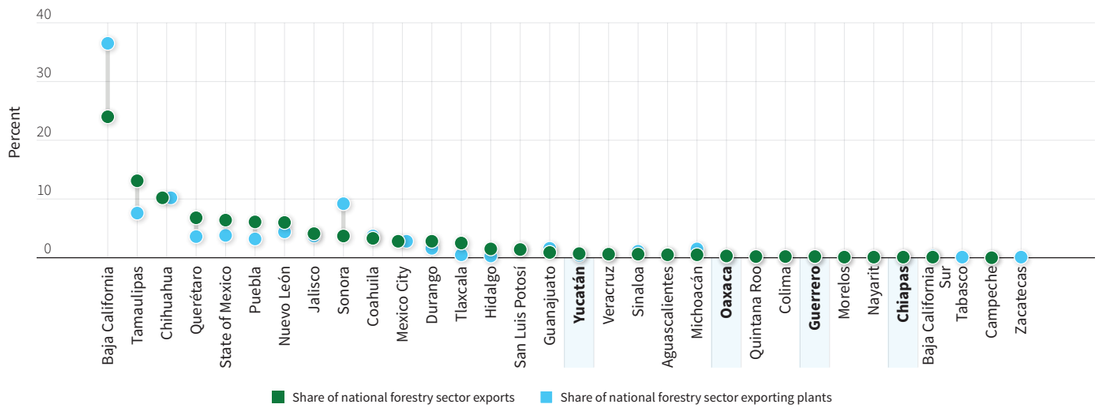
Subsector or product*	Global forestry exports, 2021			Mexico's forestry exports, 2021		
	Value (US$, millions)	Share of merchandise exports (%)	CAGR, 1995–2021 (%)	Share in global exports (%)	Value (US$, millions)	CAGR, 1995–2021 (%)
Wood and articles of wood; wood charcoal	183,339.4	0.9	4.3	0.5	877.7	3.4
Cork and articles of cork	2,246.8	0.0	2.8	0.1	2.9	7.0
Pulp of wood or other fibrous cellulosic material; waste and scrap of paper or paperboard	52,359.1	0.2	2.6	0.0	16.2	−1.7
Paper and paperboard; articles of paper pulp, of paper or paperboard	184,827.6	0.9	2.5	1.0	1,876.1	4.1
Furniture; wooden, for office use	4,555.0	0.0	4.2	1.1	47.9	3.5
Furniture; wooden, for kitchen use	9,043.6	0.0	6.0	1.7	151.3	11.9
Furniture; wooden, for bedroom use	12,431.1	0.1	5.5	2.4	302.8	5.6
Furniture; wooden, other than for office, kitchen, or bedroom use	33,366.9	0.2	5.0	1.7	566.5	7.0
Total	482,169.6	2.2	3.4	0.8	3,841.4	4.4

Source: Calculations based on data from UN Comtrade.
*All furniture products use a Harmonized System (HS) six-digit code (940330, 940340, 940350, and 940360), while the other subsectors use an HS two-digit code (44, 45, 47, and 48). CAGR = compound annual growth rate.

In 2014, the share of the selected states in the national forestry sector exports was estimated at 1.2 percent. Based on estimations from the Atlas of Economic Complexity of Mexico (latest year available before the tool was discontinued),[33] Yucatán contributed the most to the country's forestry exports (0.7 percent), followed by Oaxaca (0.3 percent), Guerrero (0.2 percent), and Chiapas (0.1 percent). Nationally, more than 60 percent of forest exports were concentrated in just five states: Baja California (24 percent), Tamaulipas (13.1 percent), Chihuahua (10.2 percent), Querétaro (6.8 percent), and the State of México (6.4 percent) (figure 2.2).[34]

FIGURE 2.2

Forestry Sector Exports and Exporting Firms by State, 2014



Source: Calculations based on data from the Mexico Atlas of Economic Complexity database.

The selected states have comparative advantages for exporting a limited number of forestry sector goods. Table 2.2 shows that out of 57 forestry sector export products, Yucatán has four products with comparative advantages,[35] indicating that the state exported more than the national average; while Guerrero has two, Oaxaca has one, and Chiapas none. Products with comparative advantages could accelerate the development the forestry sector in the selected states.

IMPORT SUBSTITUTION ANALYSIS

In Mexico, imports of forestry sector products fell from 4.3 to 2.0 percent of total imports between 1995 and 2021. However, Mexico's share in global forestry imports increased from 1.4 percent to 1.9 percent in the same period. In 2021, the country's forestry sector imports totaled a US$10.6 billion market for import substitutions. Mexico's main import partners in the forest sector are the United States (67.2 percent), China (9.1 percent), Brazil (5 percent), Germany (3.3 percent), and Canada (2.8 percent). Mexico's fastest-growing and highest-share forest sector imports include lumber and various types of paper. Imports of paper and lumber have also increased rapidly among the selected states, along with imports of plywood, wooden veneers, and packing crates.

Based on national and regional trends, it is possible to identify products that can substitute for imports.[36] Those products include fiberboard 0.5–0.8 grams per square centimeter worked or surface covered; wooden casks, barrels, vats, tubs, among others; paper, fine, woodfree, 40–150 grams per square meter, uncoated; paper, coated, impregnated, covered, colored, or printed; and paper, self-adhesive, cut to size, in strips or rolls. Substitutable imports in neighboring states[37] and in Mexico City include paper and paperboard coated on one or both sides with kaolin or other inorganic substances; other furniture and furniture parts; uncoated paper and paperboard used for writing, printing, or other graphic purposes; nonperforated punch-cards and punch-tape paper; and other paper, cellulose wadding, and webs of cellulose fibers (table 2.3 and 2.4).

TABLE 2.2

Selected States' Competitive Export Strengths in the Forestry Sector, 2014

HS code	Description	Comparative advantage			
		Chiapas	Guerrero	Oaxaca	Yucatán
4412	Plywood, veneered panels, and similar laminated wood		✓		
4418	Builders' joinery and carpentry of wood, including cellular wood panels and assembled flooring panels; shingles and shakes			✓	✓
4420	Wood marquetry and inlaid wood; caskets and cases for jewelry or cutlery and similar articles, of wood; statuettes and other ornaments, of wood; wooden articles of furniture nes				✓
4819	Cartons, boxes, cases, bags, and other packing containers, of paper, paperboard, cellulose wadding, or webs of cellulose fibers; box files, letter trays and similar articles, of paper or paperboard of a kind used in offices, shops or the like		✓		✓
9403	Furniture and parts thereof, nes				✓

Source: Based on data from the Mexico Atlas of Economic Complexity database.
Note: HS = Harmonized System; nes = not elsewhere specified. A product is said to have a comparative advantage if its revealed comparative advantage is greater than one.

TABLE 2.3

Chiapas, Guerrero, Oaxaca, and Yucatán Leading Forest Sector Imports Ranked by Contribution to Region's Forest Sector Imports

Rank	HS code	Description	Value, 2014 (US$, thousands)	Share (%)	CAGR, 2004–14 (%)
1	4802	Uncoated paper and paperboard, of a kind used for writing, printing, or other graphic purposes, and nonperforated punch-cards and punch tape paper, in rolls or rectangular (including square) sheets, of any size, nes	11,730.2	16.5	16.7
2	4819	Cartons, boxes, cases, bags, and other packing containers, of paper, paperboard, cellulose wadding, or webs of cellulose fibers; box files, letter trays and similar articles, of paper or paperboard of a kind used in offices, shops or the like	11,464.4	16.1	1.9
3	4412	Plywood, veneered panels, and similar laminated wood	7,604.7	10.7	14.3
4	4804	Uncoated kraft paper and paperboard, in rolls or sheets, nes	7,553.6	10.6	5.2
5	4408	Sheets for veneering (including those obtained by slicing laminated wood), for plywood or for similar laminated wood and other wood, sawn lengthwise, sliced or peeled, whether or not planed, sanded, spliced or end-jointed, of a thickness not exceeding 6 mm	5,659.9	8.0	8.7
6	4801	Newsprint	5,429.4	7.6	−1.2
7	4821	Paper and paperboard labels of all kinds, whether or not printed	4,742.8	6.7	−3.3
8	4407	Wood sawn or chipped lengthwise, sliced or peeled, whether or not planed, sanded or end-jointed, of a thickness exceeding 6 mm	3,456.8	4.9	−11.9
9	4415	Packing cases, boxes, crates, drums, and similar packings, of wood; cable-drums, of wood; pallets, box-pallets and other load boards, of wood; pallet collars of wood	2,427.7	3.4	27.1
10	9403	Other furniture and parts thereof	2,295.5	3.2	−4.0
11	4823	Other paper, paperboard, cellulose wadding, and webs of cellulose fibers, cut to size or shape; other articles of paper pulp, paper, paperboard, cellulose wadding, or webs of cellulose fibers	1,848.0	2.6	0.7
12	4811	Paper, paperboard, cellulose wadding and webs of cellulose fibers, coated, impregnated, covered, surface-colored, surface-decorated or printed, in rolls or rectangular (including square) sheets, of any size, nes	1,478.8	2.1	9.4
13	4416	Casks, barrels, vats, tubs and other coopers' products and parts thereof, of wood, including staves	1,371.3	1.9	16.6
14	4820	Registers, account books, notebooks, order books, receipt books, letter pads, memorandum pads, diaries and similar articles, exercise books, blotting pads, binders (looseleaf or other), folders, file covers, manifold business forms, interleaved carbon set	806.0	1.1	28.7
15	4816	Carbon paper, self-copy paper and other copying or transfer papers (nes), duplicator stencils and offset plates, of paper, whether or not put up in boxes	524.1	0.7	4.0

Source: Based on data from the Mexico Atlas of Economic Complexity database.
Note: CAGR = compound annual growth rate; mm = millimeter; nes = not elsewhere specified.

TABLE 2.4

Chiapas, Guerrero, Oaxaca, and Yucatán Leading Forest Sector Imports Ranked by CAGR

Rank	HS code	Description	Value, 2014 (US$, thousands)	Share (%)	CAGR, 2004–14 (%)
1	4413	Densified wood, in blocks, plates, strips or profile shapes	43.3	0.1	35.4
2	4504	Agglomerated cork (with or without a binding substance) and articles of agglomerated cork	26.2	0.0	33.3
3	4820	Registers, account books, notebooks, order books, receipt books, letter pads, memorandum pads, diaries and similar articles, exercise books, blotting pads, binders (looseleaf or other), folders, file covers, manifold business forms, interleaved carbon set	806.0	1.1	28.7
4	4415	Packing cases, boxes, crates, drums, and similar packings, of wood; cable-drums, of wood; pallets, box-pallets, and other load boards, of wood; pallet collars of wood	2,427.7	3.4	27.1
5	4807	Composite paper and paperboard (made by sticking flat layers of paper or paperboard together with an adhesive), not surface-coated or impregnated, whether or not internally reinforced, in rolls or sheets	95.5	0.1	21.5
6	4818	Toilet paper and similar paper, cellulose wadding or webs of cellulose fibers, of a kind used for household or sanitary purposes, in rolls of a width not exceeding 36 cm, or cut to size or shape; handkerchiefs, cleansing tissues, towels, tablecloths	186.7	0.3	17.7
7	4802	Uncoated paper and paperboard, of a kind used for writing, printing or other graphic purposes, and nonperforated punch-cards and punch tape paper, in rolls or rectangular (including square) sheets, of any size, nes	11,730.2	16.5	16.7
8	4416	Casks, barrels, vats, tubs and other coopers' products and parts thereof, of wood, including staves	1,371.3	1.9	16.6
9	4412	Plywood, veneered panels, and similar laminated wood	7,604.7	10.7	14.3
10	4810	Paper and paperboard, coated on one or both sides with kaolin (China clay) or other inorganic substances, with or without a binder, and with no other coating, whether or not surface-colored, surface-decorated or printed, in rolls or rectangular (including square) sheets, of any size	299.6	0.4	11.8
11	4811	Paper, paperboard, cellulose wadding and webs of cellulose fibers, coated, impregnated, covered, surface-colored, surface-decorated or printed, in rolls or rectangular (including square) sheets, of any size, nes	1,478.8	2.1	9.4
12	4408	Sheets for veneering (including those obtained by slicing laminated wood), for plywood or for similar laminated wood and other wood, sawn lengthwise, sliced or peeled, whether or not planed, sanded, spliced or end-jointed, of a thickness not exceeding 6 mm	5,659.9	8.0	8.7
13	4411	Fiberboard of wood or other ligneous materials, whether or not bonded with resins or other organic substances	330.8	0.5	8.0
14	4804	Uncoated kraft paper and paperboard, in rolls or sheets, nes	7,553.6	10.6	5.2
15	4816	Carbon paper, self-copy paper and other copying or transfer papers (nes), duplicator stencils and offset plates, of paper, whether or not put up in boxes	524.1	0.7	4.0

Source: Based on data from the Mexico Atlas of Economic Complexity database.
Note: CAGR = compound annual growth rate; mm = millimeter; nes = not elsewhere specified.

3

Main Products and Potential Locations

Oaxaca is the largest producer of raw timber among the selected states and the third largest by volume in Mexico. In 2018, Oaxaca's timber production exceeded 700,000 cubic meters of roundwood (m^3r), while production in Chiapas and Guerrero was below 200,000 m^3r, and in Yucatán was around 10,000 m^3r. Pine represented more than 90 percent of timber production in Oaxaca and Guerrero, and close to 75 percent in Chiapas. Yucatán exclusively produced tropical comuna. Scantling was the main timber product in Chiapas, Guerrero, and Oaxaca, representing above 90 percent of their total production. Yucatán's main product was charcoal, which accounted for 82 percent of total timber products.

Among the selected states, Guerrero is the largest producer by volume of nontimber products, followed by Chiapas and Oaxaca. As of 2018, the main nontimber product in Guerrero, Oaxaca, and Yucatán was one or more of the 18 different plants and trees included under the "others" category.[38] Other important nontimber raw materials included fibers in Guerrero and resins in Oaxaca. Chiapas produced only resins. Guerrero had the highest production value of total nontimber materials (Mex$16.5 million), followed by Oaxaca (Mex$4.6 million).

The next step in the development of the forest industry is to transform those raw materials into industrial products.

FURNITURE

The value of Mexico's furniture market is estimated at US$2.5 billion. More than 90 percent of the country's production is concentrated in five segments: bedroom furniture (32.8 percent), seating (23.0 percent), dining room furniture (17.5 percent), living room furniture (11.7 percent), and kitchen cabinetry (6.6 percent).[39] Globally, Mexico is the eighth-largest exporter of chairs and wooden seats and the ninth-largest exporter of wooden parts and pieces for furniture.[40]

The furniture industry can be divided into craft and industrial products based on production processes. The former is more labor-intensive and caters to a narrower market, whereas the latter targets a broader market, is capital-intensive, and requires constant monitoring of consumer preferences, current trends, and technological updates to remain competitive. However, industrial furniture production requires well-established processes at each stage of the value chain; planning, engineering, and innovation capabilities; sophisticated commercial strategies; and efficient logistic systems to reach target markets—all of which are rare among small local producers in southern Mexico. As a result, production is heavily concentrated in the Central (Jalisco, Mexico City, and the State of México) and Northern (Baja California, Chihuahua, Nuevo León, Sonora, and Tamaulipas) regions.

The development of industrial parks in the selected states could help overcome these challenges by aggregating productive capabilities and know-how through public-private efforts. These parks should be located close to the raw materials and logistics and transportation infrastructures. Initially, the selected states could focus on the production of basic furniture or even furniture components to supply larger, both foreign (mainly Canada and the United States) and domestic (multinationals and local anchor firms) producers. Over time, they should gradually transition to more sophisticated products in response to global trends, such as the ready-to-assemble furniture that is gaining market because of its lower price point.

Underscoring the potential of the Mexican furniture industry, Ikea recently launched operations in Mexico. It started with online sales in 2020, followed by the opening of a store in Mexico City in 2021, and another in Puebla in 2022. Ikea announced a US$170 million investment in a 78-hectare plant in the Chuy María Industrial Park in Ramos Arizpe, Coahuila, which is expected to generate 2,000 jobs.[41]

With community involvement and internationally certified forests, Oaxaca could sustainably increase furniture production. In Oaxaca, about 80 percent of all forests are located in communal land (*comunas* and *ejidos*), and the state government has successfully promoted the community-based production of raw

timber, granting a stable source of inputs than could be used for processed products. Oaxaca has close to 10,000 hectares of land certified by the Forest Stewardship Council (third state with the greatest area). The comparative advantage of the state in the production of boards and planks and wood containers and pallets could be leveraged to launch a wider range of manufacturing activities, including furniture production as some private firms have started to do so. Box 2.1 provides an example of a successful firm already manufacturing wooden products in Oaxaca.

Chiapas and Yucatán require a sustainable production policy, as these states have grappled with illegal logging and deforestation in recent years. Chiapas ranks in the middle for timber production nationwide, but the state has suffered major deforestation in recent years, losing 692,000 hectares between 2001 and 2020 (the second state with the greatest deforestation).[42] Yucatán has much lower production levels, yet it also lost 483,000 hectares in the same period (the fourth state with greatest deforestation). As a result, many authorizations for forest production have not been renewed, particularly in Chiapas, but illegal logging has continued in both states and is one of the main causes of deforestation, along with the burning of forested land for agricultural purposes. A sustainable forest production policy that emphasizes reforestation and the development of sustainable commercial plantations and production plants could help curb the rate of deforestation, while enabling these states to harness new market opportunities.

In Yucatán, the manufacturing subsectors could continue growing despite the low availability of raw inputs in the state provided that they are brought in from elsewhere with efficient logistics. Yucatán has high productivity levels and comparative advantages in the manufacturing of fitted kitchens and modular bathroom furniture, and producers could acquire raw inputs from other states

BOX 2.1

The Case of Puertas Finas de Madera Montealban

Founded in Oaxaca in 1983, *Puertas Finas de Madera Montealban* is a key player specialized in wooden products manufacturing, ranging from wood veneers and plywoods to wooden doors and reels.

The company started as a family-owned business with operations in the states of Guerrero and Oaxaca. They started as designers and custom millworks for doors and windows to be installed in different parts of houses, offices, and hotels. Since its early years, the firm has tried to pursue sustainable business practices, which have been its main seal for commercial purposes. It has achieved different sustainable and socially responsible certifications since its early stages (1997), including the Chain of Custody Certification of the Forest Stewardship Council for forest products. By 2002, it achieved the certification in 80 percent of its products, including a sawmill, which was the first facility of its kind to achieve that certification in Mexico. Securing the certifications was critical for the firm to expand its products into international markets such as the European Union and North America, where this kind of policy is demanded to guarantee that products come from regions implementing sustainable practices.

To expand to other regions, the company got support from the International Finance Corporation (IFC), which provided not only long-term financing, but also technical advisory to the firm for improving its operations and achieving other certifications. The first and second financial support, granted in 2002 and 2013, allowed the firm to modernize its facilities to increase its production capacity, as well as achieve the Chain of Custody Certification, and improve its relations with local suppliers. The resources of the third support, granted in 2015, were used to invest in improving energy efficiency in the firm's production, as well as other processes to complete environmental and social standards.

The firm uses wooden raw materials from the regions of Guerrero and Oaxaca and provides technical assistance to local producers to increase production and adopt sustainable practices, which has been systematized with IFC's advisory.

The firm has expanded its presence in the country, establishing operations in the states of Guanajuato, Hidalgo, Mexico City, Morelos, Querétaro, and State of México, with access to some of the main domestic markets. This allowed *Puertas Finas Montealban* to become one the most important manufacturer of doors in the country in terms of sales volume (around 500,000 doors annually for a variety of furniture) and export to the Canada, the Caribbean, and the United States.

to expand this subsector while steps to counter deforestation are being implemented. Baja California offers a salient example of this approach: although its timber output is extremely low, the state is a leader in furniture production and has more than 10 times as many manufacturers of fitted kitchens and modular bathroom furniture as Yucatán. Two large furniture producers are already installed in Yucatán, one of them is a Chinese company that is harnessing the nearshoring trend to expand its operations, further highlighting the potential for this approach in Yucatán.

PULP, PAPER, AND PAPERBOARD

The production of pulp, paper, and paperboard is less dependent on forest resources and offers enormous potential for import substitution. The industry already has an incipient presence in the selected states: Yucatán has four pulp mills and Oaxaca has one, while Chiapas has around 350 paper manufacturers, Guerrero about 300, Oaxaca more than 280, and Yucatán close to 160.[43] Mexico imported US$6.21 billion in paper and paperboard in 2021 and exported US$1.87 billion. This trade deficit has nearly doubled since 2003 (and nearly quadrupled since 1995). Similarly, Mexico imported US$1.16 billion of wood pulp in 2021 but exported just US$16.15 million.[44] The global trend in this subsector is toward an increasing reliance on recycled raw materials.

One of the main challenges facing this subsector is the need to consolidate an efficient and reliable system for recycling paper and paperboard. Although Mexico has increased its recycling rate in recent years from 49.7 to 53.6 percent, it is below the global average of 58 percent and the levels of global leaders such as Australia (85 percent) and Japan (80 percent).[45] Among the selected states, using recycled inputs could be a way to expand the paper manufacturing in Oaxaca by harnessing its outstanding productivity and comparative advantages.[46] Because of the limited supply of raw materials, Oaxaca's only pulp mill for some years has operated at less than 50 percent of its capacity and shipped in raw materials from other states, including from those in Northern Mexico.[47] Moreover, increasing recycling rates reduces waste and can generate savings of up to 39 and 25 percent for energy and water, respectively.[48]

LOCATIONS WITH HIGH DEVELOPMENT POTENTIAL

Locations with potential for sustainable production of raw materials and its transformation, while being well-connected to key infrastructure and away from protected areas include the following (map 3.1):

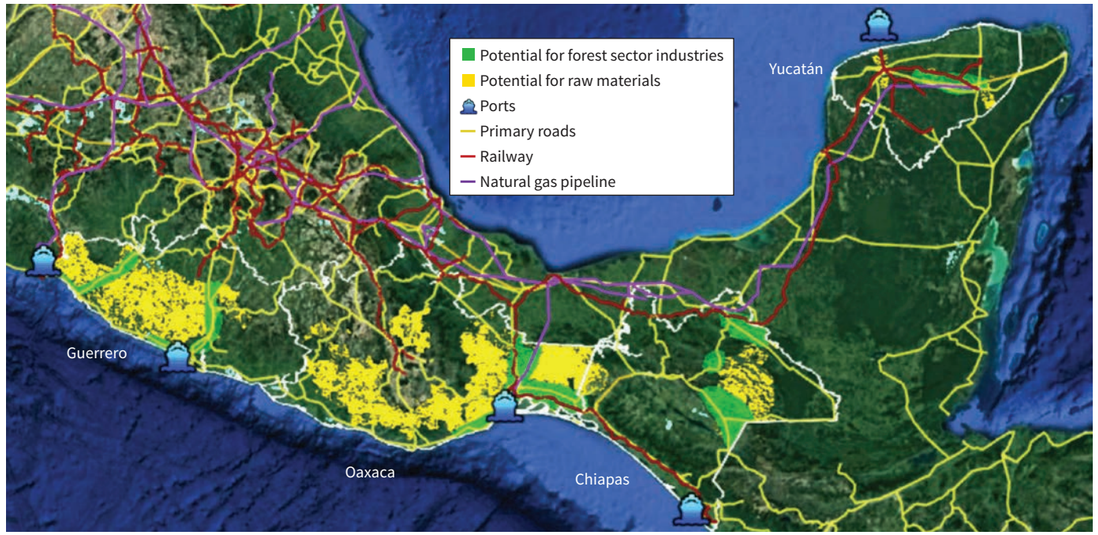
- In Chiapas, the areas with the greatest potential to increase the production of raw materials are in the eastern part of the state near the Selva Lacandona and Meseta Comiteca–Tojolabal regions. Potential locations for industrial production are near the city of Comitán, around the Federal Highway (Fed.) 190, and in the north of the state near Palenque, where pipelines and railways already exist.
- In Guerrero, key areas for raw materials production are on the western and southern parts, which include the Costa Grande, Tierra Caliente, and Centro

regions. Potential locations for industrial production are mainly along the Fed. 95D, which connects Acapulco with Mexico City via Chilpancingo and Cuernavaca; on the western side around Tierra Caliente; and the coastal region from Zihuatanejo to Lázaro Cárdenas in Michoacán.

- In Oaxaca, raw materials production potential is concentrated in the Istmo, Sierra Sur, and Valles Centrales regions. Potential locations for industrial production are along the Fed. 185 (or Transístmica) and Fed. 190 (from Juchitán to Arriaga), which also have railway access connecting to the Interoceanic Corridor of the Isthmus of Tehuantepec.[49]
- Yucatán's modest potential for raw materials production is focused on Centro, Noreste, and a small part of Oriente, close to the cities of Mérida and Valladolid. Key opportunities for industrial production are clustered around the city of Mérida and along the Mérida-Progreso and Mérida-Valladolid corridors, where existing railways are being integrated into the Mayan Train Project,[50] and where primary roads offer a comparative advantage.

MAP 3.1

Potential Regions for Developing Forest Sector Activities Based on Products and Inputs Availability and Existing Transportation and Logistics Infrastructure in the Selected States



Source: Elaborated using Google Earth with information from INEGI 2017; CONANP 2019; CONAFOR 2019; SCT 2019; SENER 2018.
Note: The symbols are only indicative and are not meant to reflect exact locations, except for potential for raw materials.

4
Challenges and Sectoral Binding Constraints

The methodology used to identify the main constraints for the development of the forest sector in the selected states is based on the growth diagnostics framework developed by Hausmann, Klinger, and Wagner (2008).[51] Using the decision-tree approach of the framework, we adapt it at the sectoral level and applied to the analysis for Chiapas, Guerrero, Oaxaca, and Yucatán,[52] which focused on human capital, geography and infrastructure, governance and institutional failures, and access to finance.

Based on this analysis, the main constraints to the forest sector in the selected states include low human capital in the manufacturing sector; deficient transportation, communications, and logistics infrastructure, as well as low availability of fuel; high regulatory compliance costs coupled with loose enforcement and inefficient government support programs; and inadequate access to finance especially among manufacturers. Alleviating these constraints could unleash the growth of the forest sector in the selected states.

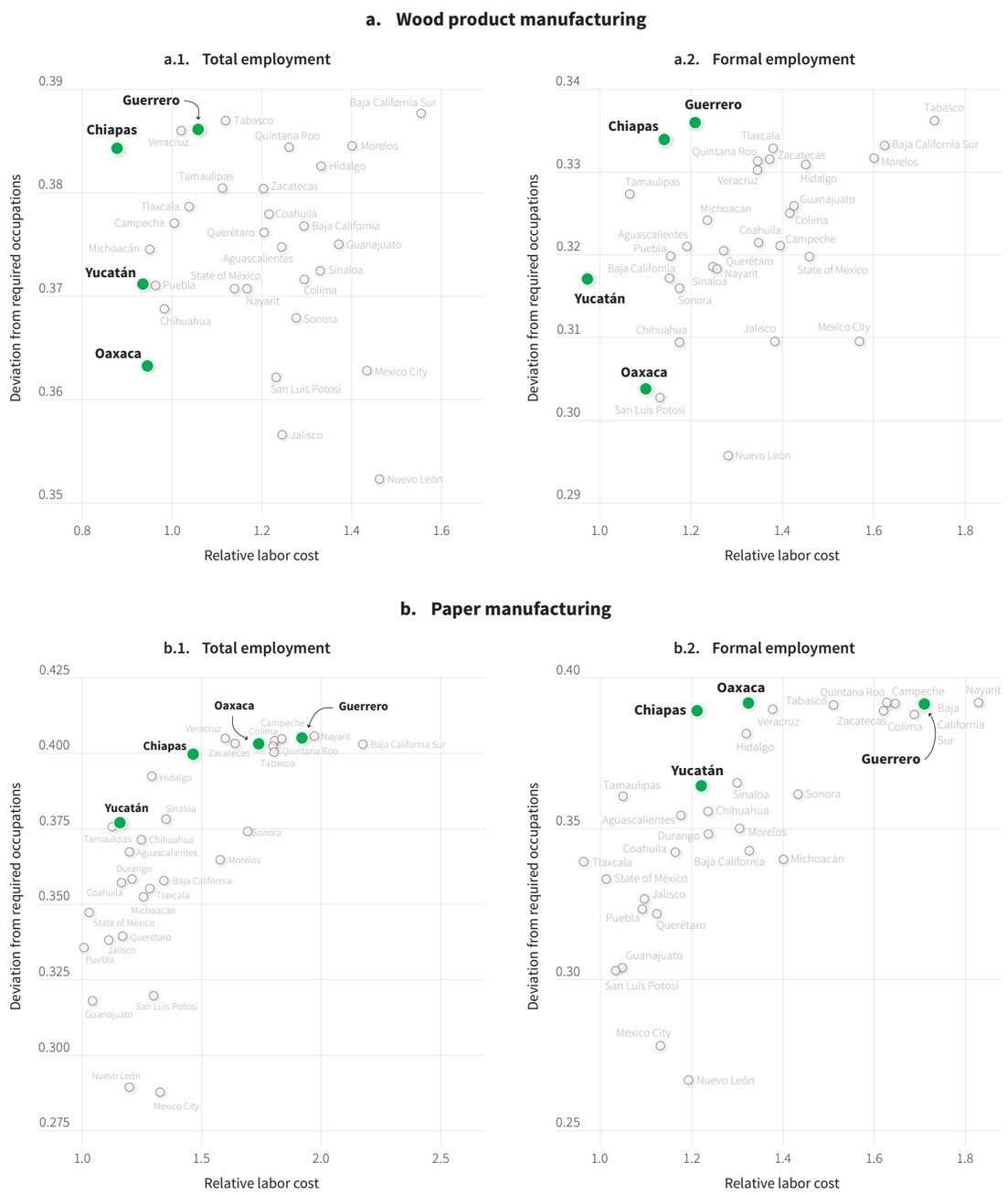
HUMAN CAPITAL[53]

Lack of human capital is a binding constraint in advanced segments of the value chains of the paper and furniture manufacturing for Guerrero and Oaxaca (particularly the former), but this constraint is less severe in Chiapas and Yucatán (particularly the latter). Most of the selected states present skills gaps, but the wage premiums to overcome this scarcity are not present across all states and forest sector activities. Wood product manufacturing in Chiapas and Guerrero have large gaps in workforce skills considering both the full pool of workers and only formal employment. Guerrero has the third-highest deviation in the former case and the second highest in the latter, while Chiapas has the seventh and third highest, respectively. Yet salaries are not especially high, suggesting that the labor force itself is not a binding constraint on the development of the subsector. However, for paper manufacturing in Guerrero and Oaxaca, a combination of large skills gaps and high salaries suggest that the scarcity of skilled workers may be hindering their growth. In the total and formal labor force, Guerrero have the fourth and third, respectively, highest skills gaps while Oaxaca have the sixth and fourth, respectively. These states also rank in the upper half among the states with the highest labor costs. Evidence also suggests that the furniture manufacturing in Guerrero and Oaxaca lacks qualified personnel. Guerrero presents the highest skills gaps considering all workers and only formal ones, and the 10th highest labor cost in the former and the highest in the latter. Oaxaca is in the upper half of skills gaps considering total labor force and just formal workers, and the 11th highest labor cost in the latter, which confirms a scarcity of human capital for formal incumbent firms. In contrast, in Chiapas and Yucatán, the evidence is less compelling as some skills gaps prevail (especially for paper manufacturing and in Chiapas) but with low salaries, which suggests that constraints other than human capital are limiting the development of these subsectors (figure 4.1).

INFRASTRUCTURE, FACTOR INTENSITY, AND SECTOR-SPECIFIC RISKS[54 AND 55]

Energy could be a constraint for veneer, plywood and engineered wood product manufacturing, and pulp, paper, and paperboard mills, mainly in Oaxaca and Guerrero. Veneer, plywood, and engineered wood product manufacturing (North American Industry Classification System [NAICS] four-digit code 3212) and pulp, paper, and paperboard mills (3221) are highly energy intensive, whereas sawmills and wood preservation (3211), converted paper product manufacturing (3222), household and institutional furniture and kitchen cabinet manufactur-

FIGURE 4.1
Skill Deviations and Labor Costs in Main Forestry Subsectors

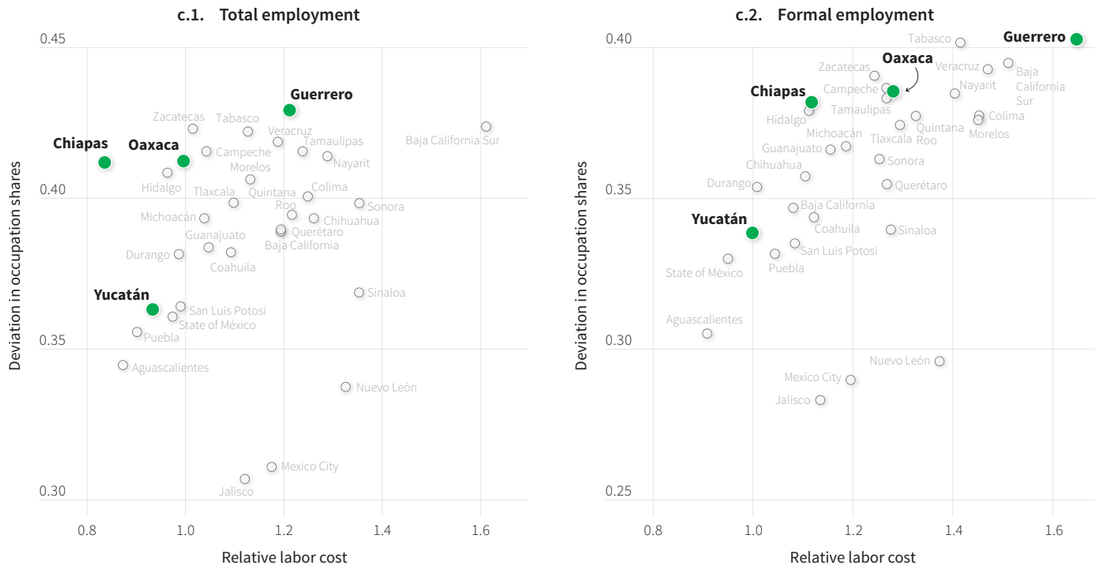


(Figure continues next page)

FIGURE 4.1

Skill Deviations and Labor Costs in Main Forestry Subsectors *(continued)*

c. Furniture and related products manufacturing



Source: Calculations based on data from INEGI's I-2019 ENOE database.
Note: In both panels, the x-axis is the ratio of the average hourly wage ratios at national and state levels, and y-axis is the deviation in occupation shares between national and state levels (measured using the symmetric mean absolute percentage error), in the first quarter of 2019. For wood product manufacturing (panels a.1 and a.2), Durango was excluded because it presented symmetric mean absolute percentage error values of more than four standard deviations below the averages for the total (0.310) and formal (0.226) labor markets. Hence, it is considered an outlier.

ing (3371), and office furniture manufacturing (3372) are less energy intensive, and other wood product manufacturing (3219) is the least energy intensive. For the most energy intensive subsectors (3221 and 3212) energy is most likely to be a constraint mainly for Guerrero and Oaxaca, as they lack high voltage transmission lines across their regions—notably in the Montaña, Tierra Caliente, and Centro regions of Guerrero and the western and northern parts of Oaxaca—and the balance of energy production to consumption is low in the latter because of limited generation, despite having high potential for renewable energy.[56]

In some parts of Guerrero, the availability of water resources (superficial and underground) could be a relevant constraint for the forest sector. Sawmills and wood preservation (NAICS 3211) and other wood product manufacturing (3219) are the only low-intensity activities, while converted paper product manufacturing (3222), household and institutional furniture and kitchen cabinet manufacturing (3371), and office furniture manufacturing (3372) are moderately water intensive, and veneer, plywood, and engineered wood product manufacturing (3212) and pulp, paper, and paperboard mills (3221) are the most water intensive. In some parts of northern Guerrero there is a lack of water availability (superficial and groundwater). This lack of water availability of the state may represent a harder constraint on the development of pulp, paper, and paperboard mills as well as veneer, plywood, and engineered wood manufacturing. Guerrero also has a high cost per volume produced and the highest cost-fare relation among the selected states, which may increase operating costs for any industry with intensive water use.

Lack of adequate transportation infrastructure may represent an important constraint for developing the sector in the selected states, notably in Guerrero. Figure 4.2 shows the intensity of freight use by subsectors. Other wood product manufacturing (NAICS 3219) and household and institutional furniture and kitchen cabinet manufacturing (3371) are moderately freight intensive, while veneer, plywood, and engineered wood product manufacturing (3212), sawmills and wood preservation (3211), pulp, paper, and paperboard mills (3221), converted paper product manufacturing (3222), and office furniture manufacturing (3372) are highly freight intensive. The limited coverage of paved roads in the selected states increases operational costs and reduces total factor productivity, especially in rural areas where forest sector production is concentrated. Guerrero faces significant constraints in terms of transportation infrastructure, especially between the state capital of Chilpancingo and the nearest port in Acapulco (which does not offer freight nor international trade). Moreover, the lack of a connection to Mexico's railway system could hinder the development of the forest sector in Guerrero.

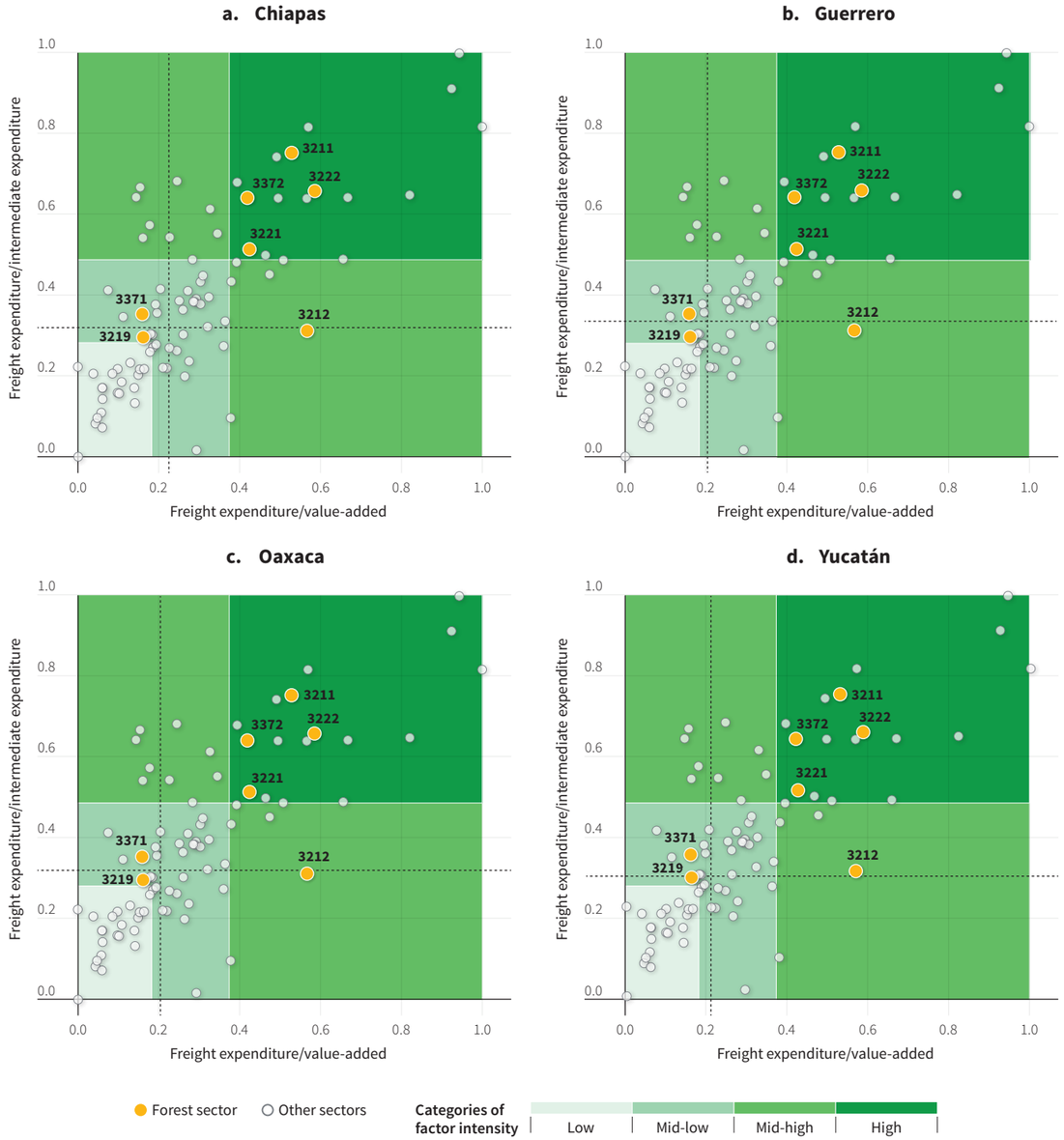
The lack of access to combustibles poses a constraint for mid-high and high fuel intensive forest sector activities, especially for Chiapas and Guerrero. These activities are veneer, plywood, and engineered wood product manufacturing (3212), sawmills and wood preservation (3211), and pulp, paper, and paperboard mills (3221). The challenge of fuel access could constrain the development of these activities in Chiapas and Guerrero, which lack access to the national natural gas system. A prospective natural gas pipeline of approximately 400 kilometers (km) in length that will span the coastal regions of Chiapas (from Salina Cruz to Tapachula) and Oaxaca has been deemed economically infeasible at present,[57] while a similar project of approximately 330 km in length that will span from Michoacán (Lázaro Cárdenas) to Guerrero (Acapulco, crossing through the cities of Zihuatanejo and La Unión) has not received public funding and will only be able to move forward if a private investor is found.[58]

Information and communication technology (ICT) infrastructures do not seem to be a constraint for the development of the forestry sector. Almost all activities are mid-low and low intensive in the use of communications, and only office furniture manufacturing (NAICS 3372) has a mid-high intensity use. Moreover, Yucatán has relatively good ICT infrastructure and, although Chiapas, Guerrero, and Oaxaca have low coverages, their limited ICT infrastructure will not prevent the development of their forestry industries.

Finally, in terms of sector-specific infrastructure, all the states have an installed capacity to produce germplasm,[59] but Chiapas and Guerrero lack sufficient storage capacity. Guerrero has no community seed banks, which leaves it dependent on other states for its seed supply. Investments in germplasm storage and community seed banks in Guerrero and germplasm storage in Chiapas will be necessary over the medium term.

Forest regions are highly vulnerable to arboreal diseases and forest fires.[60] All selected states, except Yucatán, face high risk of arboreal diseases: Chiapas, Guerrero, and Oaxaca are among the seven states with the highest risk of plagues

FIGURE 4.2
Freight Intensity by Sector, 2014 and 2019 Averages



Source: Calculations based on data from INEGI 2014; 2019.
Note: Sectors are classified using NAICS four-digit codes. Blue lines represent the average normalized value of the sectors with a revealed comparative advantage greater than one for each selected state. For Chiapas, those sectors were NAICS 3111, 3112, 3113, 3115, 3116, 3117, 3118, 3119, 3121, 3149, 3219, 3231, 3323, 3328, and 3371; for Guerrero, those sectors were 3115, 3118, 3121, 3131, 3141, 3149, 3152, 3159, 3169, 3219, 3259, 3262, 3273, 3279, 3323, 3371, and 3399; for Oaxaca, those sectors were 3113, 3118, 3121, 3131, 3141, 3149, 3211, 3219, 3241, 3273, and 3323; and for Yucatán, those sectors were 3111, 3112, 3116, 3117, 3118, 3121, 3131, 3141, 3149, 3151, 3152, 3159, 3169, 3219, 3261, 3273, 3279, 3323, 3332, 3333, 3353, 3366, 3371, and 3399. Yellow points represent group industries of the forest industry classified in at the four-digit level, except for groups with confidential information. NAICS = North American Industry Classification System.

in Mexico.[61] All selected states face a high or very high risk of forest fires. As climate change intensifies, increased attention to the prevention and control of forest fires is critical for the viability of the forest sector, especially in Chiapas, Guerrero, and Oaxaca: between 2010 and 2021, these states concentrated more than 10 percent of the fires registered in Mexican forests (around 7,500 annually) and close to a sixth of the surface affected each year (436,000 hectares on average).[62]

GOVERNANCE AND INSTITUTIONAL FAILURES

Obtaining the necessary permits for forest harvesting and transportation is a major obstacle to the development of the forest sector in the selected states, where communities and small landowners possess most of the forest resources. Since 2000, permitting processes have become more burdensome, with increasingly onerous requirements, and the involvement of multiple government agencies has increased the time it takes to obtain a permit.[63] Similarly, the increased fiscal contributions by communities have made it harder for community forestry enterprises to remain in business.

For a community or ejido, obtaining a forest-harvesting permit involves an estimated 44 steps and requires approximately 195 days.[64] Prior to requesting the permit from the *Secretaría del Medio Ambiente y Recursos Naturales* (Secretariat of Environment and Natural Resources; SEMARNAT), the ejido must obtain internal approval in a general assembly, follow the corresponding agrarian procedures, obtain the necessary financial resources to hire a registered forestry technician, and conduct a forest management study detailing the harvesting techniques and compensation measures to be implemented. Once the application is submitted to SEMARNAT, another 26 procedures are required, including an assessment of the environmental, legal, and silvicultural characteristics of the land. By law, SEMARNAT has up to 91 days to provide a resolution, but in practice approvals can take up to 195 days or more. Similarly, obtaining a transportation permit can take from three to four weeks, hindering the legal commercialization of forest products.

This long and burdensome process, combined with a loose oversight, has resulted in illegal markets to thrive. Currently, illegal logging accounts for around 70 percent of all wood sales, up from 30 percent in 2009.[65] The *Procuraduría Federal de Protección al Ambiente* (Federal Attorney for Environmental Protection) has also observed the increasing involvement of criminal groups in the illegal timber trade, and Mexico is now one of the main buyers of illegal timber from the Peruvian Amazon. Within Mexico, illegal logging reduces the profitability of law-abiding firms by an estimated 19 percent.[66]

The illegal burning of forested land is another critical governance failure affecting the forest sector in the selected states. Chiapas and Oaxaca are among the top three states in terms of the number of preliminary inquiries into illegal burning by the *Fiscalía General de la República* (Attorney General's Office), while Guerrero is eighth.[67] Yucatán does not rank among the upper half of the 32 Mexican states.[68] It is estimated that 38 percent of illegal burnings in Mexico are carried out to clear land for agricultural use.[69] Therefore, stronger government regulation and oversight are needed to curb illegal burning.

ACCESS TO FINANCE

Most direct investments in the forest sector come from domestic sources.[70] Although the sector receives very little foreign direct investment, lack of access to international financing does not appear to be a binding constraint on its development. However, access to domestic financing could be an issue in Chiapas, Guerrero, and Oaxaca, which have some of the worst financial services indicators in Mexico. These three states have very few financial access points across municipalities and relative to their population size.[71] Yucatán has somewhat better coverage indicators in per capita terms.

In 2019, the total portfolio balance in Guerrero, Oaxaca, Chiapas, and Yucatán represented 2.8, 6.1, 6.6, and 10.3 percent of nonoil gross domestic product, respectively. Guerrero had the second lowest ratio in the country, while Oaxaca and Chiapas had the fifth and seventh lowest, respectively. Yucatán's ratio, however, was among the top ten nationwide. Interest rates charged by commercial banks to forest sector firms are in line with those of other sectors, and interest rates charged by development banks are exceptionally low.[72] Interest rates vary with firm size, but their distribution is consistent with that observed in other sectors. Consequently, interest rates do not appear to be particularly high.

Although interest rates are low, access to finance could be a constraint for the development of forest sector manufacturing in all the selected states, especially in Oaxaca. In line with the weak financial penetration, forest sector manufacturers in the selected states are much less likely to have a bank loan or a line of credit than those in states with established forest sector manufacturing industries. Oaxaca has a large number of firms in the sectors analyzed as part of the manufacturing component of the forest sector, but the proportion of firms accessing finance is among the lowest nationwide. In 2018, firms in the selected states were more likely than those in the leading states to seek finance to purchase inputs domestically and less likely to purchase inputs abroad. This difference could limit the access to better inputs by firms in the selected states. Firms in the selected states are also more likely than those in states who are sector leaders to invest in business development and less likely to seek finance to start a business or pay down their debt. These differences could imply barriers to entry.

The evidence to determine whether access to finance constrains the development of the primary segment[73] of the forest sector is inconclusive. The sector hosts few firms, and of these, only a small share have access to external financing sources (except for Guerrero, one of the states with the least number of firms in this segment). Analyzing how firms use the resources they borrow, the evidence is insufficient to determine whether access to finance is a constraint to develop this component of the forest sector.[74] However, increased financial support for new and existing firms could potentially stimulate sector grow. This is particularly relevant given the scarcity of long-term financial products that align with the investment and return periods of forest projects. Unclear property rights on communal land, which prevents its use as collateral, further exacerbate the situation. Given the small number of firms operating within the primary segment of the forest sector, expanding access to financing from development banks could incentivize the entry of new firms, encourage expansions and mergers, and increase competition more generally. Specialized financial support for new firms could spur the growth of this subsector, potentially aiding the development of manufacturing activities. Similarly, it would be beneficial to expand access to finance for inputs and equipment among new and existing firms across all forest sector activities.

OTHER RISKS AND CHALLENGES

- **Deforestation and forest degradation.** Thousands of forest hectares are lost every year because of illegal logging, the burning of forested land for agricultural and urbanization purposes, and other hazards such as wildfires and arboreal diseases. Over the last two decades, Mexico has lost 697,000 hectares (ha) of humid primary forest, which decreased the total humid primary forest area by 7.6 percent. In the same period, Mexico lost 4.5 million ha of tree cover, a contraction of about 8.4 percent since 2000, equivalent to 1.77 billion tons of carbon dioxide emissions. Almost half of the tree cover loss was concentrated in just four states: Campeche, Chiapas, Quintana Roo, and Yucatán. In this context, a renewed focus on sustainability and adequate regulations and enforcement is vital for the development of the forest sector.[75]
- **Land rights.** The prevalence of communal property in the selected states presents challenges for implementing and enforcing long-term agreements with landowners to guarantee stable and competitive primary production from larger forest surfaces with sustainable standards. There will be no substantial private investment in plants, equipment and transportation vehicles, and physical capital without reliable access to a regular supply of wood and other raw materials.
- **Regulatory compliance and certification requirements.** The forest sector, especially primary production, is highly regulated and requires constant reporting. Moreover, some of the world's largest markets require certifications that can be difficult to obtain. Collaboration between government authorities and local communities is vital to overcome these challenges, particularly in the selected states, where informality and illegal logging are highly prevalent.

5
Comparative Advantages to Be Developed

The analysis in this chapter is based on the four dimensions of Michael Porter's diamond framework (figure 5.1) for analyzing the competitive advantage of a location.[76]

1. **Factor conditions.** The selected states are among the most biodiverse places in Mexico and are rich in forest resources. Geographically, they are close to Central America, an underserved market for Mexican exports. Chiapas, Guerrero, and Oaxaca have access to the Pacific coast, enabling them to reach Asian markets directly. However, the communal property regime compounds a burdensome regulatory system and weak transportation infrastructure undermines the ability of firms in the selected states to build solid value chains and access higher-value markets. The selected states also show lower levels of labor productivity in most subsectors when compared to the national average. Lack of human capital has also been identified as a binding constraint for the development of the paper and furniture and related products manufacturing in Guerrero and Oaxaca.

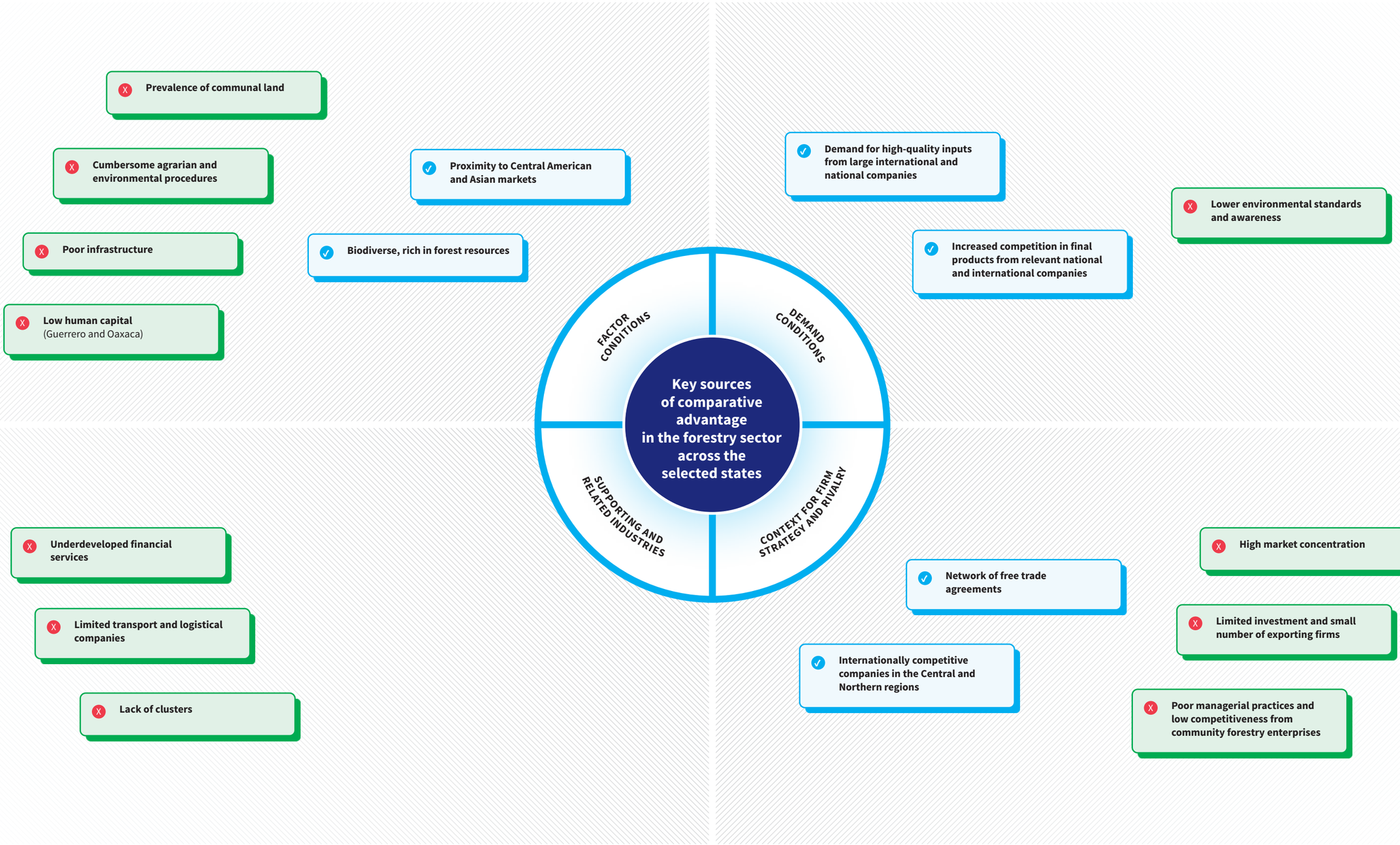
2. **Demand conditions.** Large national and international players in the cellulosic and furniture industries, such as Kimberly-Clark and El Puerto de Liverpool, demand high-quality inputs and increase competition for final products. However, domestic environmental standards and awareness lag those in Europe, Japan, and North America, which could hinder export growth. Incorporating these standards into sectoral development strategies in the selected states could be a source of competitive advantage, while an inadequate emphasis on sustainability could alienate potential consumers.

3. **Supporting and related industries.** High transportation and logistics costs limit the ability of producers to participate in the forest value chain. The establishment and consolidation of clusters in the selected states could help lower these costs by leveraging economies of scale and scope. Finance from development banks could catalyze the formation of clusters both in the primary and manufacturing segments of the forest sector.

4. **Context for strategy and rivalry.** Mexico has established itself as a world leader in commercial timber production by community-managed forests, yet community forestry enterprises (CFEs) have lower productivity levels and private firms are less likely to partner with them. Poor managerial practices undermine the competitiveness of CFEs: their directors tend to be selected by the chair of the assembly and high turnover constrains long-term planning and investment. Aggregate data for the region show limited investment and a small share of firms, while the national market seems highly concentrated among a handful of large national and international players. Mexico's extensive network of free trade agreements gives firms access to international markets, but just 1.1 percent of forest sector exporters operate in the selected states. Fostering the development of new industries in the forest sector could enable firms in the selected states to expand their presence in Asian, Central American, and European markets.

FIGURE 5.1

Key Comparative Advantages to Develop in the Selected States



Source: Adapted from Porter 2008.

6
Policy Recommendations

This chapter presents a summary of policy recommendations for developing the forest sector in the selected states based on the key challenges and binding constraints identified in chapter 4.[77] Some of the recommendations are designed to create (or strengthen) a public (or semipublic) good or input, or correct (or minimize) market failures through market interventions. Policies based on these recommendations should be informed by public-private dialogue and complemented by a robust monitoring and evaluation system.[78]

PUBLIC GOODS

1. **Improve road and railroad infrastructure to connect forest sector manufacturers with primary producers and final markets.** Public investment in transportation infrastructure is necessary to reduce logistics costs and increase productivity.

2. **Strengthen laws and enforcement mechanisms to stop illegal logging and burning.** Governance improvements are required at the federal and local levels. The authorities must build monitoring capacities, increase penalties, and simplify agrarian and environmental regulations without weakening them.

3. **Support the establishment of forest sector industry clusters.** The authorities could provide the required public investment and offer other benefits to attract private investment in areas that are close to centers of forest sector production or major paper recycling locations with access to other necessary inputs and services for manufacturing processes.

4. **Support community-based production** in areas where forested land is largely communal:
   - **Support the creation of enforceable long-term agreements to guarantee stable production with adequate volume and quality levels.** These could include joint ventures, long-term production-sharing contracts, unified negotiations, or other arrangements.
   - **Create an online registry of existing community forestry enterprises (CFEs) and other relevant community associations.** A comprehensive registry would help link community organizations with investors and other stakeholders.[79]
   - **Mediate between stakeholders to reduce the coordination problems and uncertainty that deter large-scale private investment.**

5. **Foster sustainable development practices along the entire value chain.**
   - **Offer training programs for CFEs and other primary producers.** These programs should focus on improving forest management, harvesting, and production systems, as well as business management.
   - **Create a single window to facilitate compliance** with sectoral regulations and obtain certifications.
   - **Launch enhanced federal and state programs dedicated to reforestation and forest health.** These programs should focus on reforesting with endemic species and increasing resilience against arboreal diseases. They should directly involve producers and local communities in forest protection and recovery.
   - **Create a strategy to prevent and respond to wildfires in forest regions.** The strategy should focus on those states with a high incidence of fires, including Chiapas, Guerrero, and Oaxaca.
   - **Launch public-private collection programs** to boost paper and paperboard recycling.
   - **Develop a program to support and monitor compliance** with the Forest Stewardship Council's Chain of Custody Certification along the value chain of the sector.

- **Establish a platform like those used by the Open Timber Portal and the Forest Transparency Initiative** to incentivize legal timber production.
- **Create an awareness campaign for consumers** to increase their knowledge of the environmental damages caused by illegal logging and burning of forested areas for agriculture.
- **Sign a Voluntary Partnership Agreement with the European Union** to reduce illegal logging and incentivize legal timber exports to Europe. This could be a plus because Europe is the leading importer of wood.

6 **Support the development of the furniture sector.**

- **Create research and development centers** to encourage innovation in the design of affordable and multifunctional home and office products in partnership with academic institutions and the private sector.
- **Form public-private partnerships with financial technology (fintech) and logistic firms** to create online sales platforms for furniture produced by local firms. The platforms can leverage existing logistics systems and offer credit for furniture purchases.
- **Create a financing and technical support program** to increase production efficiency and improve compliance with environmental and social responsibility requirements. The program should focus on firms interested to establish in forest sector clusters.

MARKET INTERVENTIONS

1 **Provide nondistortionary fiscal incentives to attract anchor firms to the forestry clusters.** The incentives should be complemented with other policies to promote market linkages, technology transfer, and improve forest management practices among local firms and primary producers.

2 **Provide economic and financial incentives to boost investments for maintenance, new equipment, and technological uptake and adoption** to promote a higher quality and more efficient production process along the forestry value chain. Sector-specific financial products offered by development banks could be highly effective to encourage investments to increase productivity.

Appendixes

APPENDIX A
Detailed Policy Recommendations

This appendix presents public policy recommendations organized by measures aimed at creating or strengthening public (or semipublic) goods and correcting (or minimizing) market failures through market interventions. The recommendations are not exhaustive and should be complemented, deepened, and adapted for each state, target market, products to be developed, and specific investments to attract, retain, or expand. A comprehensive and continuous public-private interaction should be carried out to complement the diagnostic and calibrate the proposals. This coordination should not only be among local actors, but also among leading firms, potential investors, academic institutions, and even other governments that have been successful in similar productive strategies in other regions. The focus should go beyond improving the competitiveness environment to develop the forestry sector; it should also aim to maximize the benefits and spillover effects and minimize any potential negative externalities.

PUBLIC GOODS

1. Improve road and railroad infrastructures to connect forest industries to main sources of primary production (which tend to be in rural or remote regions) and final markets to reduce logistics costs and increase productivity.

2. Improve electricity supply and develop the required infrastructure to provide access to natural gas in the selected states where it is absent, namely Guerrero (connecting its coastal region to the pipeline in Michoacán) and Chiapas (connecting its coastal region to the pipeline in the Isthmus of Tehuantepec in Oaxaca, with potential to provide natural gas to Central America).

3. Increase investments in infrastructure for production and storage of germplasm and seed banks for native timber and new plants that can be produced in the selected states. This action should be complemented by the development of community seed banks in local and native regions to produce higher quality products for the forest sector.

4. Enhance community production in regions where land is mainly communal property by improving both communication channels with stakeholders (landowners, civil associations, conservation groups, manufacturing firms, supporting industries, and local authorities) and arrangement mechanisms for production (joint ventures, long-term production sharing contracts, unified negotiations, among others). The support to create and strengthen community forestry enterprises (CFEs) and the mediation of local authorities with potential manufacturing investors to reach enforceable long-term agreements could help reduce coordination problems and uncertainty. Some measures to consider include:

   - Coordination mechanisms with potential investors, especially larger-scale ones, are suggested to foster a supplier development strategy to ensure that there is a productive collaboration between large enterprises and small suppliers.
   - A platform or directory containing existing CFEs and other inter-community associations in the selected states can be created to facilitate linkages between these actors and investors and other relevant stakeholders. The *Catálogo de Empresas Forestales* prepared by the *Comisión Nacional Forestal* (National Forestry Commission), *Secretaría del Medio Ambiente y Recursos Naturales* (Secretariat of Environment and Natural Resources), The United Nations Development Programme, and the World Bank could be the base for such directory.

5. Create training programs for CFEs and other primary producers, to improve their forest management, harvesting and production systems, and business management practices.

6. Increase the number of public programs dedicated to reforestation and recovery of forest lands and partnering with local communities and existing producers of the sector to sow endemic species.

7. Increase the number of public programs aimed at preserving forest health to reduce the areas affected by plagues and other diseases in forested regions. These programs should include advocacy campaigns that would teach producers and the population near forested regions how to identify potential plagues and diseases from forest plants and provide information on solutions and treatments to heal affected species.

8. Enhance safety regulations to control forest fires in the selected states to reduce risks, strengthen the response capacity and prevent future events, especially in areas with a high incidence of fires (Chiapas, Guerrero, and Oaxaca).

9 Improve legal frameworks and enforcement mechanisms across federal and local governments to increase the penalties for illegal producers and maximize economic returns from authorized activities while protecting the environment. Some actions in this direction are to:

- Enhance the capacities of governments for monitoring the conservation of forests and protected areas and receive its share of revenue generated through authorized activities in public land, which in turn must be used for sustainability policies of the sector.
- Increase penalties (and enforcement) for illegal logging and arson of forest lands.
- Create a public campaign to increase consumer awareness of environmental damages by consuming wood products from illegal logging and goods produced with crops from former forest lands converted to agricultural lands via arson.
- Enhance the efficacy (without weakening) of agrarian and environmental regulations (number of procedures, time, and costs).
- Implement a program to support and enforce the use of the Chain of Custody Certification of the Forest Stewardship Council for forest products.
- Sign a voluntary partnership agreement (VPA) with the European Union (EU) to combat illegal logging and incentivize legal timber exports into Europe, the leading wood importing continent.[80] The VPA would fast track the entry of forest products into the EU, reducing compliance costs for the exporting entity and increasing the competitiveness of the national forest sector for this market.
- Establish a platform similar to the Open Timber Portal and the Forest Transparency Initiative to incentivize legal timber production. This platform should enable forest sector firms to disclose essential information including permits, production processes, certifications, and any other relevant data, fostering transparency and attracting clients, partners, and investments to strengthen the sector in Mexico. Furthermore, the platform can serve as a centralized repository for government actors to upload regulatory information pertaining to the forest sector. This may include laws and guidelines, as well as data and statistics.

10 Support the establishment or strengthening of forest clusters to reduce transportation costs, increase productivity, facilitate the dissemination of knowledge, and create synergies. These clusters could be located close to the main forest areas (or main recycling locations in the case of paper and pulp manufacturing) to promote an industrialization "in situ," provided that all the required production inputs are available.

11 Regarding the furniture sector:

- Create research and development centers for innovation in the design of affordable and multifunctional (home and office) products in partnership with the academic and private sectors.
- Create a platform or partnerships with financial technology (fintech) and delivery firms to promote online selling of furniture products from local firms

leveraging existing logistics routes, with the option of getting credit while purchasing.
- Create a financing and technical support program, with support from organizations with the know-how for innovating and improving practices along the forest sector's value chain while observing social and environmental best practices.

12 Create government collection programs for the recycling of paper and paperboard. Consolidate units among rural or remote areas to facilitate the collection.

MARKET INTERVENTIONS

1 Provide incentives to attract the first anchor firms to develop products that can be produced competitively in the selected states. These firms can also help develop the forest clusters.

2 Develop a fiscal regime for CFEs that incentivizes productivity and the provision of environmental services.

3 Provide incentives for local producers to invest in maintenance, new equipment, and new technologies adoption for higher quality and more efficient production and activities along the value chain of the forest sector.

4 Consolidate financial resources from development banking institutions (including Bancomext when imports and exports are considered) to design tailor-made products to support the development of the forest sector in the selected states. Financing and technical assistance can also be provided for firms to comply with the VPA, in case Mexico decides to sign one with the EU.

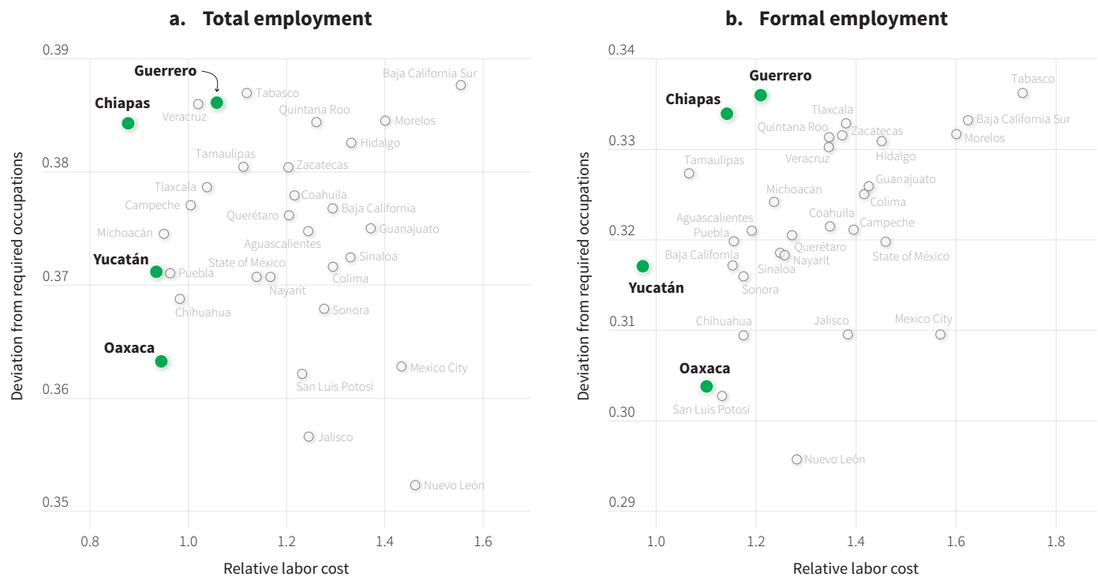
APPENDIX B
Assessment of Human Capital Constraints

Based on the availability and cost of labor we assess whether this is a binding constraint for the development of the forest sector in the selected states. The analysis was carried out following the methodology developed by Barrios and others (2018a; 2018b) using data from the *Encuesta Nacional de Ocupación y Empleo* (National Survey of Occupation and Employment) and the *Sistema Nacional de Clasificación de Ocupaciones* (National Classification System for Occupations).[81] Three manufacturing subsectors were assessed: wood products, paper, and furniture. For each subsector, we calculate the deviation between the share of existing occupations at the national and state levels, using the symmetric mean absolute percentage error (SMAPE) to measure the availability of workers performing the occupations required.[82] Because of the high prevalence of informality in the selected states and the salary gap between formal and informal jobs, the analysis was made for total employment (formal and informal) and considering just the formal sector.

For the wood product manufacturing subsector, figure B.1 shows that Guerrero and Chiapas have high deviations of required occupations (SMAPE) for the formal and informal pool of workers and only formal pool. Guerrero has the third-highest deviation in the former case and the second-highest in the latter, while Chiapas has the seventh and third highest, respectively. Among Mexico's 32 states, however, the relative salaries of Chiapas and Guerrero rank in the lower half (Chiapas has the lowest when considering all workers), along with Oaxaca and Yucatán, which are among five states with the lowest labor costs and whose deviation in occupations are also among the lowest. The results suggest that the scarcity of qualified labor force is not a binding constraint to develop this subsector.

Figure B.2 provides strong evidence that for the paper manufacturing subsector human capital may be a binding constraint for some of the selected states. Guerrero (fourth and third, respectively) and Oaxaca (sixth and fourth, respectively) have the highest deviations of required occupations for the total and formal labor markets, and both states also rank in the upper half among the states with high labor cost (Guerrero has the fourth and third highest relative salary in the total and formal labor markets, respectively). Hence, Guerrero and Oaxaca (particularly for the former) may find it hard to fill key positions in paper manufacturing activities, which is reflected by the higher wage premiums. On the other hand, for Chiapas and Yucatán the evidence is less compelling (particularly for the latter). Chiapas ranks in the upper half among the states with higher deviations (11th) and labor cost (13th) considering all workers. Although Chiapas ranks in the upper half of deviations in the formal sector, the state is in the lower half in terms of relative salaries, which does not reflect a scarcity of workers for potential formal firms that could develop this industry. In Yucatán, although it ranks in the upper half of occupation deviations for the total and formal labor markets, it ranks in the lower half in terms of relative salaries for both markets.

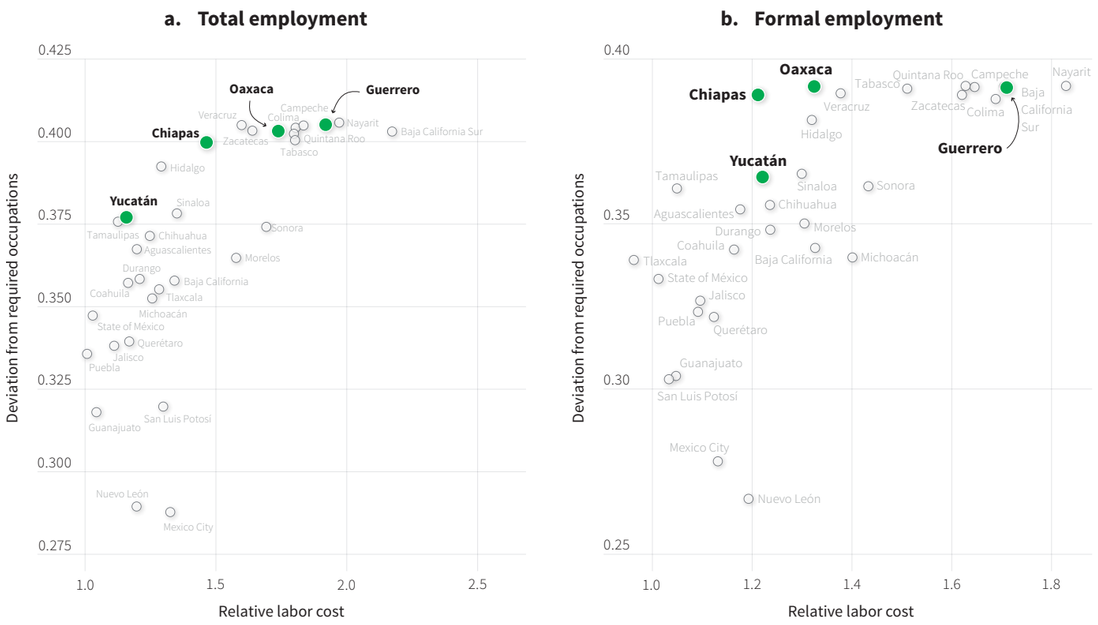
FIGURE B.1
Skill Deviations and Labor Costs in Wood Product Manufacturing, 2019



Source: Calculations based on data from INEGI's I-2019 ENOE database.
Note: Durango was excluded from the figure because it presented SMAPE values of more than four standard deviations below the averages for the total (0.310) and formal (0.226) labor markets. Hence, it is considered an outlier. SMAPE = symmetric mean absolute percentage error.

FIGURE B.2

Skill Deviations and Labor Costs in Paper Manufacturing, 2019

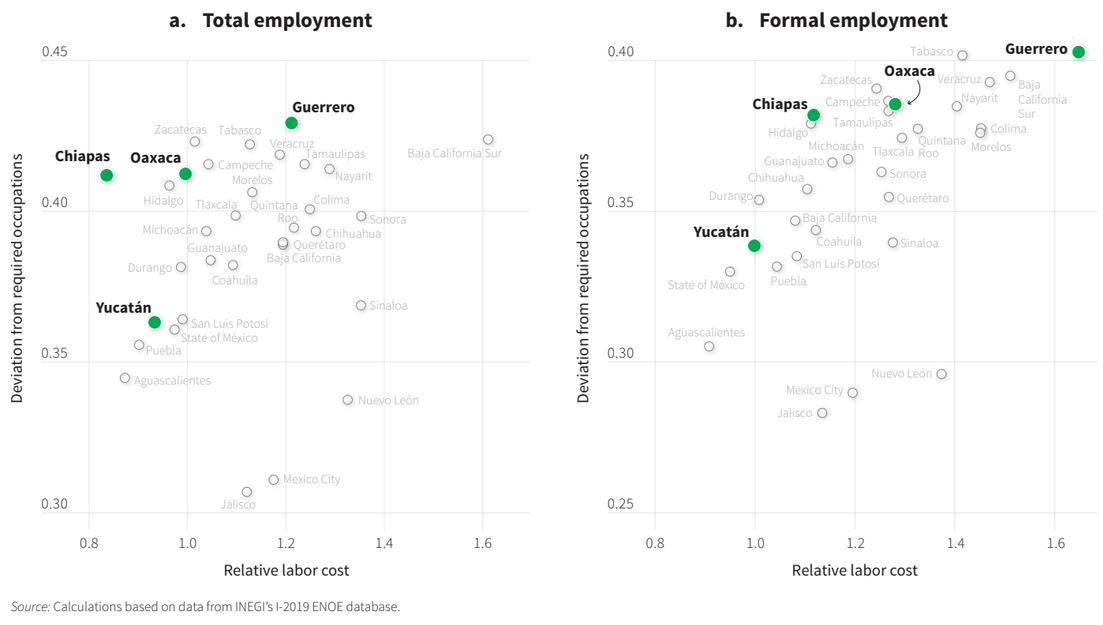


Source: Calculations based on data from INEGI's I-2019 ENOE database.

In the furniture, mattresses, and blinds manufacturing subsector, figure B.3 suggests a lack of qualified personnel for the subsector's activities for Guerrero and Oaxaca. Guerrero has the highest deviations of required occupations considering all workers and only formal ones and the 10th highest labor cost for all workers and the highest for only formal. Oaxaca ranks in the upper half of deviations of required occupations for all workers and only formal ones; although it ranks in the lower half in terms of relative salaries for all workers and 11th highest labor cost for only formal ones among Mexico's 32 states, reflecting a scarcity of human capital for formal incumbent firms. The evidence is not compelling for Chiapas and Yucatán. Chiapas has the 10th highest deviation for the total labor market, but the lowest labor cost among Mexico's 32 states, and for only formal jobs it has the 11th highest required occupations deviation and 10th lowest labor cost. Yucatán ranks in the lower half among Mexico's 32 states for all labor indicators of the subsector.

FIGURE B.3

Skill Deviations and Labor Costs in Furniture and Related Products Manufacturing, 2019



Source: Calculations based on data from INEGI's I-2019 ENOE database.

APPENDIX C
Infrastructure and Geographic Conditions in the Selected States

INFRASTRUCTURE

The first step to identify potential infrastructure-related constraints that could hinder the development of the forest sector in Chiapas, Guerrero, Oaxaca, and Yucatán, was to assess the key inputs for the production processes namely electricity, water, combustibles, transport, telecommunications infrastructure, and other sector-specific infrastructure. The findings of those assessments in this appendix were combined with the analysis of the intensity of use of each input by the forestry subsectors presented in appendix D to determine whether potential mismatches between supply and demand of some of them could be a binding constraint for the sector.[90]

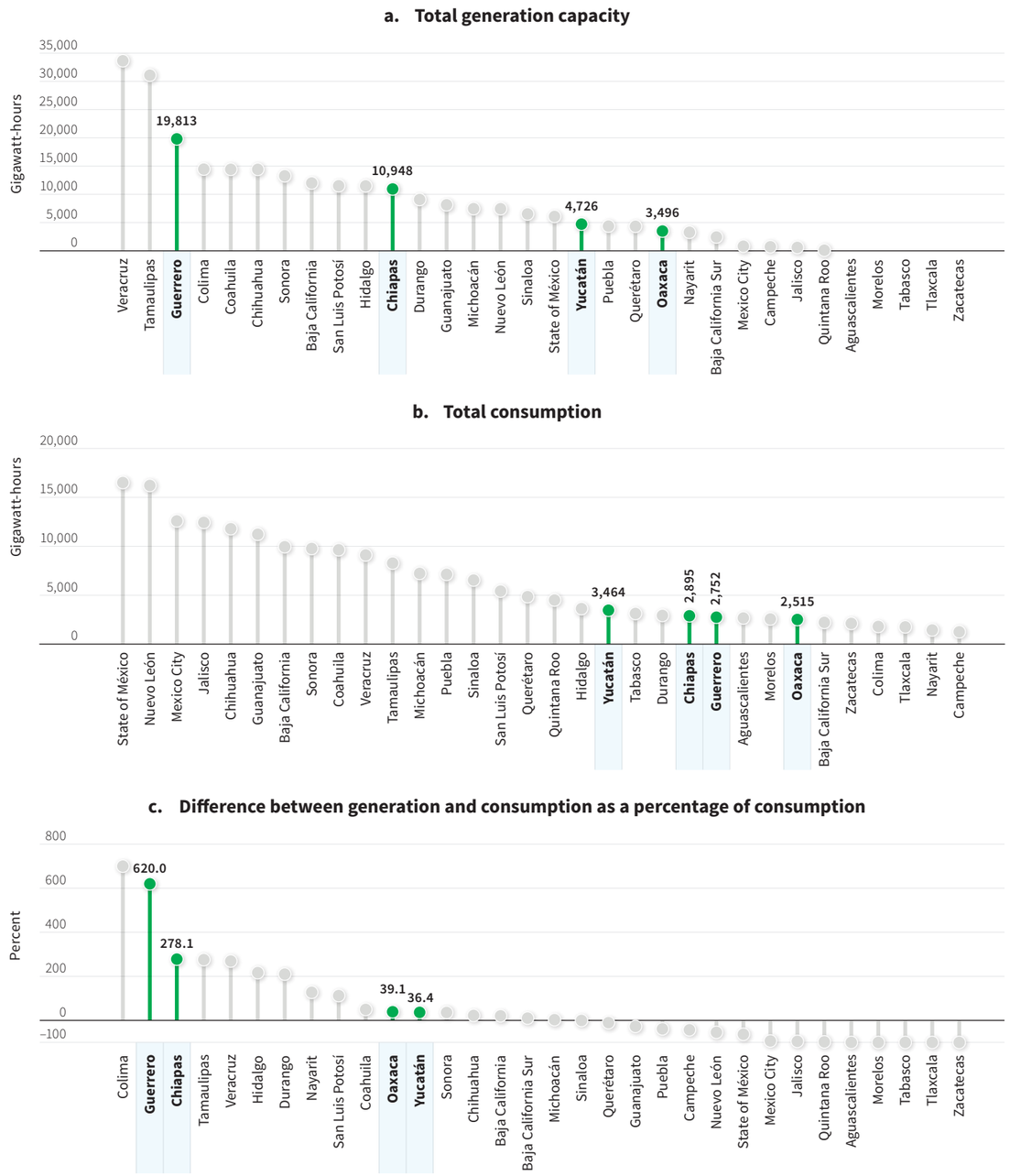
ELECTRICITY

Assessing the conditions of electricity infrastructure involved comparing the electricity generation, consumption, and balance, as well as the access and coverage of the electricity network and the quality of services across states.

As figure C.1 shows, the selected states generate more electricity than what they consume. Guerrero had the highest difference between generation and consumption at 620 percent of the state's consumption, followed by Chiapas (278 percent), Oaxaca (39 percent), and Yucatán (36 percent). Because generation capacity is higher than consumption, electricity seems sufficient for the development of forest sector activities in the selected states.

In terms of access to electricity in households, figure C.2 shows that only Yucatán, with 98.9 percent, has coverage levels close to the national average. Despite having improved coverage levels in 2020, Chiapas, Guerrero, and Oaxaca still have the lowest levels in the country. Between 2010 and 2020, in Oaxaca,

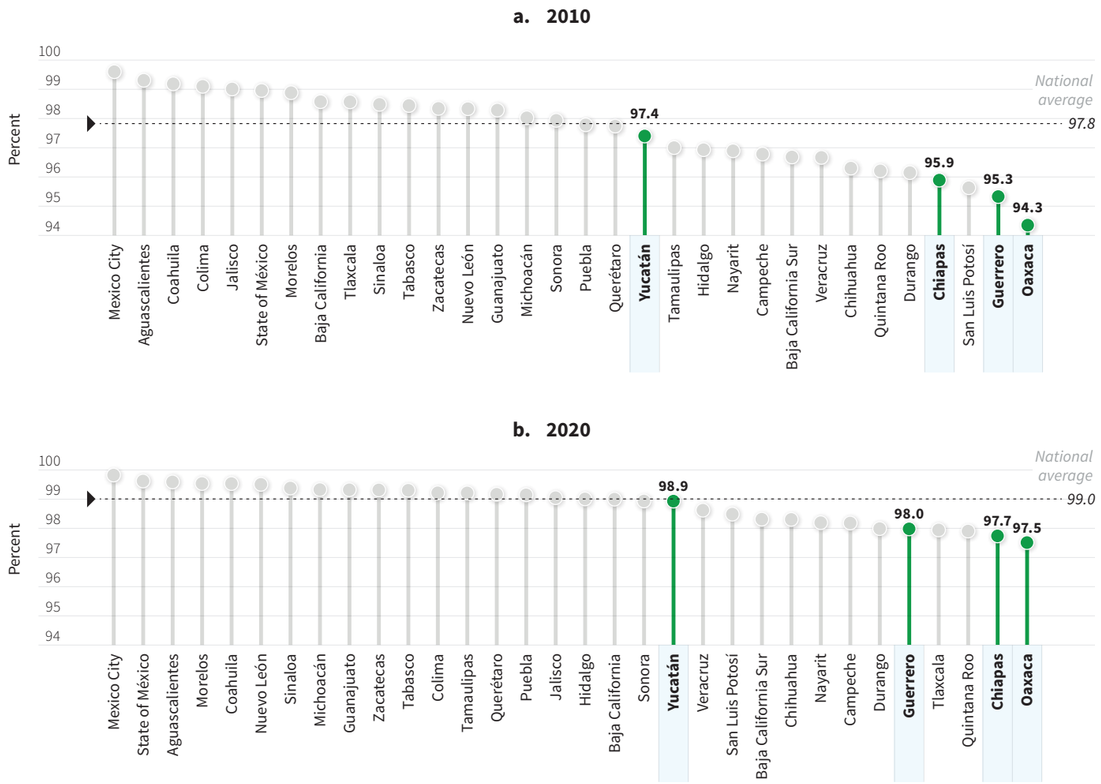
FIGURE C.1
Electricity Generation Capacity and Consumption, State Comparison, 2017



Source: Calculations based on data from SENER's SIE database.
Note: The most recent available electricity generation and consumption data is for 2017.

FIGURE C.2

Households with Access to Electricity, State Comparison



Source: Based on data from INEGI 2010; 2020.

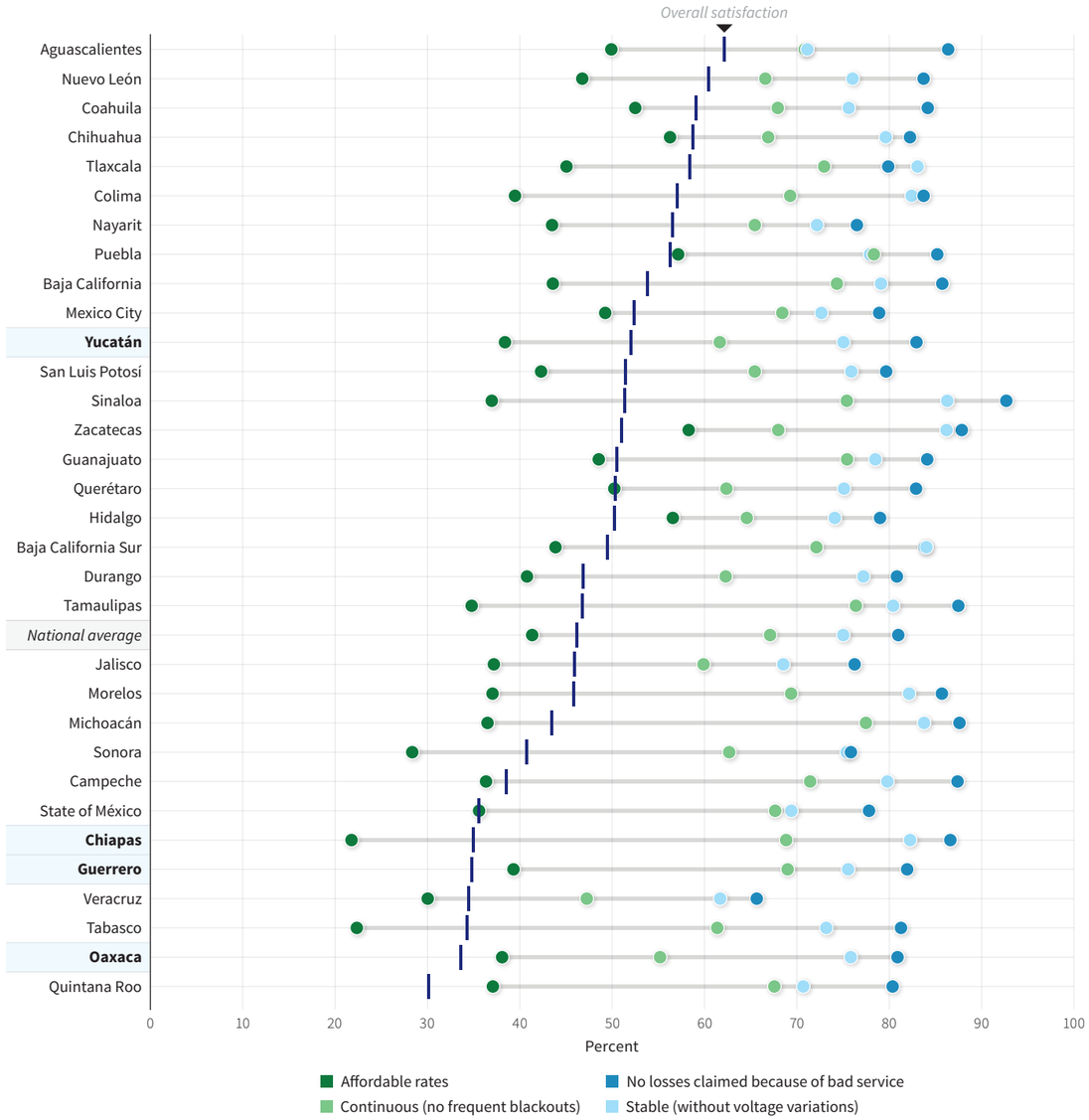
it went up from 94.3 percent to 97.5 percent; in Guerrero, it went up from 95.3 to 98 percent; and, in Chiapas, it went up from 95.9 to 97.7 percent.

Figure C.3 shows that firms in the selected states are not satisfied with electricity services. Only 33.6 percent of firms in Oaxaca reported they were satisfied, just below Guerrero and Chiapas at 34.8 and 35 percent, respectively. Meanwhile, 52 percent of firms in Yucatán were satisfied with electricity-related services, the only selected state above the national average (46.2 percent). However, in most Mexican states, firms are not satisfied, so the quality of electricity services is not particularly low when compared with national averages.

An important consideration for understanding the availability of electricity services in the selected states is the infrastructure of the national electricity system illustrated in map C.1. Chiapas has numerous hydroelectric power plants, mainly located in the central and northern parts of the state. A main transmission line (400 kilovolts [kV]) runs from Tapachula to Tuxtla Gutiérrez, intersecting through the state of Tabasco. However, the rest of the state lacks 400 or 230 kV transmission lines. Guerrero has a limited number of hydroelectric

FIGURE C.3

Firms' Satisfaction with Electricity-Related Services, 2016



Source: Based on data from INEGI 2016.
Note: The survey included an assessment of energy services only until 2016.

power plants situated in its central region and 230 kV transmission lines running from the city of Acapulco, around its coast, to Michoacán, and from Acapulco to the state of Morelos, crossing its capital of Chilpancingo. Oaxaca has significant wind power potential in the La Ventosa region, at the Isthmus of

MAP C.1

Mexico's National Electric System, Southern and Peninsular Regions, 2018

Source: CENACE 2018.
Note: kV = kilovolts.

Tehuantepec. Several transmission lines (400 kV and 230 kV) from this region link with those in the state of Veracruz. Another transmission line comes from the north of Oaxaca and goes to the Valles Centrales region, reaching the state's capital. However, the rest of Oaxaca lacks transmission line connections. Yucatán mainly generates wind and coal power production around its main cities. Several low-tension transmission lines (69 to 115 kV) and a single 400 kV transmission line run through the state. From this perspective, the selected states lack sufficient transmission infrastructure to cover all their regions, which could pose challenges in distributing high volumes of energy, particularly for industries that use this input intensively.

WATER

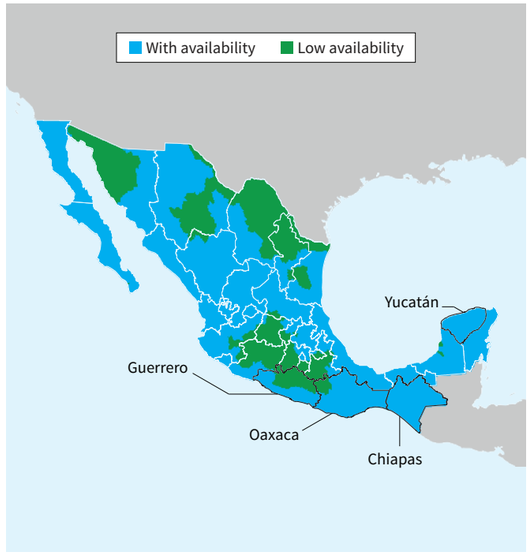
To assess whether the provision of water is a binding constraint for expanding the forestry sector in the selected states, we used a series of measures to understand how this basic input is provided and used in production processes.

Maps C.2 and C.3 present geographic information on the availability of water resources in the selected states. As the maps show, adequate superficial water is available in all selected states, except in the northwest region of Guerrero where availability is low. In addition, there is adequate availability of underground water in the four states. Therefore, water is not a constraint for productive activities requiring this input.

Figure C.4 assesses firms' satisfaction levels with the provision of water services. Guerrero, Chiapas, and Oaxaca had one of the lowest levels of satisfaction

MAP C.2

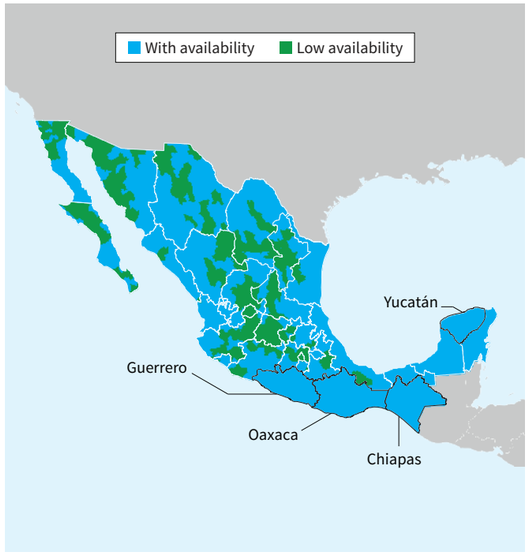
Superficial Water Availability in Mexico, 2016



Source: CENACE 2018.

MAP C.3

Underground Water Availability in Mexico, 2016



Source: CENACE 2018.

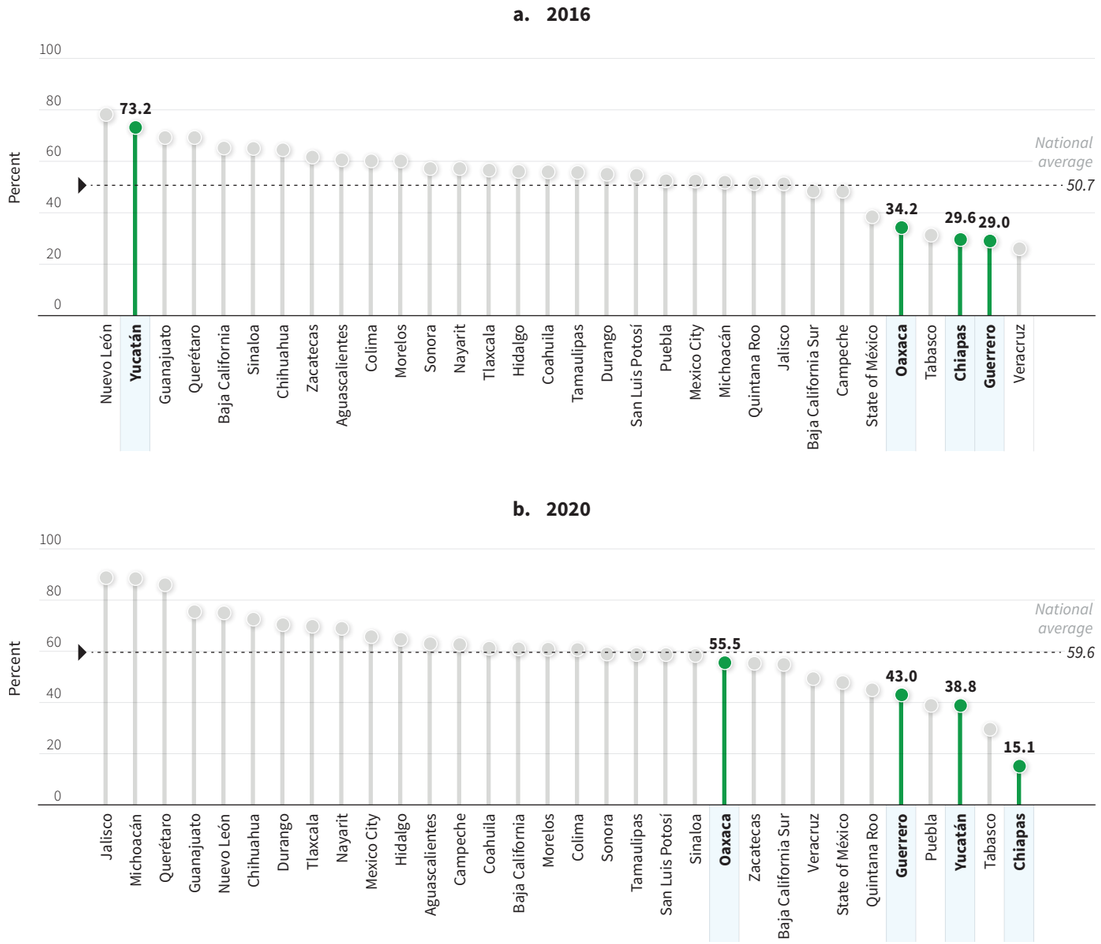
with potable water provision services in 2016, with 29 percent, 29.6 percent and 34.2 percent, respectively. Meanwhile, Yucatán had the second-highest levels of satisfied firms in the country, with 73.2 percent. However, by 2020 that fell to 38.8 percent, the third lowest among Mexico's 32 states. In Chiapas, the share of satisfied firms dropped as well by half to 15.1 percent. In contrast, the levels of satisfaction in Oaxaca and Guerrero increased to 55.5 and 43.0 percent, respectively. Although these changes on the firm´s perception could be related to the pandemic impact on supply and demand, the quality of water services must be monitored to guarantee an adequate provision for productive use.

To identify the specific causes of the low satisfaction levels in water services provision, figure C.5 presents accessibility and quality of service rates in four aspects: reliability of water provision, level of pressure, level of potability, and level of clarity and purity. On average, more than 75 percent of firms agree that the rate they pay is affordable in the selected states, ranging from 56.8 percent in Oaxaca to 90.3 percent in Yucatán. However, the reliability of water services provision in Chiapas, Guerrero, and Oaxaca is lower than the national average. All the selected states are also lower than the national average in terms of pressure, purity, clarity, and potability of water. On the other hand, in Chiapas and Yucatán, more than 80 percent of firms agree that there no water is wasted because of leaks, and, although this share is above 50 percent for Guerrero and Oaxaca, they are still below the national average.

Figures C.6, C.7, and C.8 present detailed analysis for the cost of fares for water supply and the efficiency of the water supply of local agencies. Here, the fares for water are among the lowest in the country for Yucatán and Chiapas,

FIGURE C.4

Firms' Satisfaction with Water-Related Services

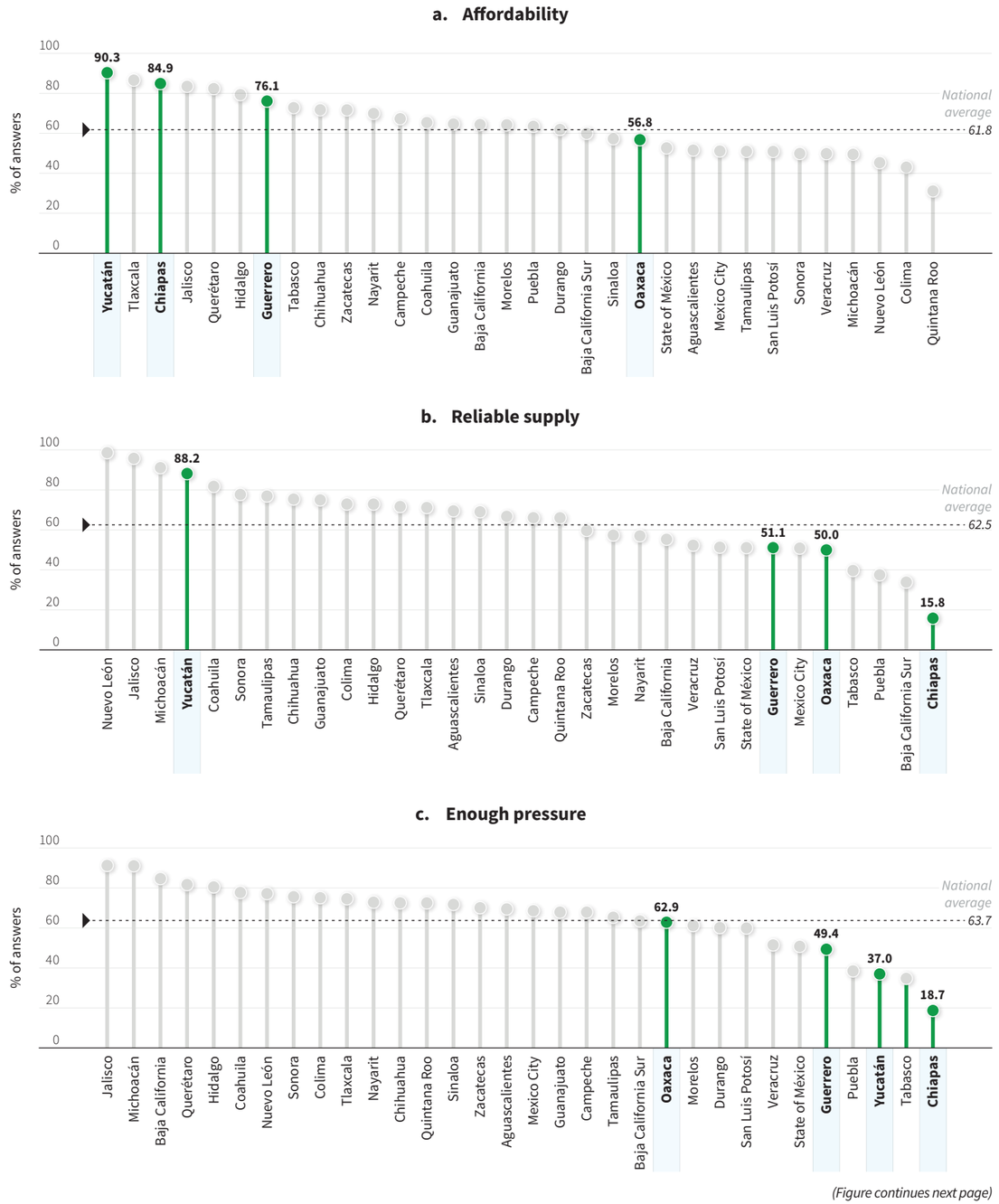


Source: Based on data from INEGI's ENCRIGE database.

with a relationship in cost-fare of 0.003 and 0.005, respectively. In Guerrero and Oaxaca, this ratio is even higher, with 11.5 and 18.1, respectively, placing these states in the middle of the ranking. The cost per volume produced is also low in Chiapas and Yucatán, whereas for Guerrero and Oaxaca, it increases heavily. However, state agencies have very low overall efficiency, except for Oaxaca, which has one of the top three, with 47.9 percent of it. This suggests that water utilities do not have full coverage to collect fares within their regions.

FIGURE C.5

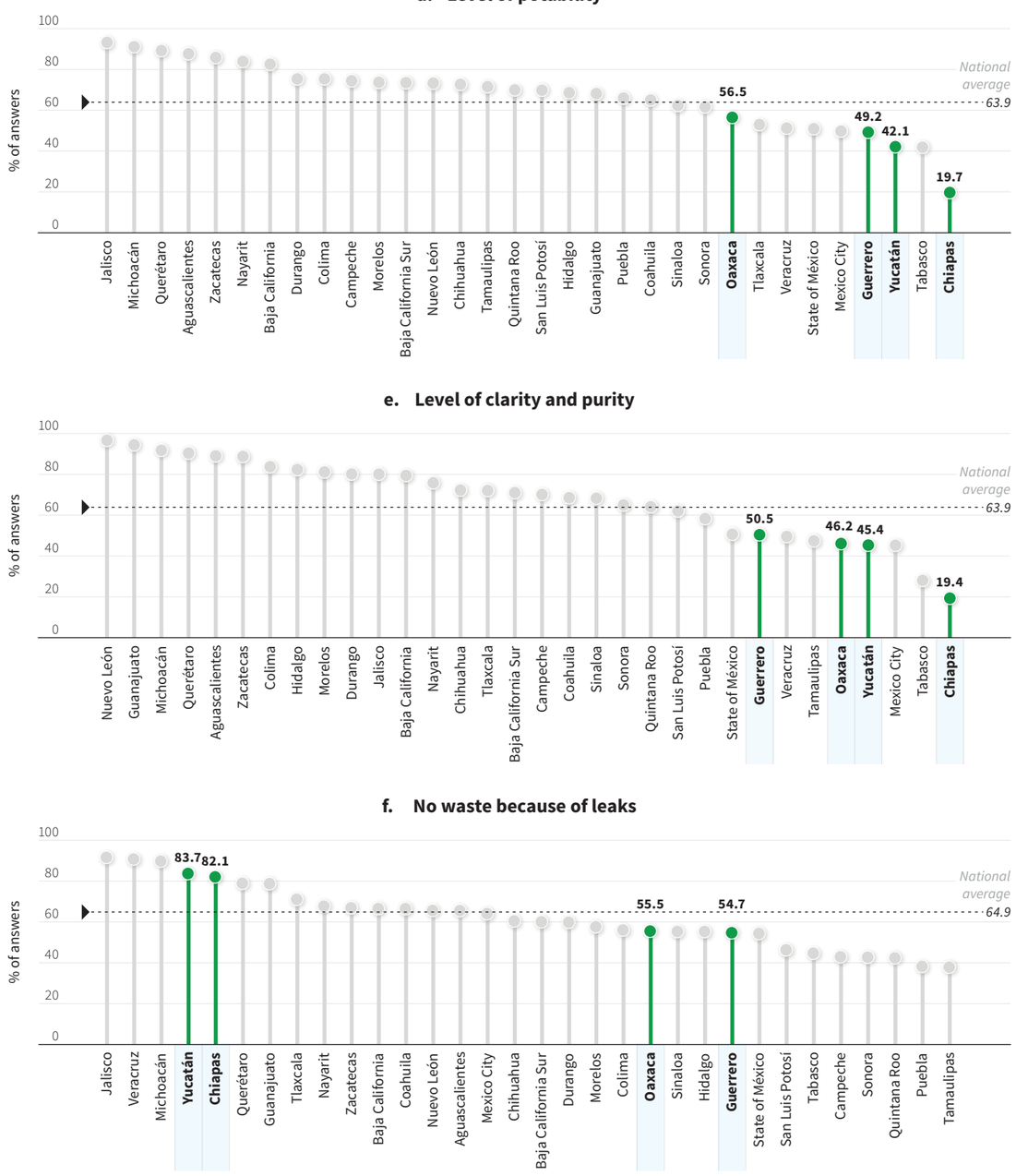
Indicators of Firms' Satisfaction with Water Services, 2020



(Figure continues next page)

FIGURE C.5

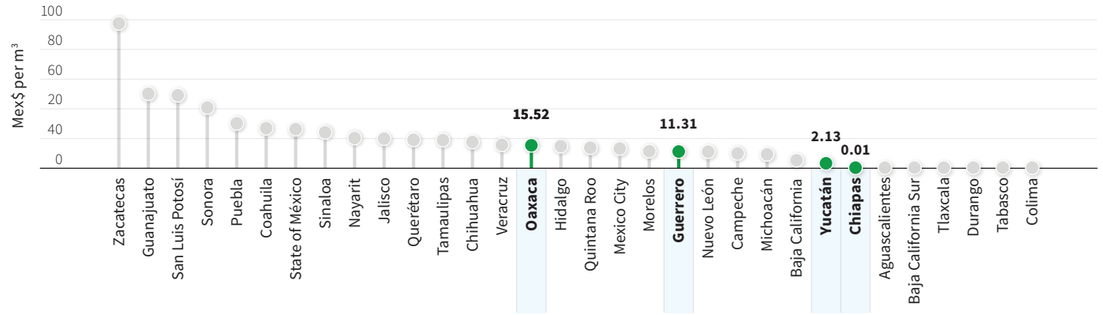
Indicators of Firms' Satisfaction with Water Services, 2020 *(continued)*



Source: Based on data from INEGI's ENCRIGE database.

FIGURE C.6

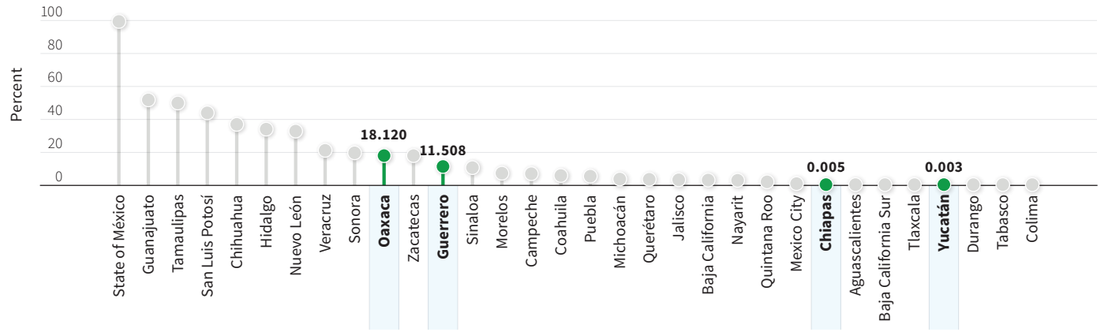
Cost per Volume Produced, 2017



Source: Based on data from CONAGUA and IMTA 2017.
Note: m³ = cubic meter.

FIGURE C.7

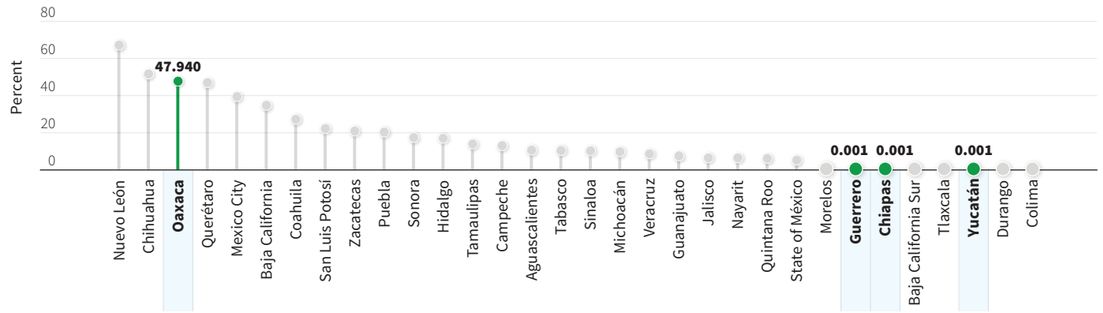
Cost-Fare Relation, 2017



Source: Based on data from CONAGUA and IMTA 2017.

FIGURE C.8

Simple Average for Global Efficiency, 2017



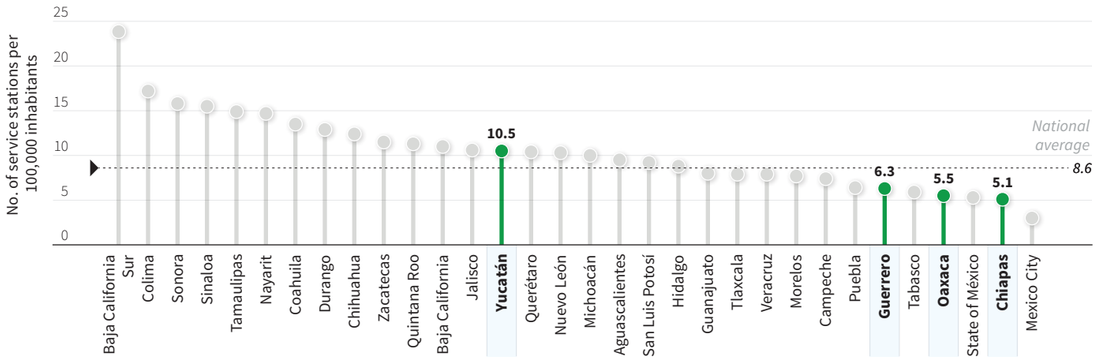
Source: Based on data from CONAGUA and IMTA 2017.
Note: Figure shows the volume of water collected by volume produced.

COMBUSTIBLES

To identify potential constraints in the access to combustibles, we assess the physical infrastructure, consumption, and satisfaction levels. In terms of service stations per 100,000 inhabitants for gasoline and diesel, figure C.9 shows that Chiapas, Oaxaca, and Guerrero are below the national average (8.6), with a rate of 5.1, 5.3, and 6.3, respectively. Although Yucatán is the only selected state with an above-average rate (10.5), it still ranks mid-range in comparison to other states. Regarding the consumption of natural gas, figure C.10 shows that in 2019, Guerrero was the only selected state without any reported consumption, whereas Oaxaca, Chiapas, and Yucatán consumed 31.1, 43.5, and 104.5 million cubic feet per day, respectively.

FIGURE C.9

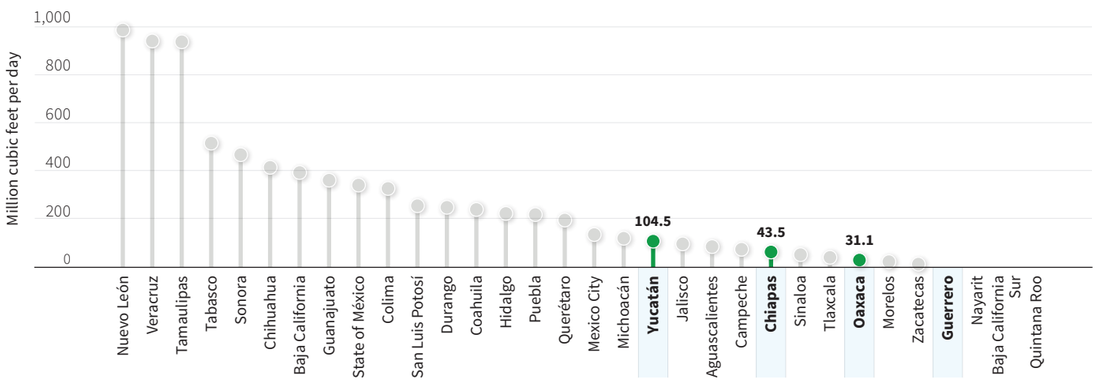
Number of Service Stations per 100,000 Inhabitants, 2017



Source: Based on Pemex 2019.
Note: Service stations are those that supply gasoline and diesel.

FIGURE C.10

Consumption of Natural Gas per State, 2019



Source: Based on data from SENER's SIE database.

One key aspect about the null consumption of natural gas in Guerrero is its disconnection from the *Sistema de Transporte y Almacenamiento Nacional Integrado de Gas Natural* (National Interconnected System of Natural Gas; Sistrangas) (see map C.4). For Guerrero to offer competitive delivery of a basic fuel source such as natural gas, it requires a connection to Sistrangas. However, given the low demand for gas (mainly driven by the lack of industries with intensive gas consumption), establishing a pipeline is not an economically feasible project for the state. Thus, the absence of a gas pipeline will continue to be an important constraint for many manufacturing activities in Guerrero requiring this input intensively.

Despite the low availability of physical infrastructure for the delivery of combustibles in the selected states, figure C.11 shows that the satisfaction of firms in the delivery of combustibles is high for all of them. Chiapas and Yucatán are in the top positions, with 57 percent satisfaction. Guerrero has 48 percent satisfaction and Oaxaca has 34 percent, which is the only one below the national rate of 37 percent.

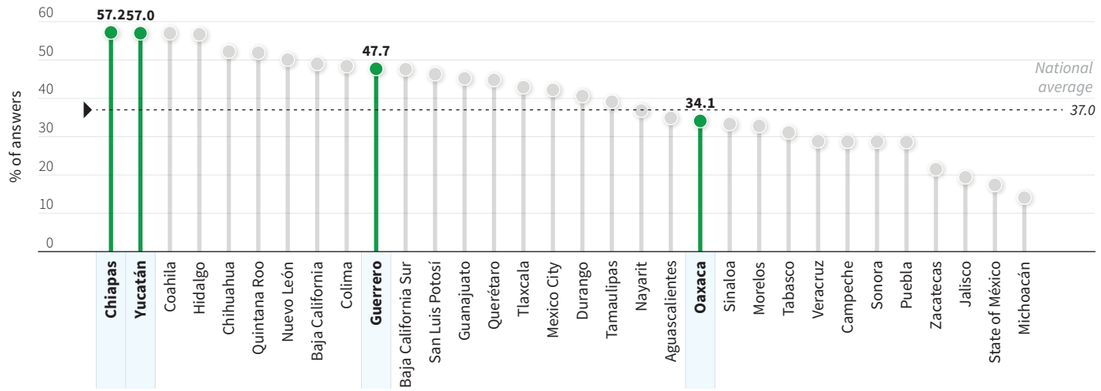
MAP C.4

Mexico's Interconnected System of Natural Gas (Sistrangas), 2019

Source: Based on information from the *Secretaría de Energía*.

FIGURE C.11

Firms' Satisfaction with Combustibles-Related Services, 2016



Source: Based on data from INEGI's ENCRIGE database.
Note: The survey included an assessment of combustible-related services only until 2016.

TRANSPORTATION

To determine whether the condition of transportation infrastructure represents a binding constraint to the development of the forestry sectors in the selected states, three transport modes used intensively by many manufacturing industries were assessed: roads, ports, and railways. Figure C.12 shows the indicators of physical condition. In terms of share of paved roads, Oaxaca, Chiapas, and Guerrero fall below the national average (43.4 percent), with 23.6, 31.1, and 35.3 percent, respectively. Yucatán is the only state among the selected ones that surpasses the average, with 50.7 percent of its total roads paved. In addition, none of the selected states has more than 4 percent of their roads that are four lanes or wider.

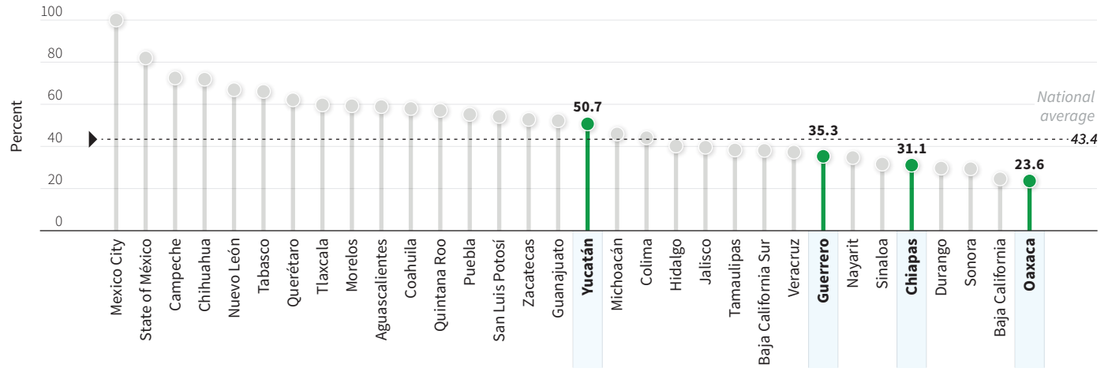
Figures C.13 and C.14 show the densities of the road network by inhabitants (per 10,000 individuals) and area (per 100 square kilometers [km2]). Among the selected states, Yucatán has the most extensive network of paved roads relative to its population and area. Followed by Guerrero, with 19.5 km of paved roads per 10,000 inhabitants and 10.43 km per 100 km2. Both these states surpass the national averages. Although Oaxaca has a higher density of paved roads per 10,000 inhabitants than Chiapas, this trend is reversed when it comes to paved roads per 100 km2, with Chiapas taking the lead.

Paved roads are typically managed and maintained by local, state, and federal governments. However, toll roads are usually under the management of private entities or publicly owned agencies. Federal highways serve as the main routes connecting the regions of the states to other parts of the country. These roads are often free to use and can sometimes be congested, especially in urban areas, resulting in reduced average speeds and longer travel times. Some toll roads are under the control of private operators. These roads are often more efficient, reducing travel times because of higher average speed limits, and may be more competitive and attractive for logistics purposes for firms, provided that the toll fares do not pose a significant financial burden.

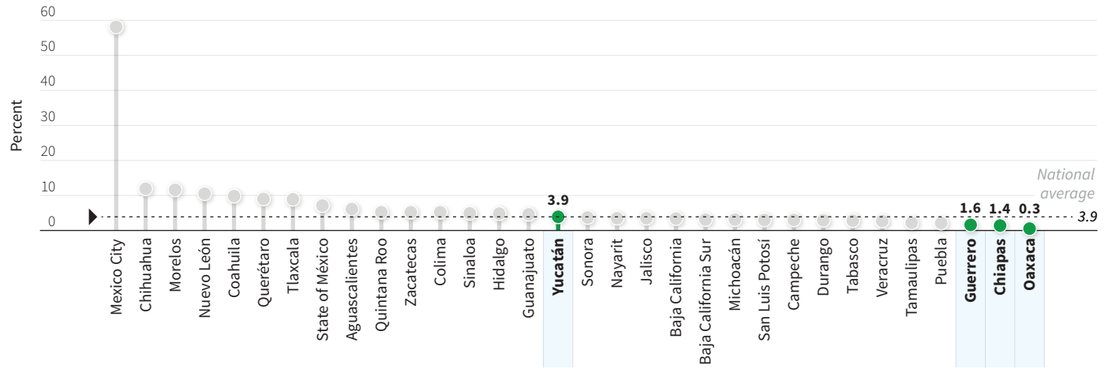
FIGURE C.12

Road Conditions At the National Level, 2018

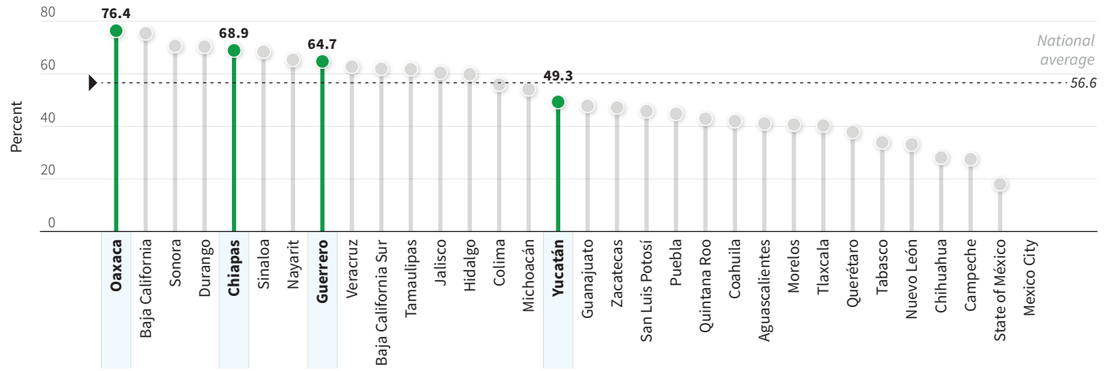
a. Share of paved roads



b. Share of roads with four or more lanes



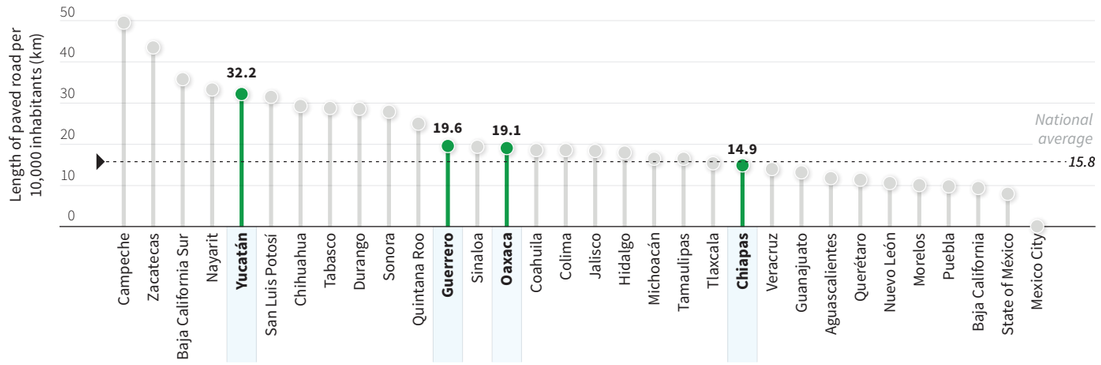
c. Share of unpaved roads



Source: SCT 2020.

FIGURE C.13

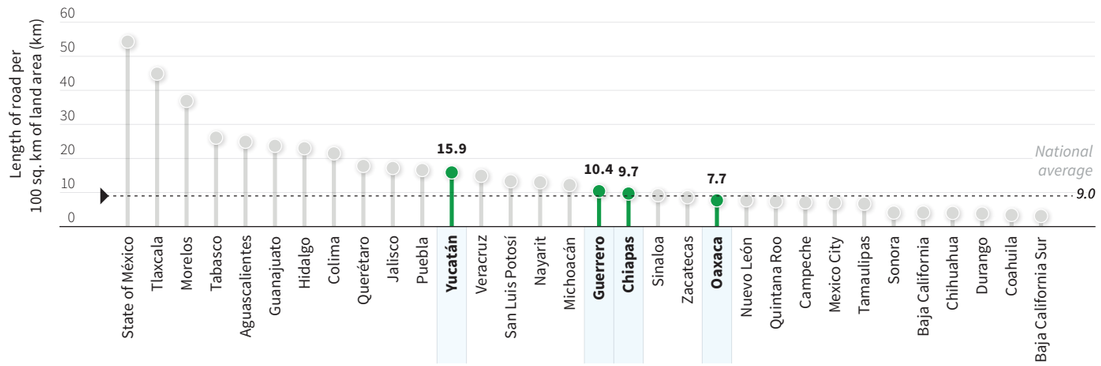
Length of Paved Roads per Inhabitant, 2018



Source: Calculations are based on data from SCT 2018.
Note: km = kilometer.

FIGURE C.14

Length of Paved Roads per Area, 2018



Source: Calculations are based on data from SCT 2018.
Note: km = kilometer.

In the selected states, federal highways connect their main cities and take part of the road corridors of the country. However, these states have few toll roads. Map C.5 shows that Chiapas has three toll roads: Tuxtla Gutiérrez–San Cristóbal de las Casas (Federal Highway [Fed.] 190D), Tuxtla Gutiérrez–Arriaga (Fed. 190D), and Ocozocoautla-Coatzacoalcos (Fed. 145D). Guerrero has only one toll road, known as Autopista del Sol, which connects Acapulco to Chilpancingo, Cuernavaca (Morelos), and Mexico City. Oaxaca has three toll roads: one from Oaxaca City to Puebla and Mexico City, another from Mitla to Santo Domingo Tepuxtepec (an incomplete road that eventually will connect to Santo Domingo Tehuantepec), and the last one from Salina Cruz to Santo Domingo Tehuantepec. Yucatán only has one toll road from Progreso to Cancún in Quintana Roo.

MAP C.5

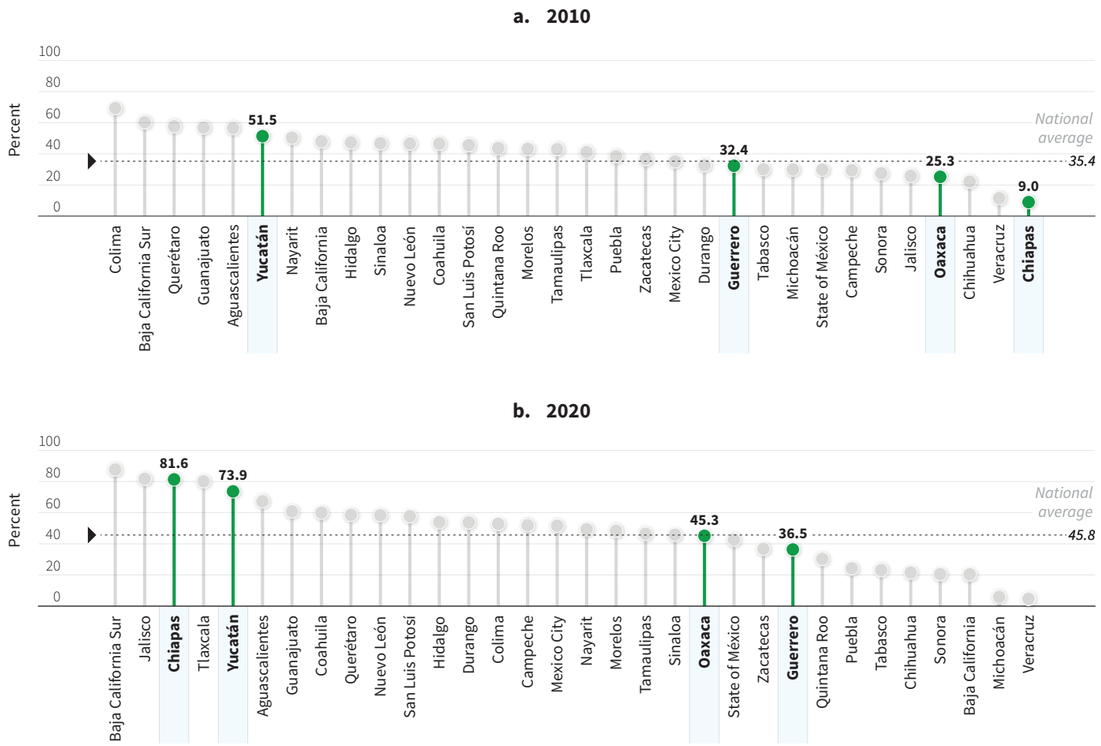
Federal and Toll Roads in the Selected States, 2019

Source: Adapted from SCT-IMT's *Red Nacional de Caminos*.

Figure C.15 shows the satisfaction levels of firms for roads across the states. The share of satisfied firms in the selected states is lower than the national average, except for Yucatán. In 2016, the satisfaction of firms for roads in Chiapas, Oaxaca, and Guerrero were 9, 25, and 33 percent, respectively (the national average was 36 percent), with Chiapas at the bottom of the ranking. Yucatán had the sixth-highest share of satisfied firms, with a rate above 50 percent. In 2020, this metric dramatically improved in Chiapas to 81.6 percent (the third-highest proportion), while Guerrero and Oaxaca remain below the national average. Yet, the last metrics are probably distorted by the pandemic crisis. This analysis and the previous one imply that deficiencies in roads could be a constraint to attract new industries into the selected states.

Regarding port infrastructure and operations, all the selected states, except for Guerrero, have ports with the capacity for international trade. Such ports include Puerto Chiapas, in Chiapas; Puerto de Salina Cruz, in Oaxaca; and Puerto de Progreso, in Yucatán. Guerrero only has a port in Acapulco, which attends mainly to coastal and touristic trade. Between 1996 and mid-2021, a private concessionaire operated this port. However, in June 2021, control of the port was returned to the federal government under the jurisdiction of the *Secretaría de la Marina* (Secretariat of the Navy).

FIGURE C.15
Firms' Satisfaction for Roads

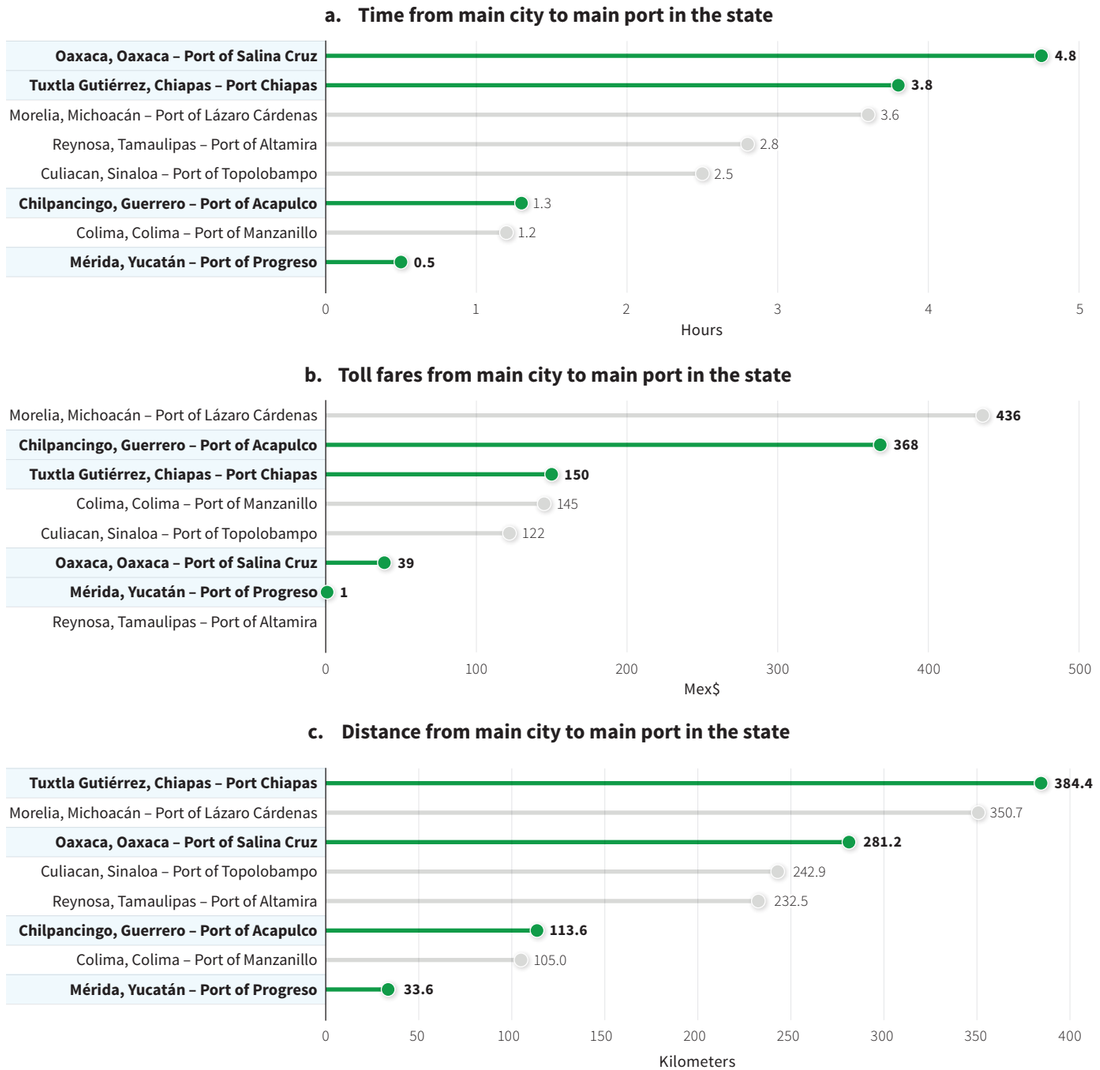


Source: ENCRIGE 2016 and 2020.
Note: Toll roads are excluded from the figure.

First, we compared three indicators to assess the feasibility of arriving at selected ports from the main economic regions of the states where they are located: time, cost, and distance. Figure C.16 shows that Yucatán has the lowest levels in these metrics, with a time to transport from Mérida (main city) to Progreso (port city) of less than one hour, no toll fares, and distance of below 50 km. In Guerrero, the route from Chilpancingo (main city) to the port of Acapulco is competitive in distance and time, but not in toll fares, which are the second highest among the selected states. Oaxaca is only competitive in the toll fares needed to pay to transport from Oaxaca (main city) to Puerto de Salina Cruz of less than Mex$100, while time and distance results were not competitive. Finally, Chiapas has a low performance in time and distance from Tuxtla Gutiérrez (main city) to Puerto Chiapas, although toll fares account for less than Mex$150.

Second, we analyzed the level of saturation of ports in the selected states to identify the potential use of incoming firms into the region with existing infra-

FIGURE C.16
Indicators of Ports Availability to the Main Cities, Selected Ports, 2020

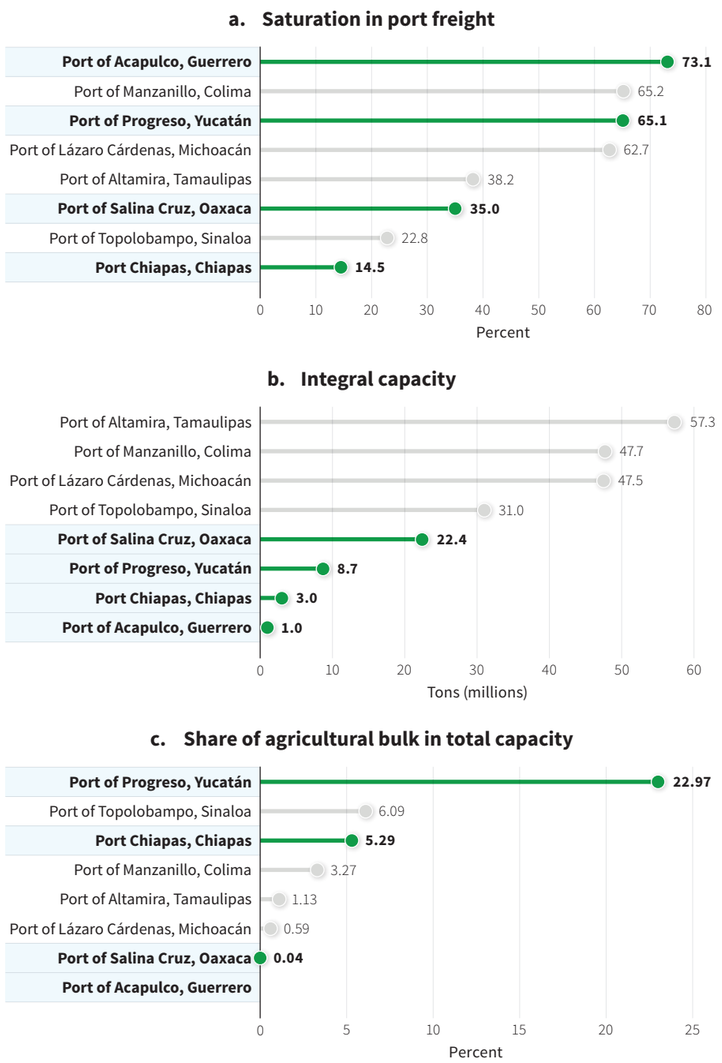


Source: Based on data from SCT's MAPPIR application.
Note: For panel b, toll fares were estimated for an automobile.

structures. Figure C.17 shows that Puerto de Acapulco in Guerrero is the most saturated at 73 percent, as well as the port with the lowest integral capacity (less than 1 million tons). Results for Puerto Chiapas showed that it is the least saturated port at 14 percent. However, its absolute capacity of only 3 million tons is low. Puerto de Salina Cruz is also less saturated (only 35 percent) and has the highest integral capacity (22.4 million tons). Puerto de Progreso has a saturation

FIGURE C.17

Level of Saturation and Capacity of Selected Ports, 2017



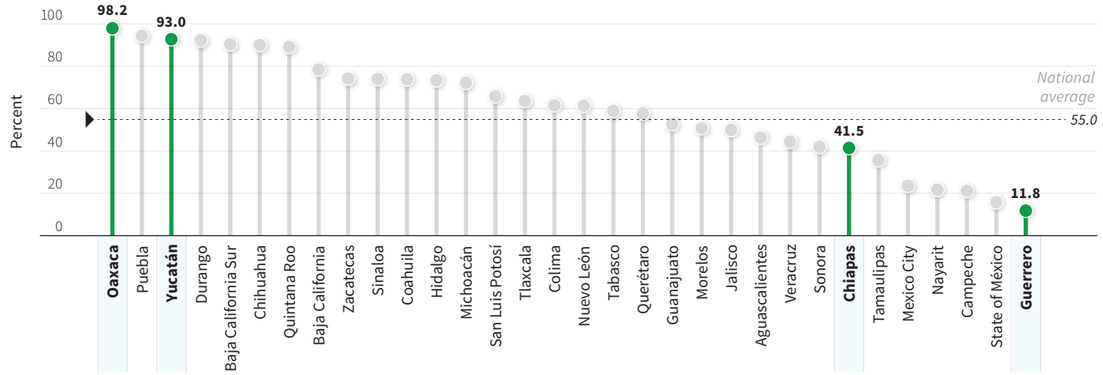
Source: Calculations based on data from SCT 2020; Idom Consulting 2017.

rate of 65 percent and an integral capacity of only a third of Puerto de Salina Cruz. Only Puerto de Progreso and Puerto Chiapas are able to mobilize agricultural bulk, whereas Puerto de Salina Cruz registers a very low rate and Port of Acapulco has none.

Third, the satisfaction levels of firms using the port infrastructures are compared. Figure C.18 shows that Oaxaca has the highest level of satisfaction in Mexico, with a rate of 98 percent. Yucatán follows, ranking third at 93 percent.

FIGURE C.18

Satisfaction of Firms with Port Infrastructure by State, 2016



Source: Based on INEGI's ENCRIGE database.
Note: The survey included an assessment of port services only until 2016.

Chiapas and Guerrero are below the national average (55 percent), with rates of 42 and 12 percent, respectively. Among all the states of the country, Guerrero performed worst. These results, coupled with the previous analysis, confirm that port infrastructure is a constraint for Guerrero. The port in Acapulco not only lacks the capacity for bulk agricultural freight and international trade, but it is also the most saturated among the ports of the selected states and its connectivity is inefficient.

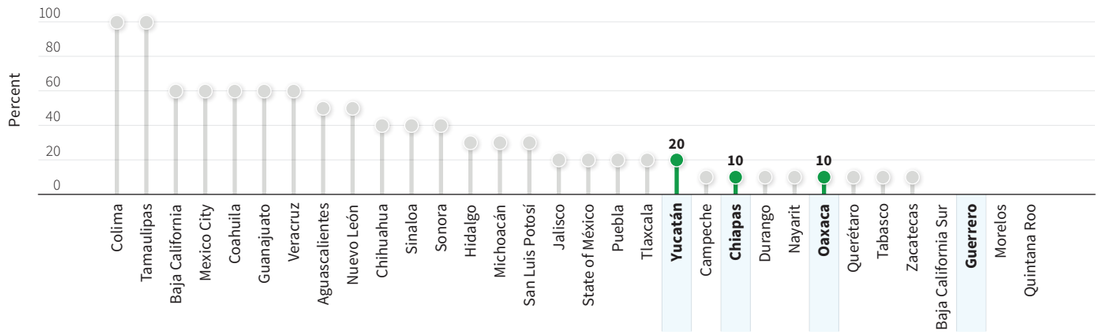
All of the ports in the selected states count on heterogeneous infrastructure facilities. The port in Chiapas has terminals for containers, agriculture bulks, and cruises, as well as a customs facility (*recinto fiscalizado*). However, the port has a maximum draft of only 10.5 meters (m), which restricts the size of vessels it can accommodate. Additionally, because it is not located in a natural port, it requires annual dredging to maintain its draft at the same depth. The port of Acapulco in Guerrero only has a draft of 9 m and counts with a small terminal for cruises, a terminal for vehicles, and another one for soil bulks. The port of Salina Cruz in Oaxaca has a draft of 12 m and terminals for general purposes, oil products, containers, and a fiscal pier. The port of Progreso in Yucatán has terminals for containers, agriculture and mineral bulks, and a place for ship repairs. It has a draft of 10.4 m.

The railway infrastructure completes the assessment of transportation infrastructure. The selected states have a poor performance in the use of railway to transport products. Figure C.19 shows that Chiapas and Oaxaca have an index of density of freight moved by railways of 10 percent, while Yucatán has 20 percent. Guerrero is the only selected state with zero freight density.

The low density of freight transported by railways is related to the coverage of Mexico's railway system. Map C.6 shows that Chiapas shares the same line as Oaxaca and Yucatán, the Chiapas-Mayab Line and Isthmus of Tehuantepec Railway, which belongs to a state-owned company. Guerrero is the only selected state with no rail infrastructure within its territory. It only has an old right-

FIGURE C.19

Index of Density of Freight Moved by Railways by State, 2018



Source: ARTF 2018.
Note: Normalized values are based on total products transported using the available rails within each state. A value of 100 percent represents a high density, 10 percent represents a low density, and 0 percent represents either no movement of products or no railways available for freight.

MAP C.6

Mexico's Railway System, 2021

Source: ARTF 2022.

of-way from the state of Morelos that is not being used anymore. This lack of railway connection to the rest of Mexico's railway system constrains any manufacturing industry using intensively this transport.

Regarding the airport infrastructure, as of 2021, Mexico has a network of 77 airports, 64 of which provide international routes, in addition to 1,492 aerodromes (map C.7). Among the selected states, there are a total of 11 airports

MAP C.7

Main Airports in Mexico, 2021

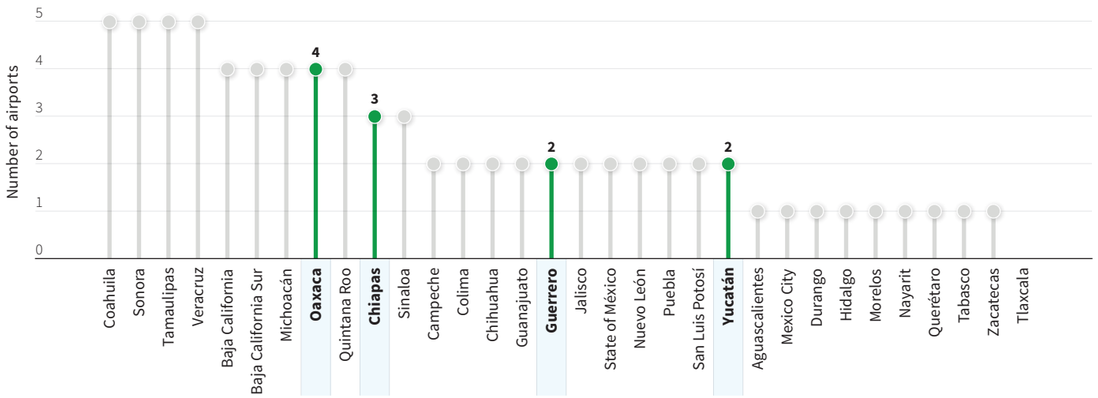
Source: SCT 2022.

Source: SCT 2022.

and 60 aerodromes. Figures C.20 and C.21 show that Oaxaca has the highest number of airports among the selected states, with four airports in the cities of Huatulco, Ixtepec, Oaxaca, and Puerto Escondido. Chiapas follows with three airports located in the cities of Palenque (with no operations), Tapachula, and

FIGURE C.20

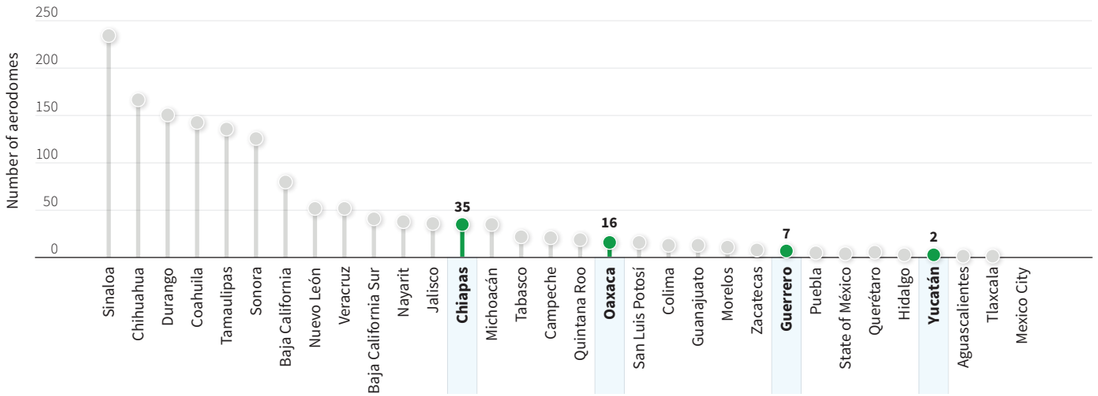
Number of Airports by State, 2021



Source: SCT 2022.

FIGURE C.21

Number of Aerodromes by State, 2021



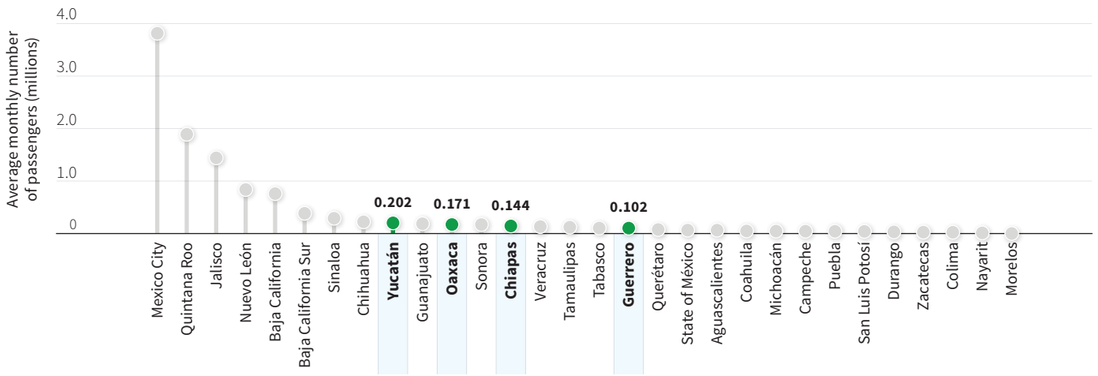
Source: SCT 2022.

Tuxtla Gutiérrez. Guerrero and Yucatán each has two airports: Acapulco and Ixtapa Zihuatanejo in Guerrero and Kaua and Mérida in Yucatán.[83] Chiapas is the selected state with the highest number of aerodromes (35), followed by Oaxaca (16), Guerrero (7), and Yucatán (2).

Regarding operations, figures C.22 and C.23 show that Yucatán has the highest number of passengers and freight mobilized by air; Oaxaca and Chiapas were in the middle of the distribution among Mexico's 32 states, but very far from the top performers, while Guerrero had one of the lowest numbers of passengers and freight mobilized.

FIGURE C.22

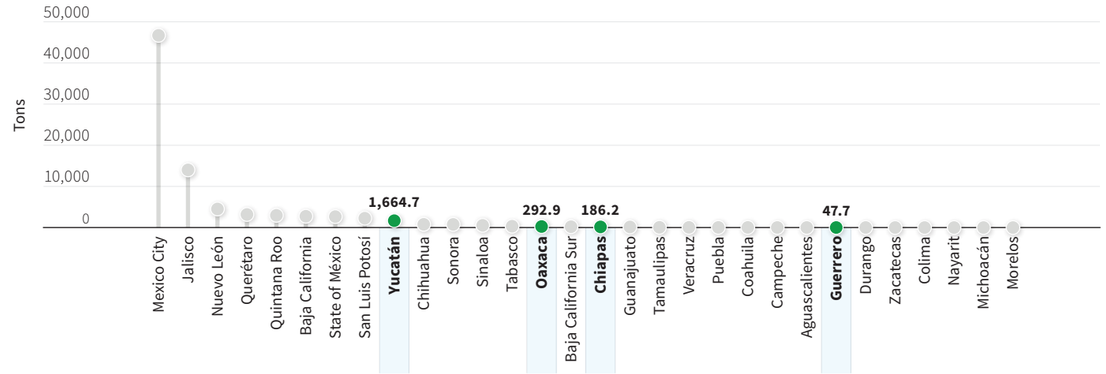
Monthly Average Number of Passengers Mobilized by State, 2015–19



Source: Calculations based on data from SCT's *Estadística Operativa de Aeropuertos, Dirección General de Aeronáutica Civil*.
Note: The figure corresponds to the months of November from the years considered.

FIGURE C.23

Monthly Average of Freight Transported by State, 2015–19



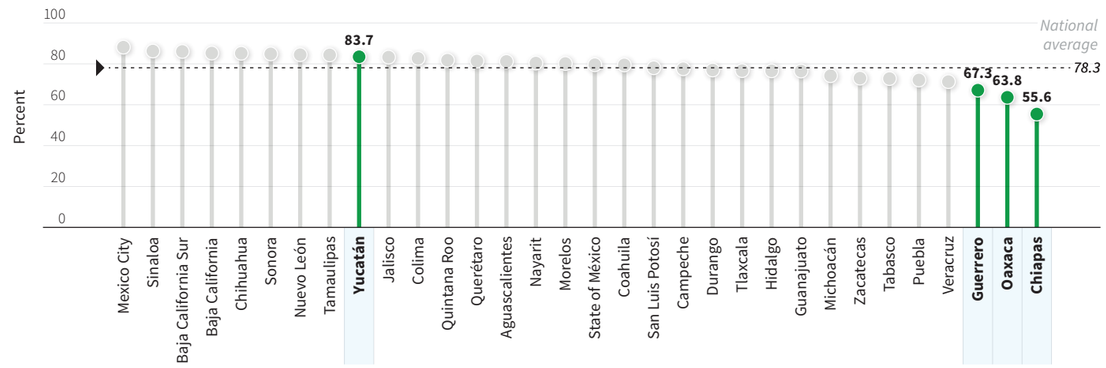
Source: Calculations based on data from SCT's *Estadística Operativa de Aeropuertos, Dirección General de Aeronáutica Civil*.
Note: The figure corresponds to the months of November from the years considered.

TELECOMMUNICATIONS

Figures C.24, C.25, and C.26 show that Chiapas, Guerrero, and Oaxaca had the lowest shares of population using mobile telephony and internet across the country in 2021. Yucatán was the only selected state with a usage rate above the national average (78.3 and 75.6 percent, respectively) for both metrics, with 83.7 and 79.9 percent, respectively. For households with an internet connection, Oaxaca and Chiapas had the lowest shares in the country and Guerrero's rate fell below the national average of 66.4 percent. Yucatán reached the same proportion as the national level, yet it still fell almost 20 percentage points below the most connected state. This implies that although the number of telecommunications users is growing, not all places within the selected states have access to internet connectivity.

FIGURE C.24

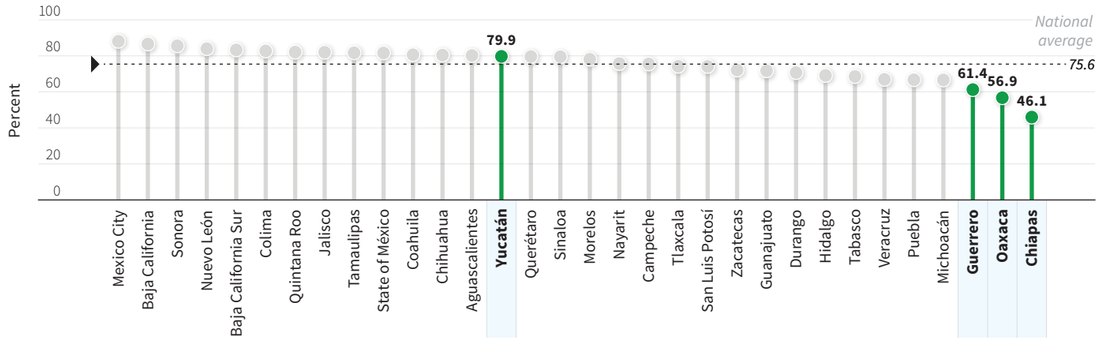
Share of Mobile Telephony Users, 2021



Source: Based on data from INEGI's EDUTIH database.

FIGURE C.25

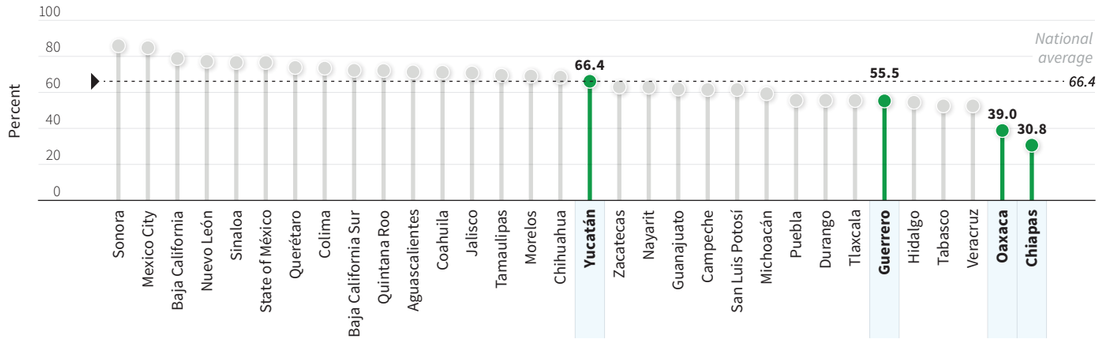
Share of Internet Users, 2021



Source: Based on data from INEGI's EDUTIH database.

FIGURE C.26

Share of Households with Internet Connection, 2021

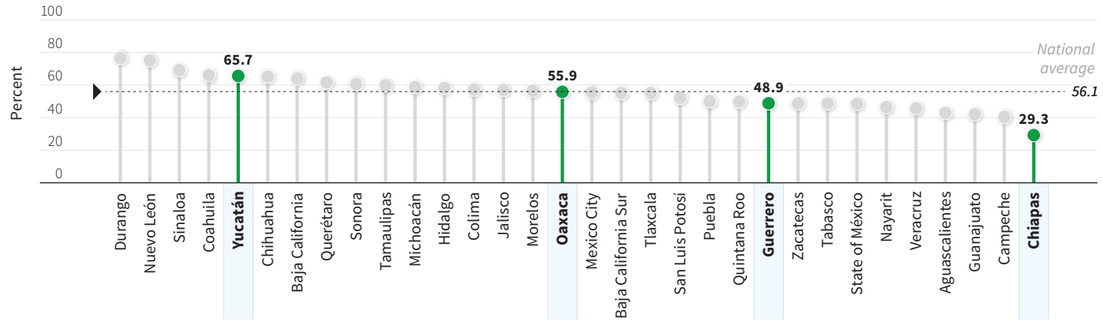


Source: Based on data from INEGI's EDUTIH database.

Despite these poor levels of telecommunications coverage, figures C.27 and C.28 show that the satisfaction levels of firms is relatively high in the selected states. For internet service, in 2016, all the selected states, except Oaxaca, exceeded the national satisfaction average of 58 percent, with Yucatán at 70 percent, Guerrero at 65 percent, and Chiapas at 62 percent. In terms of mobile telephony service, only Yucatán surpassed the national average of 56 percent. Oaxaca was tied with the national average, Guerrero reported a satisfaction level of 49 percent, and Chiapas ranked at the bottom with a satisfaction level of 29 percent.

FIGURE C.27

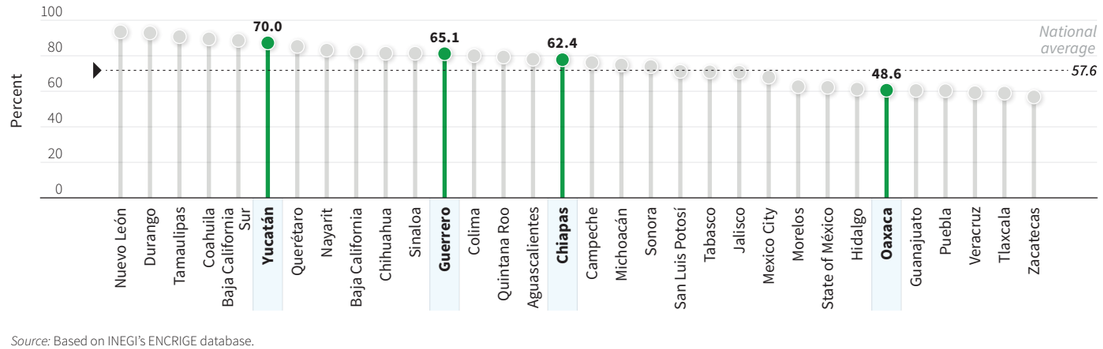
Firms' Satisfaction for Mobile Telephony Services, 2016



Source: Based on INEGI's ENCRIGE database.
Note: The figure reflects the latest available data for mobile telephony services.

FIGURE C.28

Firms' Satisfaction for Internet Services, 2016



Source: Based on INEGI's ENCRIGE database.
Note: The figure reflects the latest available data for internet services.

INFRASTRUCTURE FOR THE FOREST SECTOR

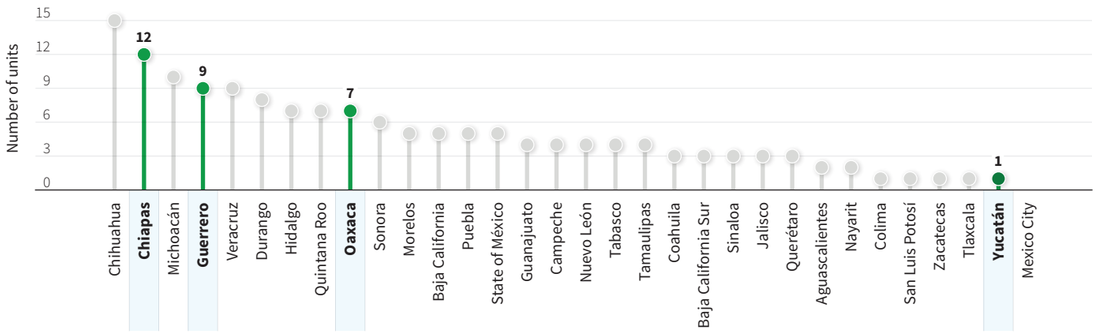
Specific infrastructure for the forest sector is mainly required for growing and developing special seeds and inputs. In this regard, we analyzed three main assets: units for germplasm production,[84] units for germplasm storage,[85] and community seed banks.[86]

For the selected states, figure C.29 shows that the highest number of units for germplasm production is in Chiapas (12), followed by Guerrero (9), Oaxaca (7), and Yucatán (1). For germplasm storage, figure C.30 shows that Oaxaca has the highest capacity with 10 tons, followed by Yucatán with 6 tons. While Chiapas and Guerrero do not have units for germplasm storage.

Regarding the stock of community seed banks, figure C.31 shows that, in 2018, out of 26 community seed banks in Mexico, 11 were located in Oaxaca, making it the state with the highest stock of seed banks. Chiapas and Yucatán each had two seed banks, and Guerrero had none. As for the capacity of these seed banks, figure C.32 shows that Oaxaca's banks had the highest capacity in

FIGURE C.29

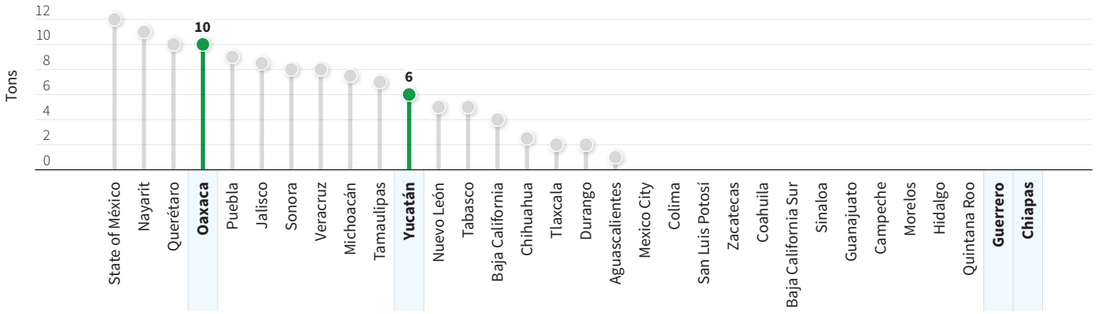
Germplasm Production, by State, 2019



Source: CONAFOR 2019a.

FIGURE C.30

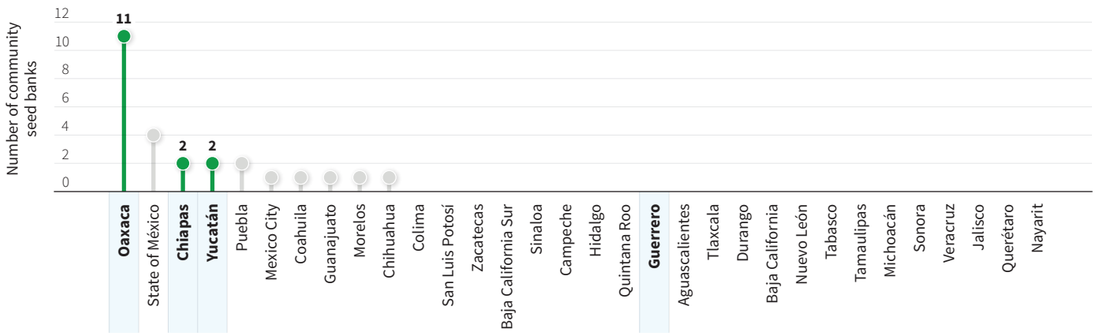
Germplasm Storage Capacity, by State, 2019



Source: CONAFOR 2019a.
Note: The figure considers only one unit per state.

FIGURE C.31

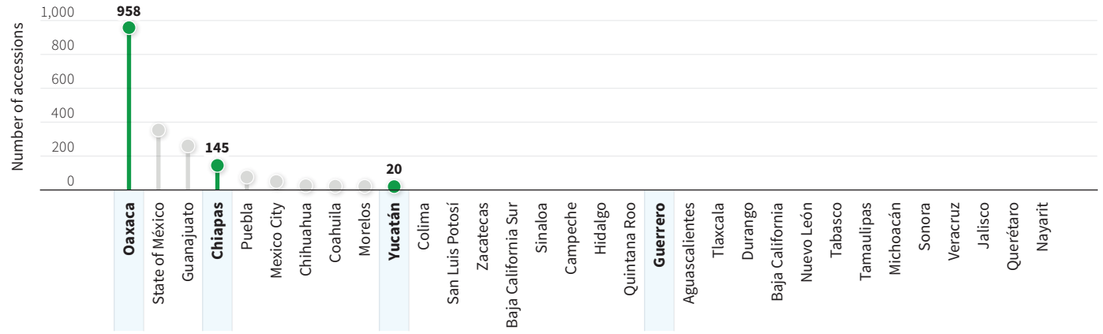
Community Seed Banks, by State, 2018



Source: SNICS 2018.

FIGURE C.32

Production Capacity of Community Seed Banks, by State, 2018



Source: SNICS 2018.

the country, with up to 958 accessions.[87] Among the selected states with community seed banks, Chiapas had the second highest capacity with 145 accessions, while Yucatán had the least capacity with only 20 accessions.

This analysis suggests that the availability of seeds and germplasm production in the selected states may be a constraint to produce forest raw materials, especially for Guerrero where there is a lack of seeds storage and community seed banks.

GEOGRAPHIC CONDITIONS

This section focuses on the qualitative analysis of the natural conditions and potential risks that could threaten the development of the forestry sector in the selected states. The natural conditions that were assessed include the topography of the states, climate, soil predominance, and ecological and environmental management plans. For potential risks, seismicity, risks of hurricanes, fires, floods, and droughts of the selected states were assessed.

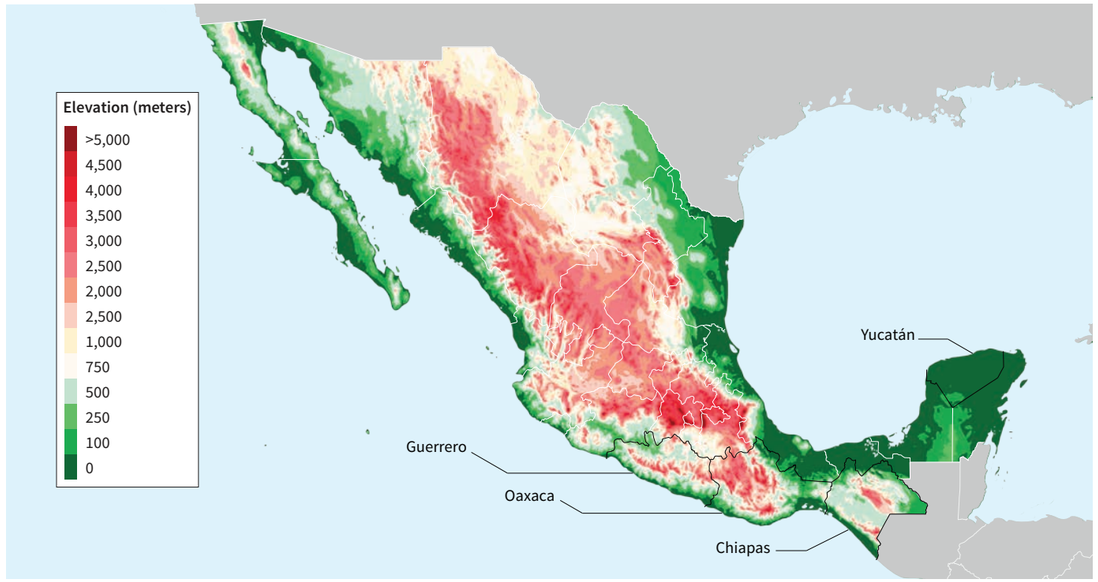
NATURAL CONDITIONS

The topography of the selected states is quite diverse. In Guerrero and Oaxaca, there is a highly rugged area, with high mountains part of the Sierra Madre del Sur. This mountain system extends from western Guerrero to eastern Oaxaca. It divides the coastal regions of both states from the regions near the Valley of Mexico. Oaxaca has a flat region in the Isthmus of Tehuantepec that connects to Veracruz and joins both coasts, representing the shortest distance between the Gulf of Mexico and the Pacific Ocean. Chiapas also has a mountain system, the Sierra Madre de Chiapas on its western side. Yucatán, on the other hand, is mostly flat, with no important changes in its topography within all its territory (map C.8).

Regarding climate conditions, Yucatán, as well as coastal regions of Chiapas and Oaxaca and most of the territory of Guerrero, have subtropical weather conditions. The northern region of Chiapas has tropical weather while its central region, where the city of San Cristóbal de las Casas is located, has mild weather. The northern part of Oaxaca has mild weather as well, while the central part of the state has predominantly dry weather (map C.9).

MAP C.8

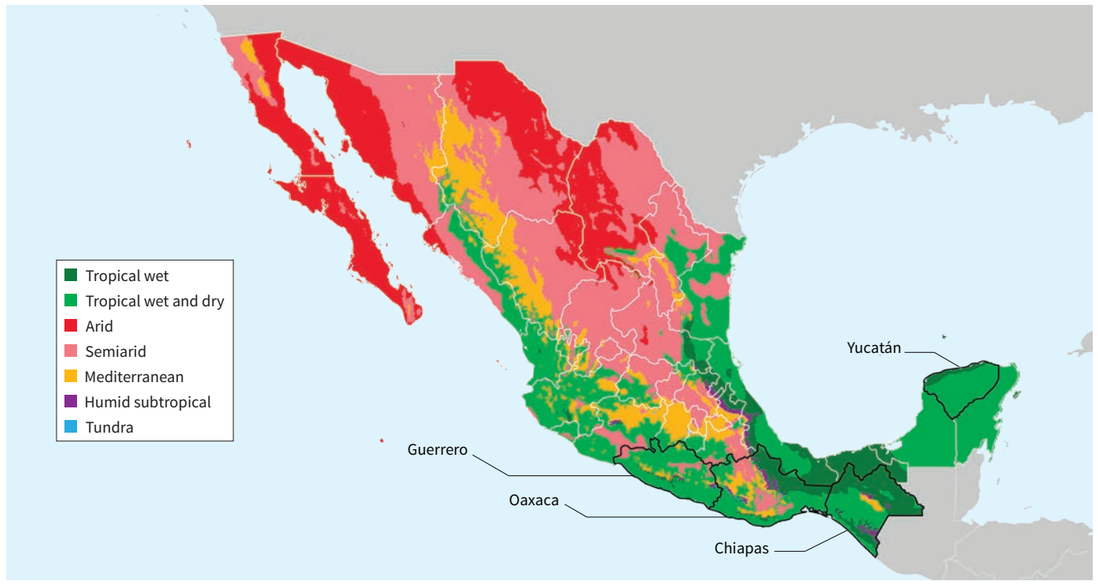
Mexico's Topography, 2015



Source: Based on SEMARNAT's *Atlas Digital Geográfico.*

MAP C.9

Mexico's Climate, 2015



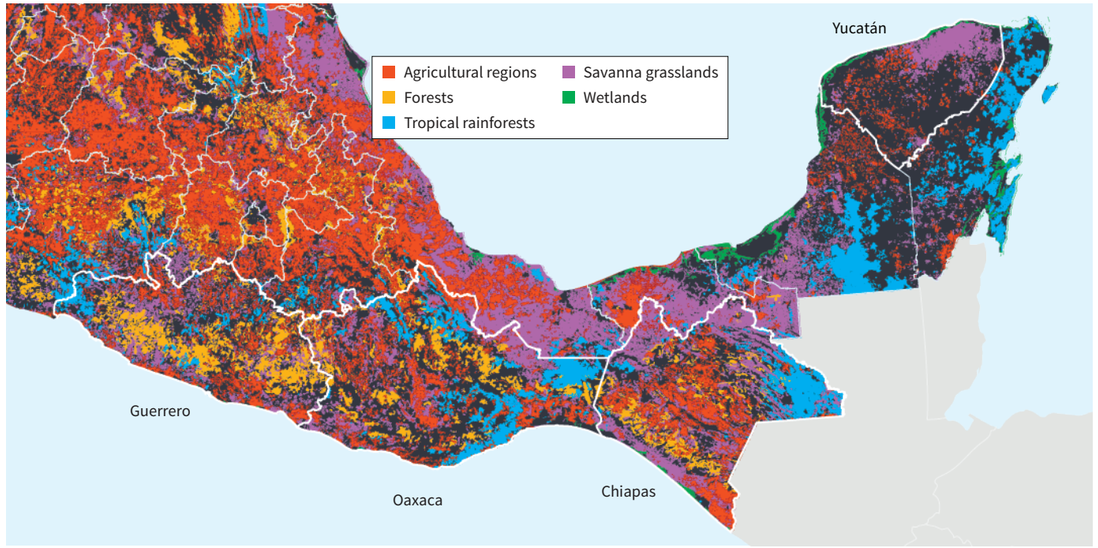
Source: Based on SEMARNAT's *Atlas Digital Geográfico.*

Weather conditions do not represent a particular constraint for the development of forestry in the selected states. However, the ripped topography could be a constraint for infrastructure building in the mountainous parts of these states.

Map C.10 presents land uses and vegetation in the selected states. Guerrero has mainly forest vegetation in the mountain regions of the state and few tropical rainforests in the northern and western regions. Chiapas has forested areas in the Frailesca region, a tropical rainforest region on the eastern side (Selva Lacandona), and savanna and grassland areas on the coastal and northern regions. Oaxaca has mainly tropical rainforest vegetation on the eastern and southeastern regions and few forest vegetation in the mountain regions. Yucatán stands for mainly having savanna and grassland areas, especially on its northeastern region. The selected states have several protected areas.[95] As map C.11 shows, Chiapas has the largest number of protected areas, mainly in the Frailesca and Selva Lacandona regions. Oaxaca has a protected area in the Mixteca region on the north of the state. Guerrero and Yucatán only have only protected regions on the coastal and mountain parts of these states. Protected areas allow some economic activities within them. However, they are restricted to only preservation and conservation activities with proven sustainable practices.

MAP C.10

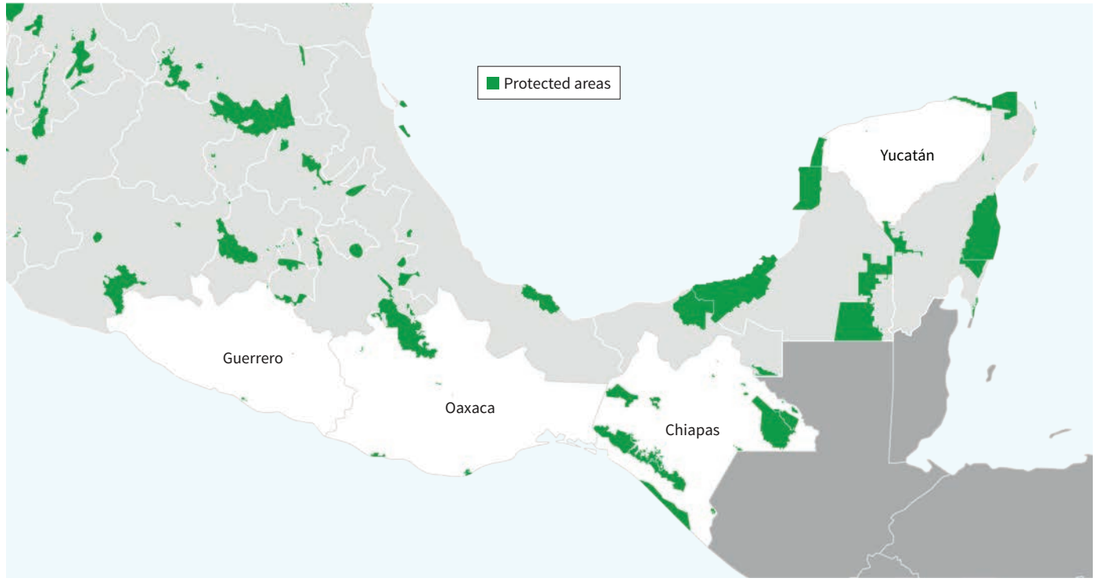
Land Uses in the Selected States (Simplified), 2015



Source: Based on data from INEGI 2017.
Note: The map is a simplified version.

MAP C.11

Protected Areas in the Selected States, 2019



Source: CONANP 2019.

MAP C.12

Seismic Regionalization At the National Level, 2015

Source: Based on CENAPRED's *Sistema de Información Sobre Riesgos.*

RISKS BY REGION

Map C.12 shows that Chiapas, Guerrero, and Oaxaca have the highest seismic regions in the country, since the northern border of the Cocos Plate extends through the coastal line of these states. The seismic risk is very high on the coastal regions of these states (zone D) and high for the rest of their territories (zone C). Only Yucatán has a low risk of earthquake.

In addition to the risk of earthquake for the selected states, intensity is a relevant aspect to consider. Map C.13 shows that the intensity is high on the coastal regions of Chiapas, Guerrero, and Oaxaca (ranging from VIII to XI on a scale of I–XI [highest intensity]). Construction projects in high intensity areas would require a higher investment in their design to comply with code requirements to minimize impacts of earthquake in any structure.

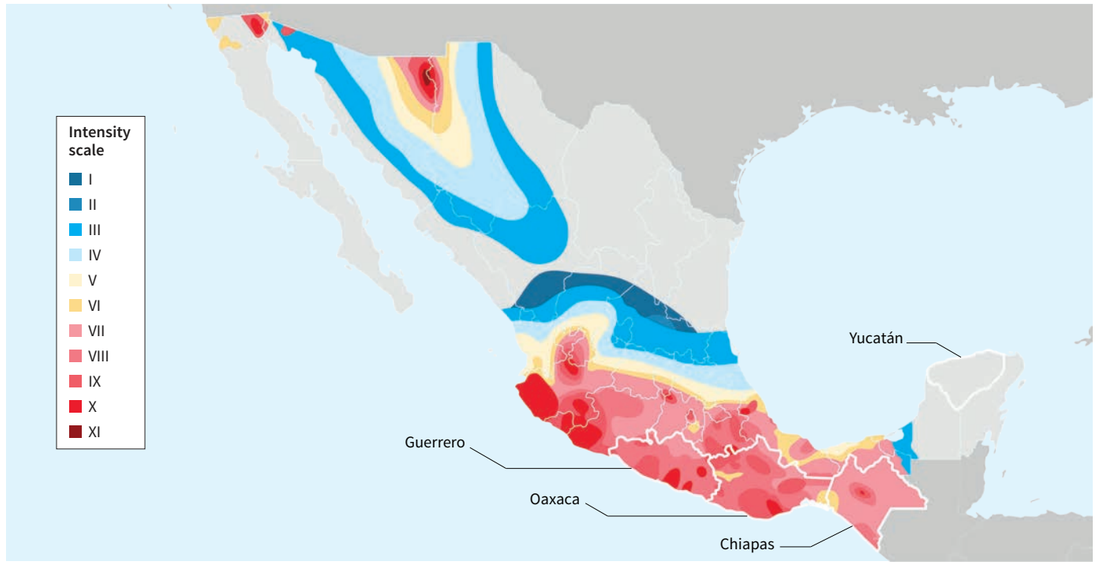
Another risk to consider for forest-based activities is the potential for droughts and floods. Map C.14 shows that the risk for droughts is low in all the selected states, with only a small region with high risk in the north of Chiapas.

The risk of floods is potentially higher than that of droughts, especially in Yucatán (since it is a flat region). Map C.15 shows that the risk for floods is mild in the coastal regions of Chiapas, Guerrero, and Oaxaca. However, this is not a constraint for economic development in the selected states, especially if adaptation measures are implemented.

Regarding potential risks for storms and hurricanes, as map C.16 shows, all selected states have a risk of being impacted by a tropical storm, with the southern coast of Chiapas and the region around Huatulco in Oaxaca exhibiting a

MAP C.13

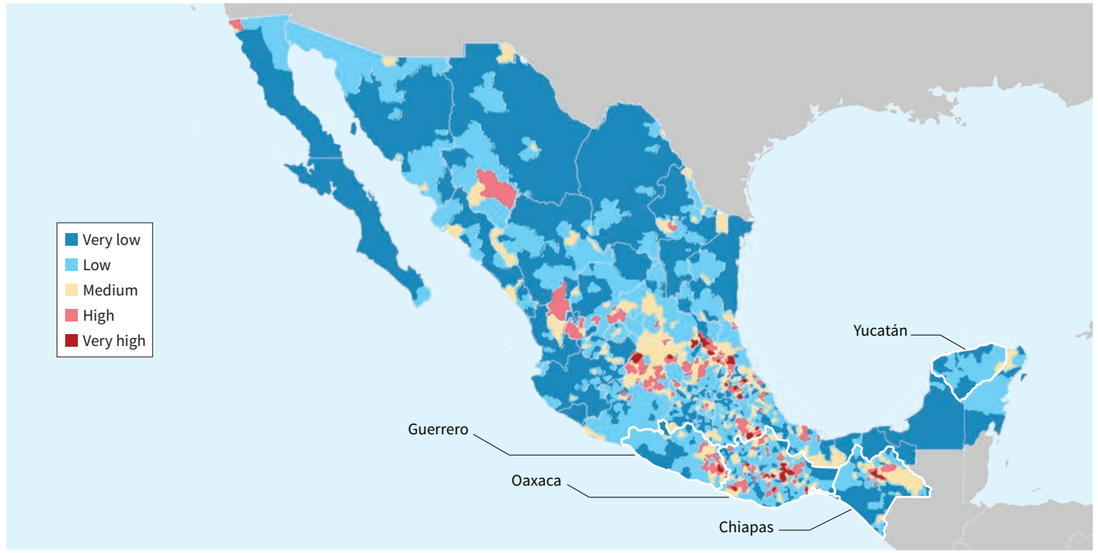
Intensity of Earthquakes in Mexico, 2017



Source: Based on CENAPRED's *Sistema de Información Sobre Riesgos.*
Note: Intensity levels range from I (lowest) to XI (highest).

MAP C.14

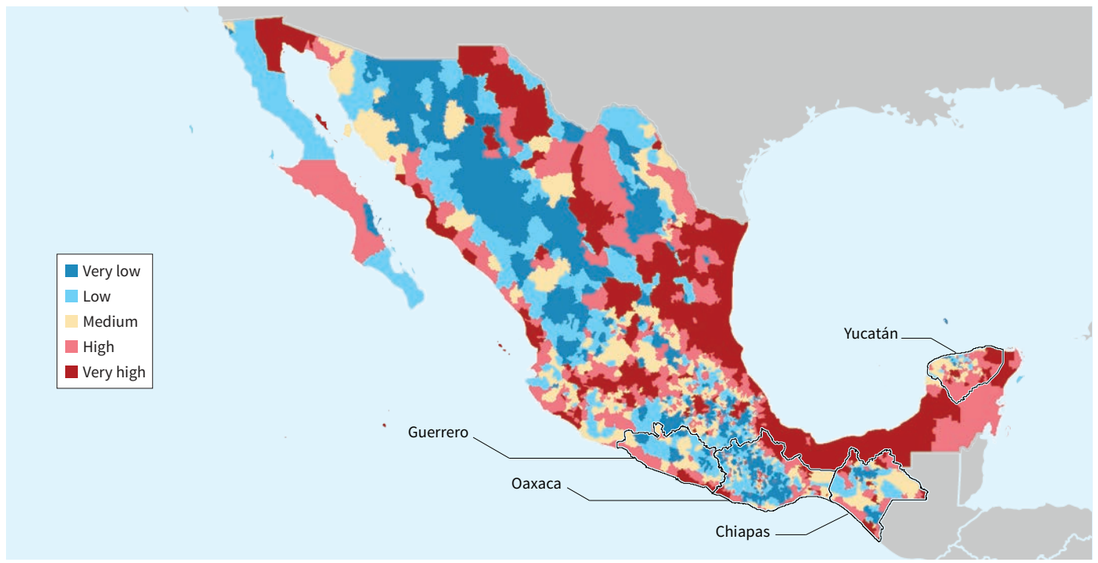
Drought Risk in Mexico, 2017



Source: Based on CENAPRED's *Sistema de Información Sobre Riesgos*.
Note: The map presents qualitative data.

MAP C.15

Flood Risk in Mexico, 2017



Source: Adapted from CENAPRED's *Sistema Nacional de Información Sobre Riesgos*.
Note: The map presents qualitative data.

MAP C.16

Storm and Hurricane Risks in the Selected States, 2017

a. Tropical storm

b. Category 1 hurricane

c. Category 2 hurricane

d. Category 3 hurricane

e. Category 4 hurricane

f. Category 5 hurricane

Source: Adapted from CENAPRED's *Sistema Nacional de Información Sobre Riesgos*.
Note: Hurricane wind speeds are classified into five categories according to the Saffir-Simpson Hurricane Wind Scale. A category 1 hurricane has wind speeds ranging from 119 to 153 kilometers per hour (km/h), often causing minimal damage. Category 2 hurricanes exhibit wind speeds from 154 to 177 km/h, resulting in moderate damage. The wind speeds of a category 3 hurricane, which is considered to cause extensive damage, range from 178 to 208 km/h. Category 4 hurricanes have wind speeds between 209 and 251 km/h and can cause severe damage. Finally, a category 5 hurricane, which can cause catastrophic damage, has wind speeds of 252 km/h or higher.

higher likelihood (probability of 0.66–1.0). While the other coastal parts of the selected states show a lower risk, with probabilities falling below 0.6. For category 1 and 2 hurricanes, coasts of selected states have a fairly low chance of being impacted, with probabilities ranging from 0 to 0.167. Notable exceptions are the Isthmus region of Oaxaca and Chiapas, where this probability increases to between 0.168 to 0.5. For more severe hurricanes, namely categories 3, 4, and 5, the risk drops across all states, with probabilities less than 0.077. Therefore, given these relatively low probabilities, the potential risk of hurricanes does not represent a particular risk for economic development in the selected states.

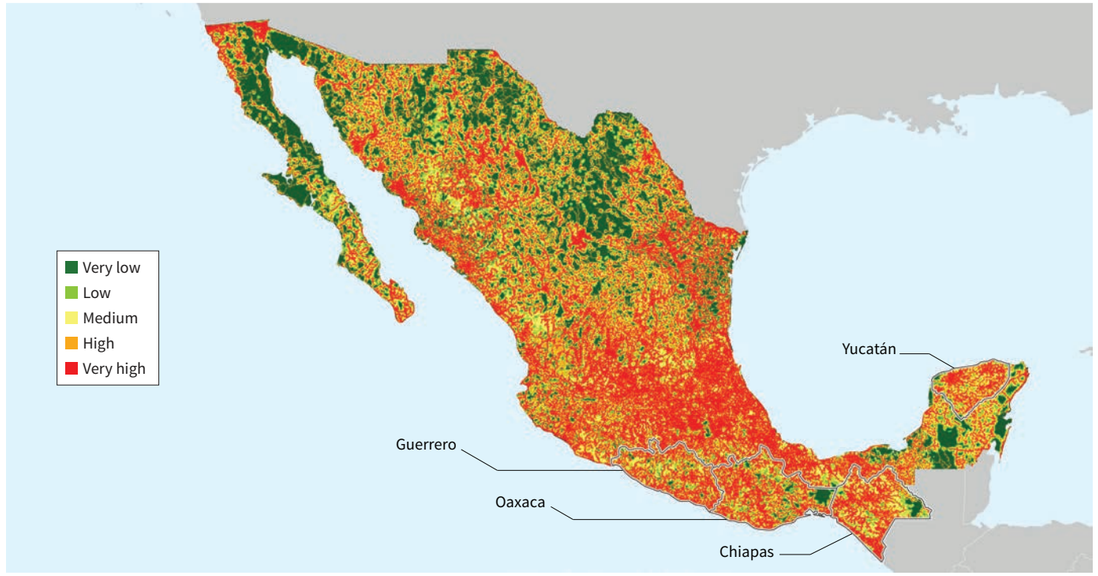
The risk of forest fires caused by human activities increases in the regions with higher population density. In the selected states, as map C.17 illustrates, the risk of occurrence is high to very high mainly in Guerrero. In Oaxaca and Chiapas, the risk is similar and only two regions have very low risk (Chimalapas in both states and Selva Lacandona in Chiapas). For Yucatán, the risk of fires is also high to very high across the state.

Among the selected states, figure C.33 shows that there is a higher probability of a forest fire occurring in Chiapas, Guerrero, and Oaxaca. Between 2010 and 2021, on average, Chiapas had the highest number of forest fires registered each year (333), followed by Oaxaca (249), and Guerrero (192), while Yucatán registered the least (47).

Map C.18 presents the geographical distribution of risks of plague of parasite insects and plants. In this regard, all selected states, except Yucatán, present a high to very high risk of these plagues in their regions. According to the

MAP C.17

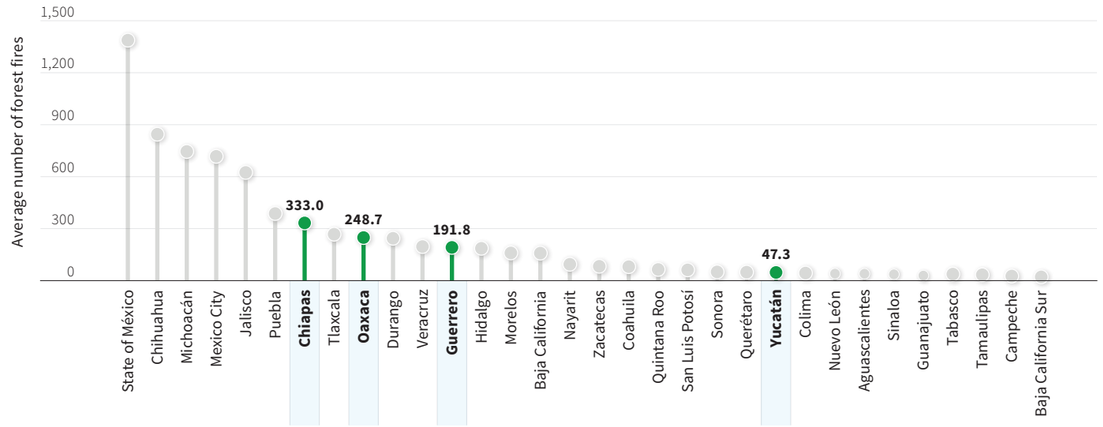
Risk of Human-Caused Forest Fire Occurrence in Mexico, 2020



Source: Based on CENAPRED's *Sistema de Información Sobre Riesgos.*

FIGURE C.33

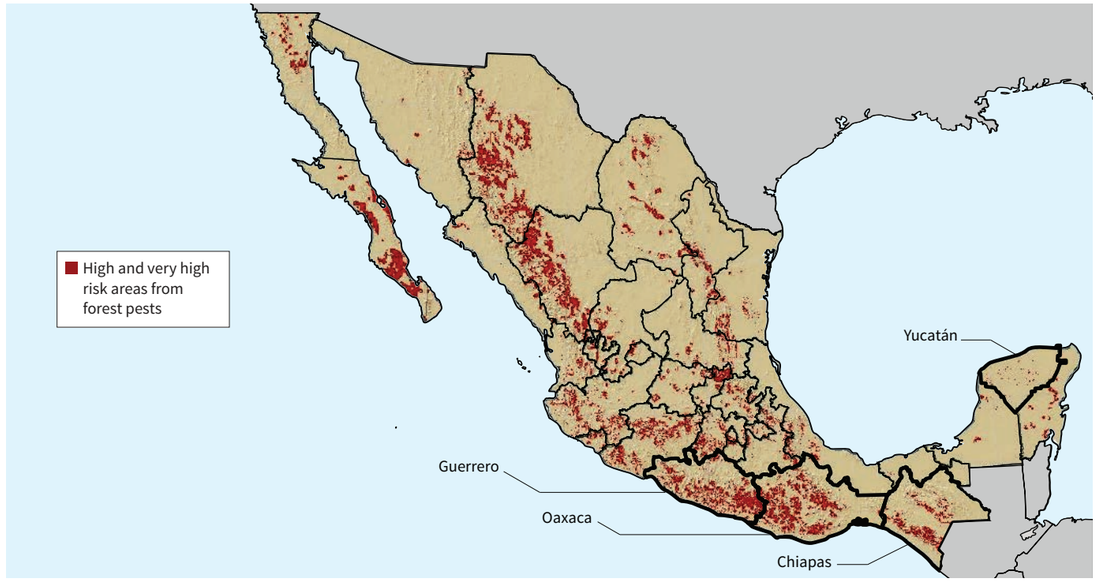
Average Number of Forest Fires Every Year, 2010–21



Source: Based on data from SEMARNAT's SNIARN database.

MAP C.18

High Risk Regions for Outbreaks of Forest Pests and Parasitic Plants in Mexico, 2020



Source: CONAFOR 2020a.

Comisión Nacional Forestal, the states that present a higher surface with high and very high risk for plagues are Chiapas, Chihuahua, Durango, Guerrero, Jalisco, Michoacán, and Oaxaca. Having no control of these plagues could be a constraint for efficiently developing agricultural and forestry activities.

APPENDIX D
Factor Intensity in the Forestry Sector

To identify infrastructure-related constraints hindering the development of the forest sector in the selected states, we analyze the use of key inputs in the production process including energy (electricity), water, combustibles, logistics (freight), and communications, and contrast these intensities with the availability of each input (see appendix C).[88]

Based on firm level data, we measure how various manufacturing activities at the national level[89] perform using two metrics of factor usage intensity: (1) consumption or expenditure of a factor, as a percentage of intermediate consumption and (2) consumption or expenditure of a factor, as a percentage of value added. The logic of this is if a sector is intensive in the use of one of these factors in which the state has deficiencies, this could represent a binding constraint.

Two benchmarks to reflect the intensity of use of those factors were considered. The first is the national average for all existing manufacturing activities. The second is the average of those manufacturing activities in which the selected states have a revealed comparative advantage greater than one (competitive sectors in these states). Following the methodology of Barrios and others (2018a; 2108b), from the first benchmark, four categories were created to classify the intensity of factor usage: (1) high intensity, for industry groups with a dependence of the factor higher than the sum of the national average and half a standard deviation for both metrics (dark green quadrant); (2) mid-high intensity, for industry groups with a dependence of the factor higher than the sum of the national average and half a standard deviation in one of the metrics (medium-dark green quadrant); (3) mid-low intensity, for those groups with a dependence of the factor below half standard deviation of national average in both or one of the metrics, but with the other metric below the sum of the national average and half a standard deviation (medium-light green quadrant); (4) low intensity, for those industry groups with a factor below the difference between the national average and half a standard deviation in both metrics (light green quadrant).

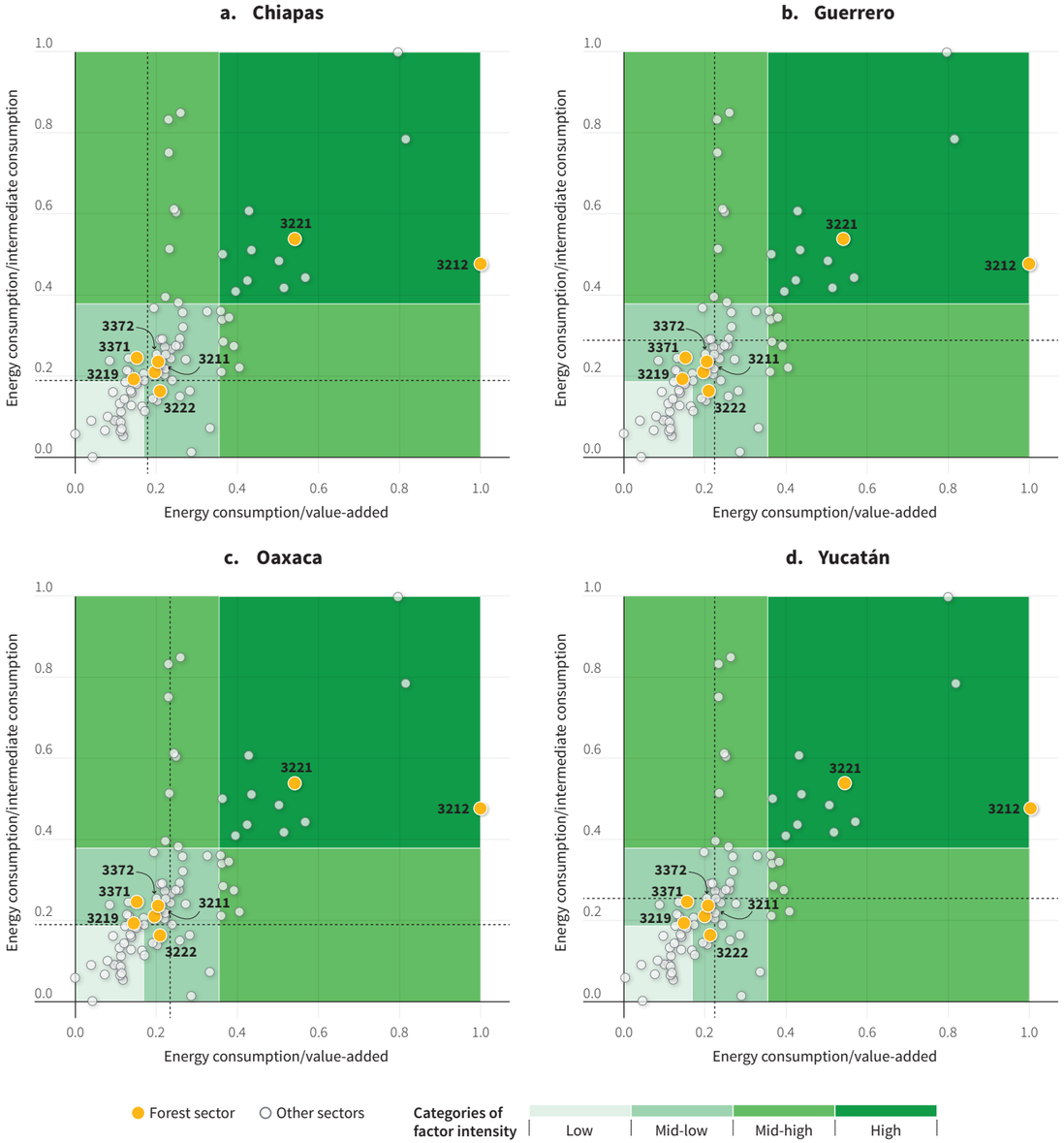
As figure D.1 shows, forest sector activities have a heterogeneous intensity in the use of energy. Veneer, plywood, and engineered wood product manufacturing (North American Industry Classification System [NAICS] four-digit product code 3212) and pulp, paper, and paperboard mills (3221) are in the high-intensity quadrant. Sawmills and wood preservation (3211), converted paper product manufacturing (3222), household and institutional furniture and kitchen cabinet manufacturing (3371), and office furniture manufacturing (3372) fall in the mid-low-intensity quadrant, as well as the average of the activities with a comparative advantage in the selected states. Other wood product manufacturing (3219) falls next to the low-intensity quadrant. Therefore, energy could be a constraint for developing 3221 and 3212 activities, mainly in Guerrero and Oaxaca, where the difference between energy production and consumption is very low, and Oaxaca also lacks the connections between the transmission lines in the northern and western parts of the state.

Figure D.2 shows that forest sector activities have a heterogeneous intensity in the use of water. Sawmills and wood preservation (NAICS 3211) and other wood product manufacturing (3219) are the only activities that fall in the low-intensity quadrant. Converted paper product manufacturing (3222), household and institutional furniture and kitchen cabinet manufacturing (3371), and office furniture manufacturing (3372) fall in the mid-low-intensity quadrants. Veneer, plywood, and engineered wood product manufacturing (3212) is in the mid-high-intensity quadrant, with a higher intensity in the metric of water consumption as a percentage of value added. Lastly, pulp, paper, and paperboard mills (3221) is the only activity that falls in the high-intensity quadrant. Therefore, water availability can be a constraint for developing activity 3221, and to a lesser extent, for activity 3212. As described in appendix C, the selected states have water availability (superficial and groundwater), except for some parts of northern Guerrero; water availability may represent a harder constraint for the state because it has a high cost per volume produced and the highest cost-fare relation among the selected states and may increase operating costs for water-intensive industries.

Figure D.3 shows the results for freight intensity. All forest sector activities are in the mid- and high-intensity quadrants. Other wood product manufacturing (NAICS 3219) and household and institutional furniture and kitchen cabinet manufacturing (3371) are mid-low freight intensive. Veneer, plywood, and engineered wood product manufacturing (3212) is in the mid-high-intensity quadrant, with a higher intensity in the metric of freight expenditure as a percentage of value added. Sawmills and wood preservation (3211), pulp, paper, and paperboard mills (3221), converted paper product manufacturing (3222), and office furniture manufacturing (3372) are in the high-intensity quadrant. These results suggest that the lack of adequate transportation infrastructure may represent an important constraint for developing these activities in the selected states. Moreover, the low rates of paved roads in the selected states increases operational costs, which reduces total factor productivity and lowers the level of users' satisfaction. This is a relevant issue, especially for Chiapas, Guerrero, and

FIGURE D.1

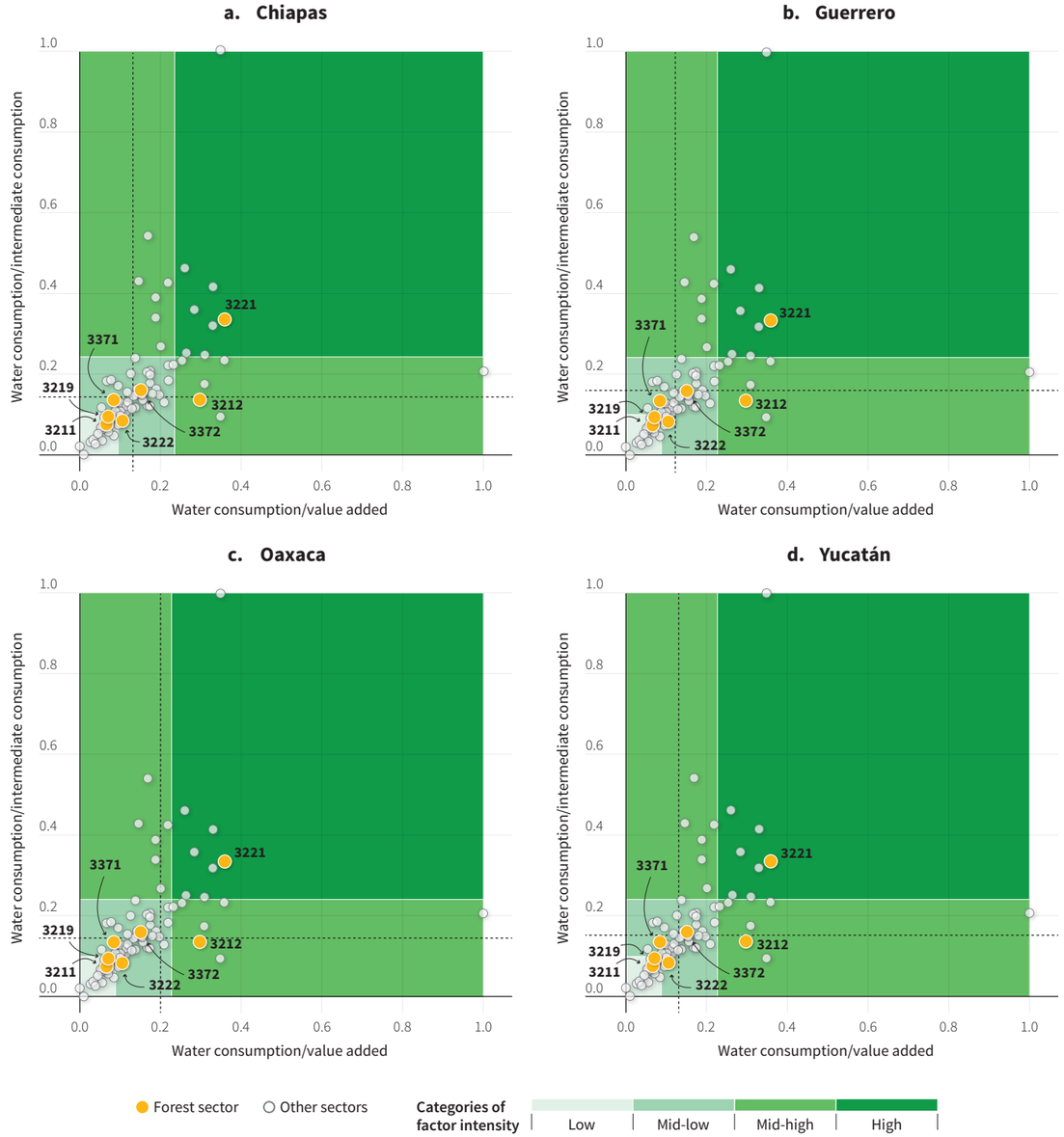
Energy Intensity by Sector, 2014 and 2019 Averages



Source: Calculations based on data from INEGI 2014; 2019.
Note: Sectors are classified using NAICS four-digit codes. Dashed lines represent the average normalized value of the sectors with a revealed comparative advantage greater than one for each selected state. For Chiapas, those sectors were NAICS 3111, 3112, 3113, 3115, 3116, 3117, 3118, 3119, 3121, 3149, 3219, 3231, 3323, 3328, and 3371; for Guerrero, those sectors were 3115, 3118, 3121, 3131, 3141, 3149, 3152, 3159, 3169, 3219, 3259, 3262, 3273, 3279, 3323, 3371, and 3399; for Oaxaca, those sectors were 3113, 3118, 3121, 3131, 3141, 3149, 3211, 3219, 3241, 3273, and 3323; and for Yucatán, those sectors were 3111, 3112, 3116, 3117, 3118, 3121, 3131, 3141, 3149, 3151, 3152, 3159, 3169, 3219, 3261, 3273, 3279, 3323, 3332, 3333, 3353, 3366, 3371, and 3399. Yellow points represent group industries of the forest industry classified in at the four-digit level, except for groups with confidential information. NAICS = North American Industry Classification System.

FIGURE D.2

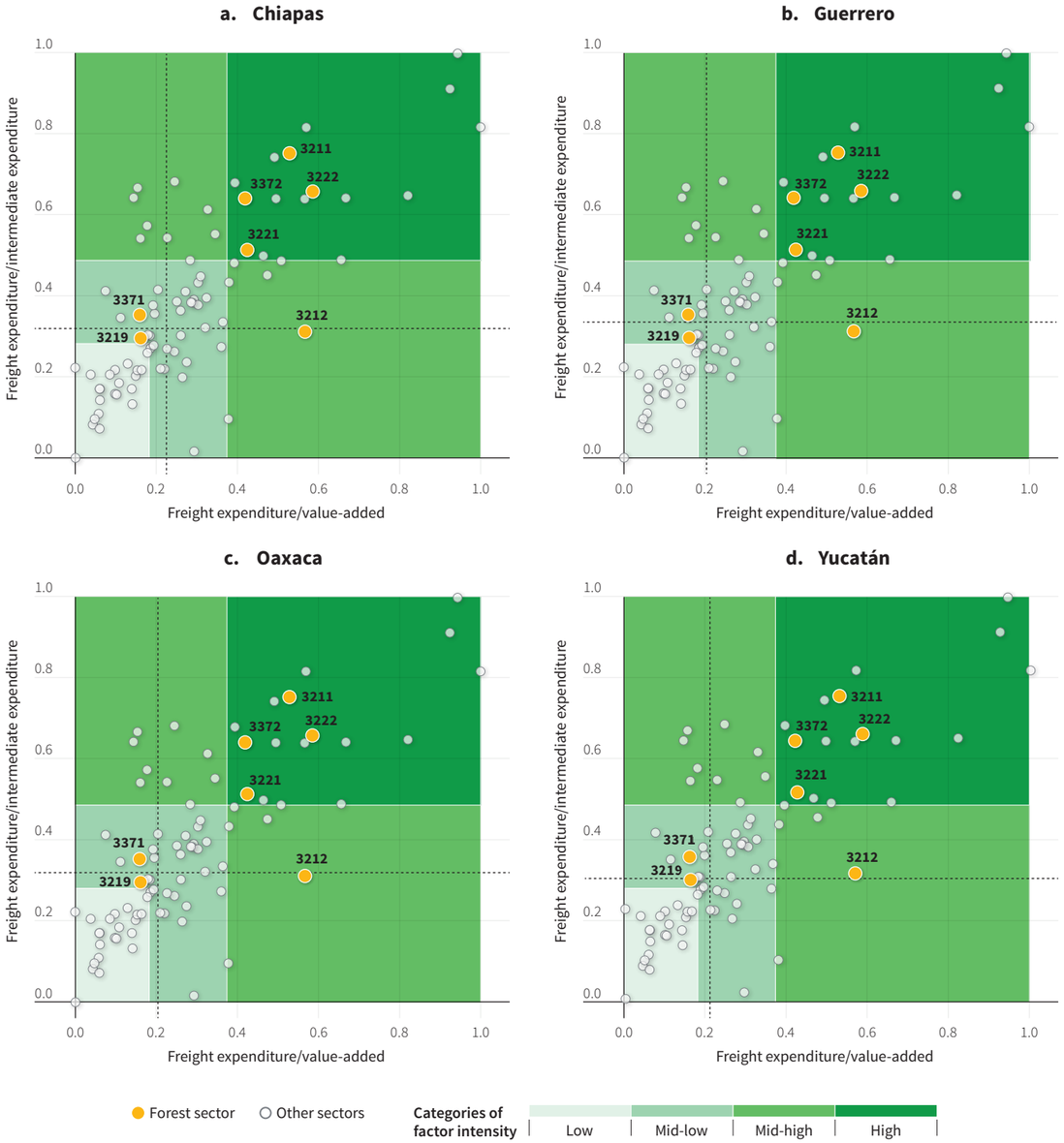
Water Intensity by Sector, 2014 and 2019 Averages



Source: Calculations based on data from INEGI 2014; 2019.
Note: Sectors are classified using NAICS four-digit codes. Blue lines represent the average normalized value of the sectors with a revealed comparative advantage greater than one for each selected state. For Chiapas, those sectors were NAICS 3111, 3112, 3113, 3115, 3116, 3117, 3118, 3119, 3121, 3149, 3219, 3231, 3323, 3328, and 3371; for Guerrero, those sectors were 3115, 3118, 3121, 3131, 3141, 3149, 3152, 3159, 3169, 3219, 3259, 3262, 3273, 3279, 3323, 3371, and 3399; for Oaxaca, those sectors were 3113, 3118, 3121, 3131, 3141, 3149, 3211, 3219, 3241, 3273, and 3323; and for Yucatán, those sectors were 3111, 3112, 3116, 3117, 3118, 3121, 3131, 3141, 3149, 3151, 3152, 3159, 3169, 3219, 3261, 3273, 3279, 3323, 3332, 3333, 3353, 3366, 3371, and 3399. Yellow points represent group industries of the forest industry classified in at the four-digit level, except for groups with confidential information. NAICS = North American Industry Classification System.

FIGURE D.3

Freight Intensity by Sector, 2014 and 2019 Averages



Source: Calculations based on data from INEGI 2014; 2019.
Note: Sectors are classified using NAICS four-digit codes. Blue lines represent the average normalized value of the sectors with a revealed comparative advantage greater than one for each selected state. For Chiapas, those sectors were NAICS 3111, 3112, 3113, 3115, 3116, 3117, 3118, 3119, 3121, 3149, 3219, 3231, 3323, 3328, and 3371; for Guerrero, those sectors were 3115, 3118, 3121, 3131, 3141, 3149, 3152, 3159, 3169, 3219, 3259, 3262, 3273, 3279, 3323, 3371, and 3399; for Oaxaca, those sectors were 3113, 3118, 3121, 3131, 3141, 3149, 3211, 3219, 3241, 3273, and 3323; and for Yucatán, those sectors were 3111, 3112, 3116, 3117, 3118, 3121, 3131, 3141, 3149, 3151, 3152, 3159, 3169, 3219, 3261, 3273, 3279, 3323, 3332, 3333, 3353, 3366, 3371, and 3399. Yellow points represent group industries of the forest industry classified in at the four-digit level, except for groups with confidential information. NAICS = North American Industry Classification System.

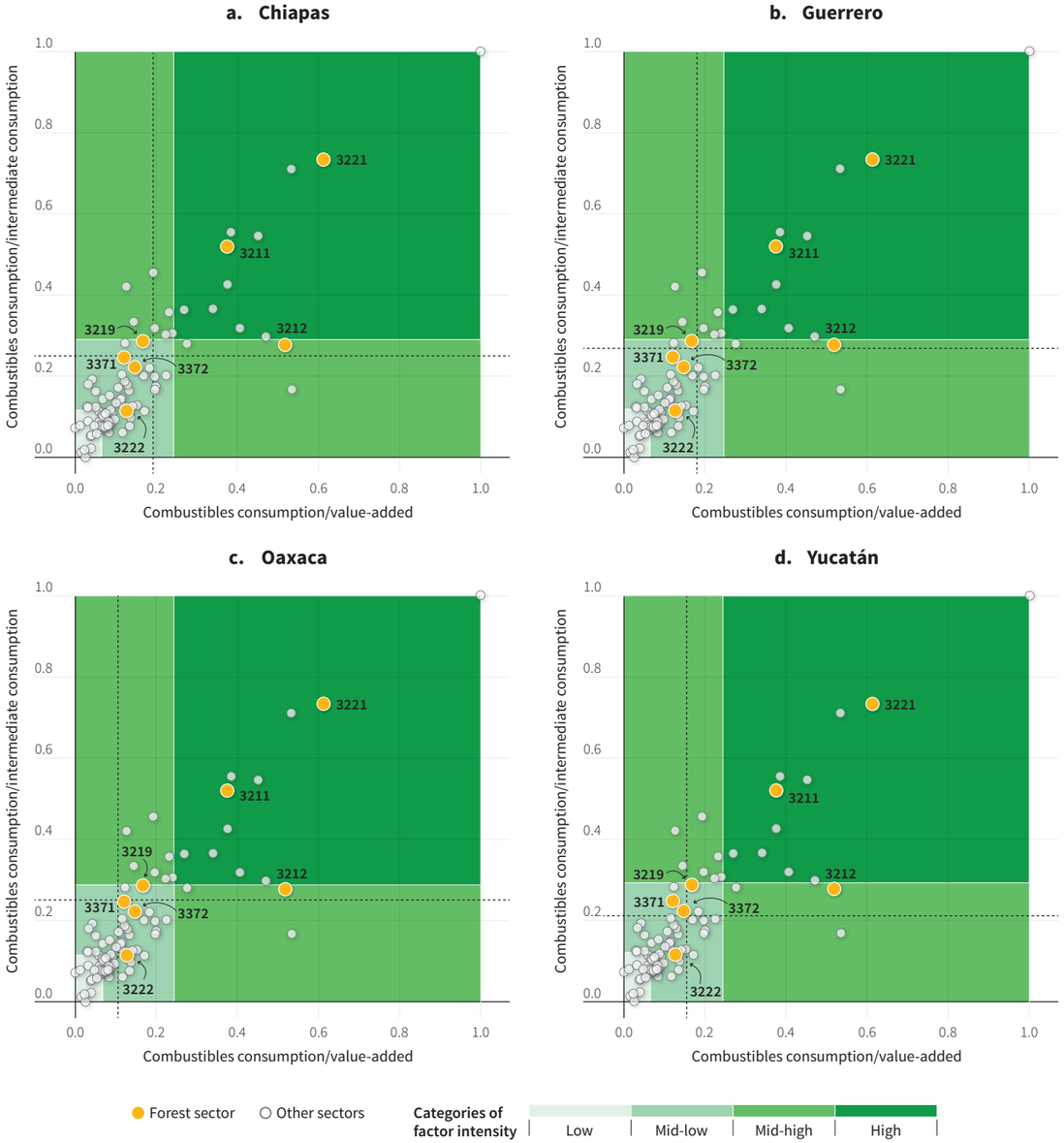
Oaxaca, given their rugged topography, which complicates not only the provision of basic services but also the connections between rural regions (where the production of forest products is concentrated) and urban areas. Guerrero faces even greater constraints in terms of transportation infrastructure. It is expensive to transport merchandise from Chilpancingo—the state's capital and main city excluding tourism activities—to the city of Acapulco, where the port is located. The port of Acapulco does not offer freight nor international trade and it is the most saturated of the ports among the selected states. Another infrastructure constraint for Guerrero is its lack of connection to Mexico's railway system, which could potentially hinder the development of the forest sector in the state.

Regarding combustibles consumption, figure D.4 shows that most of the activities are in the mid-low-intensity quadrant, except for veneer, plywood, and engineered wood product manufacturing (NAICS 3212), which is in the mid-high-intensity quadrant, and sawmills and wood preservation (3211) and pulp, paper, and paperboard mills (3221), which are placed in the high-intensity quadrant. Therefore, lack of access to combustibles poses a constraint for developing 3211 and 3221 activities in the selected states, especially in Chiapas and Guerrero, where there is no current access to the natural gas national system (for details, see appendix C).

Finally, regarding sector specific infrastructure, all states have the necessary installed capacity for the production of germplasm.[90] However, Chiapas and Guerrero do not have the relevant storage facilities. Additionally, Guerrero does not have any community seed banks, which makes it particularly dependent on other states to obtain the seeds required for raw material production. Although this may not be an immediate constraint for the further development of the forest sector, it is an issue that should be addressed in due course.

FIGURE D.4

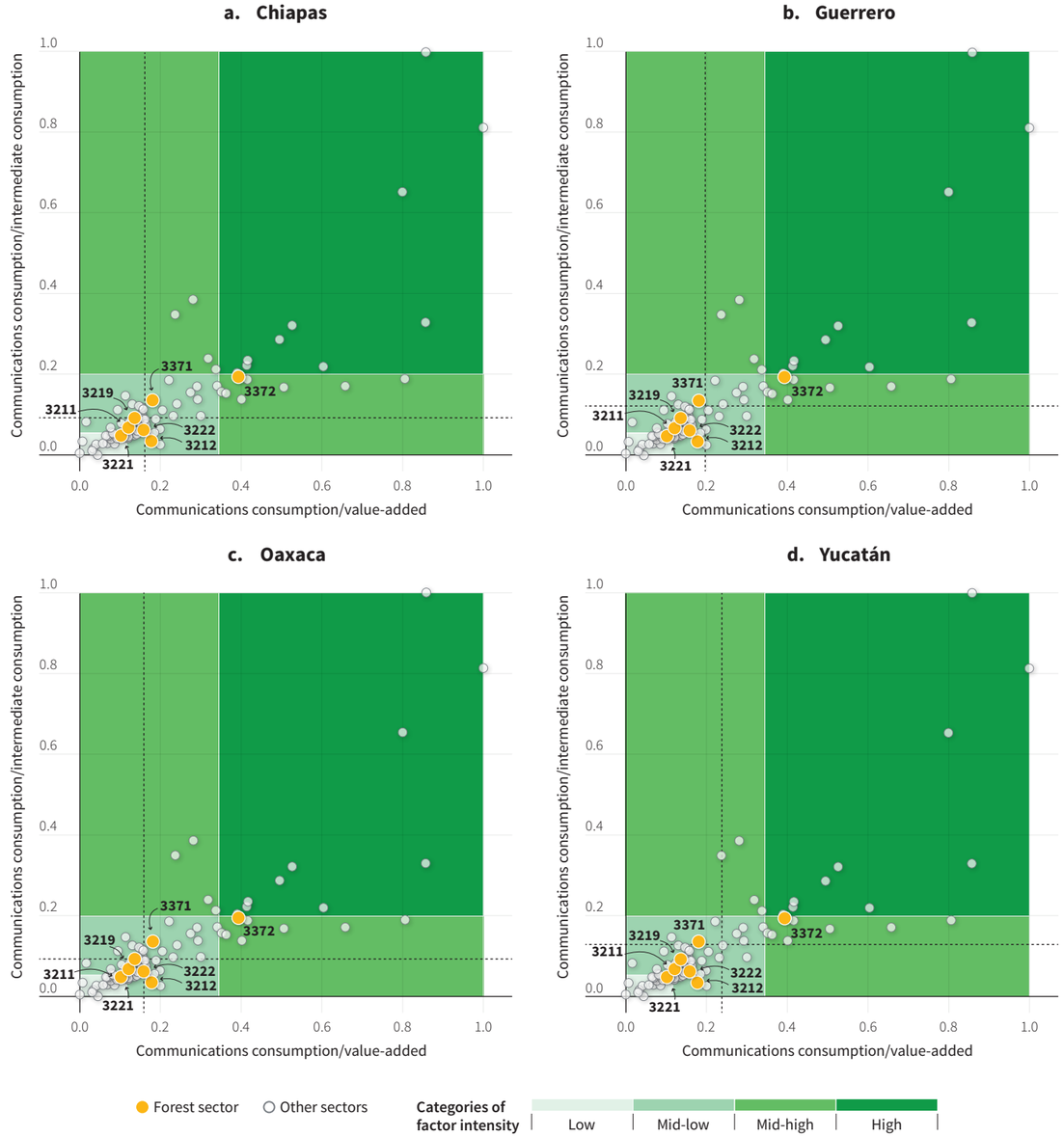
Combustible Intensity by Sector, 2014 and 2019 Averages



Source: Calculations based on data from INEGI 2014; 2019.
Note: Sectors are classified using NAICS four-digit codes. Blue lines represent the average normalized value of the sectors with a revealed comparative advantage greater than one for each selected state. For Chiapas, those sectors were NAICS 3111, 3112, 3113, 3115, 3116, 3117, 3118, 3119, 3121, 3149, 3219, 3231, 3323, 3328, and 3371; for Guerrero, those sectors were 3115, 3118, 3121, 3131, 3141, 3149, 3152, 3159, 3169, 3219, 3259, 3262, 3273, 3279, 3323, 3371, and 3399; for Oaxaca, those sectors were 3113, 3118, 3121, 3131, 3141, 3149, 3211, 3219, 3241, 3273, and 3323; and for Yucatán, those sectors were 3111, 3112, 3116, 3117, 3118, 3121, 3131, 3141, 3149, 3151, 3152, 3159, 3169, 3219, 3261, 3273, 3279, 3323, 3332, 3333, 3353, 3366, 3371, and 3399. Yellow points represent group industries of the forest industry classified in at the four-digit level, except for groups with confidential information. NAICS = North American Industry Classification System.

FIGURE D.5

Communications Intensity by Sector, 2014 and 2019 Averages



Source: Calculations based on data from INEGI 2014; 2019.
Note: Sectors are classified using NAICS four-digit codes. Blue lines represent the average normalized value of the sectors with a revealed comparative advantage greater than one for each selected state. For Chiapas, those sectors were NAICS 3111, 3112, 3113, 3115, 3116, 3117, 3118, 3119, 3121, 3149, 3219, 3231, 3323, 3328, and 3371; for Guerrero, those sectors were 3115, 3118, 3121, 3131, 3141, 3149, 3152, 3159, 3169, 3219, 3259, 3262, 3273, 3279, 3323, 3371, and 3399; for Oaxaca, those sectors were 3113, 3118, 3121, 3131, 3141, 3149, 3211, 3219, 3241, 3273, and 3323; and for Yucatán, those sectors were 3111, 3112, 3116, 3117, 3118, 3121, 3131, 3141, 3149, 3151, 3152, 3159, 3169, 3219, 3261, 3273, 3279, 3323, 3332, 3333, 3353, 3366, 3371, and 3399. Yellow points represent group industries of the forest industry classified in at the four-digit level, except for groups with confidential information. NAICS = North American Industry Classification System.

APPENDIX E

Access to Finance in the Forest Sector

Mexico's forest sector does not receive significant foreign direct investment (FDI) inflows (1.1 percent of FDI between 2003–21), and even less in the selected states (0.01 percent in the same time period).

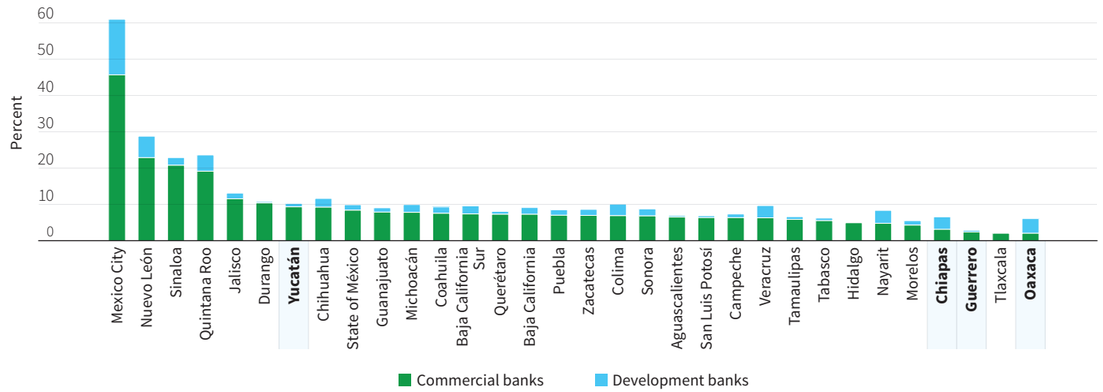
As of 2021, Oaxaca had the lowest share of municipalities with financial access points, with only 39.6 percent.[91] In contrast, approximately 74.5 percent of municipalities in Yucatán had financial access points. Chiapas and Guerrero followed with higher proportions, at 80.6 and 91.4 percent, respectively. Looking at the number of financial access points per 10,000 inhabitants, Chiapas and Oaxaca are at the bottom, with 7.6 and 8.5 access points, respectively. Guerrero fared slightly better with 9.2 access points, while Yucatán had the most with 13.1 access points.[92]

Data on the demand side mirror the findings on the supply side. As figure E.1 shows, total portfolio balance of commercial and development banks as a percentage of nonoil gross domestic product (GDP) for Guerrero, Oaxaca, Chiapas, and Yucatán represented 2.8, 6.1, 6.6, and 10.3 percent, respectively. Among Mexico's 32 states, Chiapas has the seventh-lowest percentage, Oaxaca the fifth lowest and Guerrero the second lowest. Yucatán, however, is among the 10 best states. Further evidence on how the low penetration and take up of financial services can affect forestry industry projects in the selected states is in the next section.

In terms of the conditions under which finance is accessed, national and sectoral level data indicate that interest rates charged by commercial banks to enterprises that perform forestry activities (included in the broad category for agriculture, forestry, and fishing, 13.6 percent) and related manufacturing activities (13.3 percent) are close to the ones faced by those in other sectors (figure E.2).[93] However, interest rates charged by development banks to enterprises involved in forestry activities and related manufacturing activities are among the

FIGURE E.1

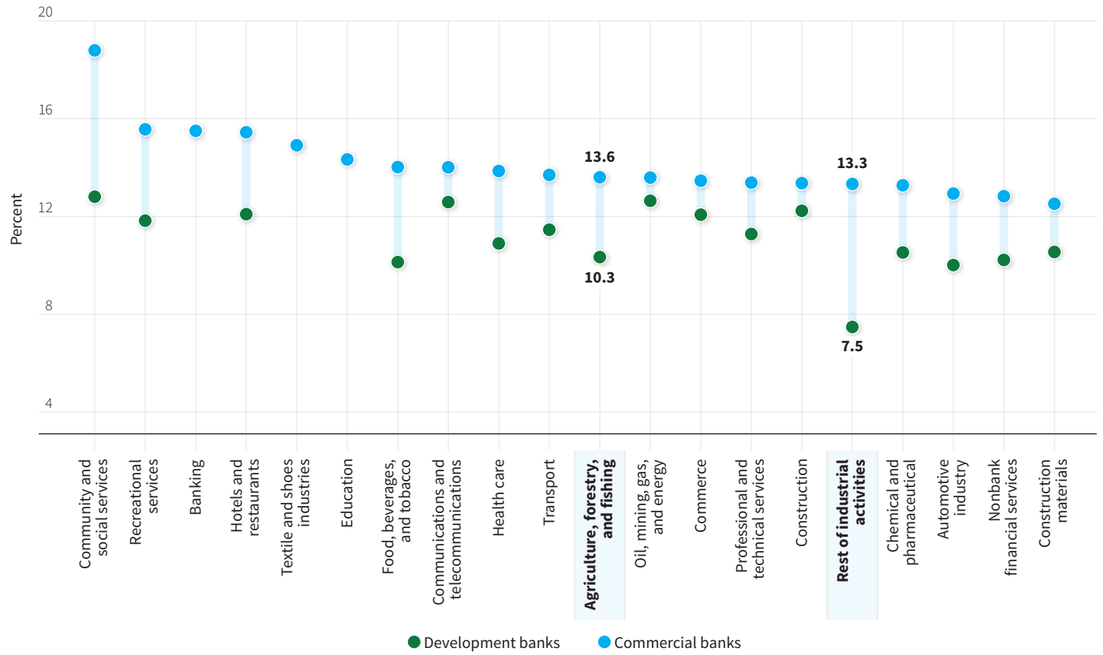
Total Portfolio Balance as a Percentage of Nonoil GDP, End 2019



Source: Based on data from Banxico and INEGI's National Accounts.
Note: Figure refers to the credit portfolio for all sectors, as state-level data is not disaggregated by public and private sectors. Bars are ordered by the size of commercial bank's credit portfolio as percentage of nonoil GDP. GDP = gross domestic product.

FIGURE E.2

Weighted Average Interest Rates Paid by Firms in Various Industries, October 2022



Source: Based on data from CNBV's *Portafolio de Información* (Information Portfolio) for December 2016 and October 2022; Banxico.
Note: The figure only considers credits in local currency. The CNBV's latest Information Portfolio does not provide interest rate data at the sector level. To estimate the interest rates charged to firms by sector, the spread between (1) the monetary policy rate from December 2016 and (2) the weighted average interest rate charged by commercial and development banks by sector in December 2016 (the latest year for which the CNBV's previous information portfolio offers data), was calculated. By maintaining the spread constant for each sector, the interest rates for October 2022 were estimated using the monetary policy rate from October 2022 (the latest month for which the CNBV's latest portfolio provides data). Development banking institutions, which include Nafin, Bancomext, and Banobras, had no reported interest rates for the sectors of education, textiles, footwear, and banking services. CNBV = *Comisión Nacional Bancaria y de Valores.*

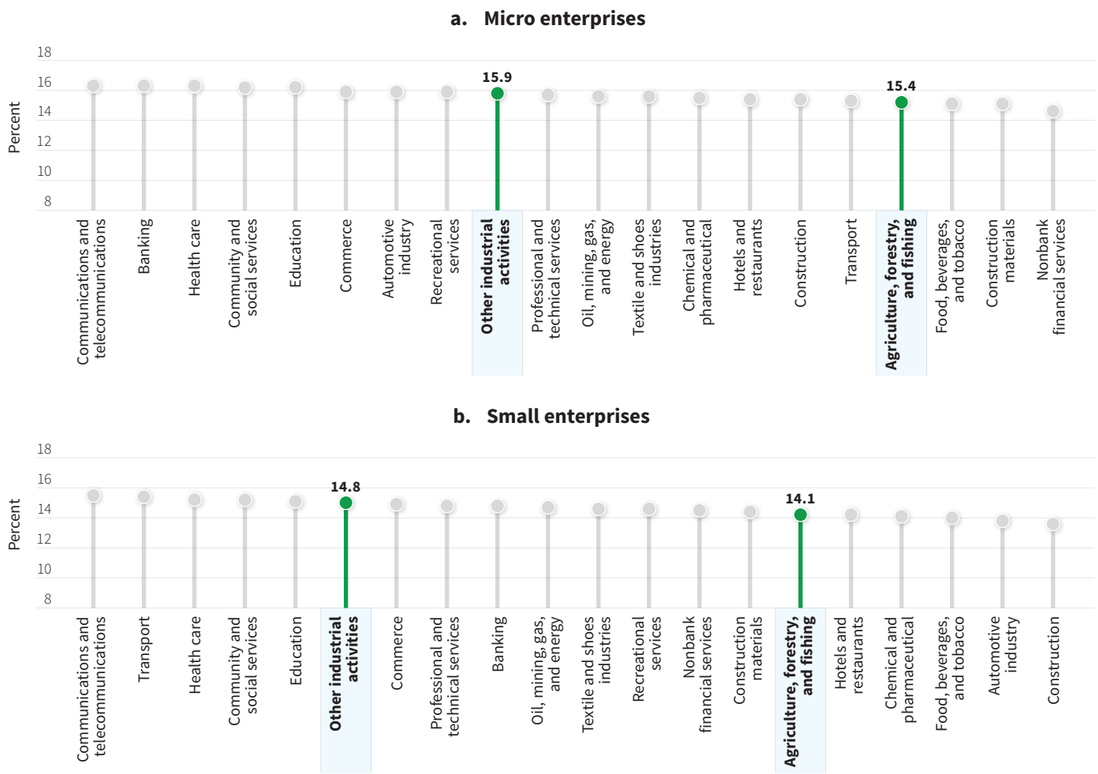
lowest (10.3 percent and 7.5 percent, respectively), and the differential between commercial and development banks is among the highest in these two sectors (3.3 and 5.8 percentage points, respectively). In this regard, borrowing costs at the national level by economic activities (and acknowledging the data limitations) are not perceived as a relevant constraint.

Because of the lack of interest rates data at the state level, we use interest rates faced by firms depending on their size and economic activity. Unsurprisingly, as figure E.3 shows, small firms pay higher interest rates, while large firms are charged lower interest rates. More specifically, for firms in the forestry sector, interest rates seem to be among the lowest (except for medium firms), while for those in related manufacturing activities interest rates are in the higher end (except for large firms).

To confirm how binding this constraint is, figure E.4 presents a comparative assessment of access to external financing sources by firms between the selected states and leading states in the country. As a benchmark, we also look at

FIGURE E.3

Interest Rates Paid by Enterprises in Various Industries by Size, October 2022



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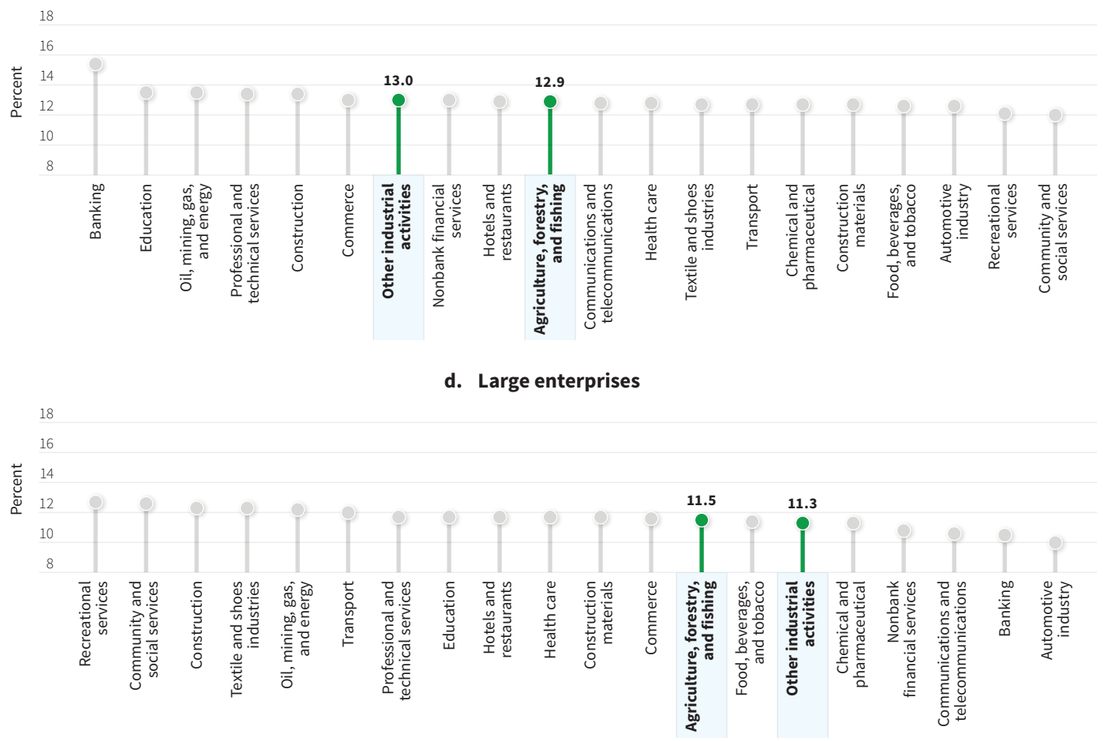
the top five states with the highest contribution of forest sector added value to their nonoil GDP, which are highlighted in yellow in the figure.[94] Given the differences between the primary and manufacturing activities in the forest sector, we analyze them separately.[95] Regarding the former, as of 2018, very few firms received financing from external sources in general[96] and even less from banks. Comparing the percentages in the selected states with those in the leading states, it seems that firms in the top-five states are more likely to seek finance in general. Given the small presence of this sector[97] in the selected states, this is not sufficient evidence to confirm whether financing is a constraint to further develop the segment of the forest sector in the selected states.

With regards to the forest sector related manufacturing (a much larger industry when compared to the primary component of the forest sector), firms in the leading states are more likely to receive financing. In terms of external sources, the selected states are below the observed national levels (9.6 percent). This

FIGURE E.3

Interest Rates Paid by Enterprises in Various Industries by Size, October 2022 *(continued)*



Source: Based on data from CNBV's *Portafolio de Información* (Information Portfolio) for December 2016 and October 2022; Banxico.
Note: The figure only considers credits in local currency. The CNBV's latest Information Portfolio does not provide interest rate data at the sector level. To estimate the interest rates charged to firms by sector, the spread between (1) the monetary policy rate from December 2016 and (2) the weighted average interest rate charged by commercial and development banks by sector in December 2016 (the latest year for which the CNBV's previous information portfolio offers data), was calculated. By maintaining the spread constant for each sector, the interest rates for October 2022 were estimated using the monetary policy rate from October 2022 (the latest month for which the CNBV's latest portfolio provides data). Development banking institutions, which include Nafin, Bancomext, and Banobras, had no reported interest rates for the sectors of education, textiles, footwear, and banking services. CNBV = *Comisión Nacional Bancaria y de Valores.*

FIGURE E.4

Firms' Access to External Financing, State Comparison, 2018

a. All economic activities

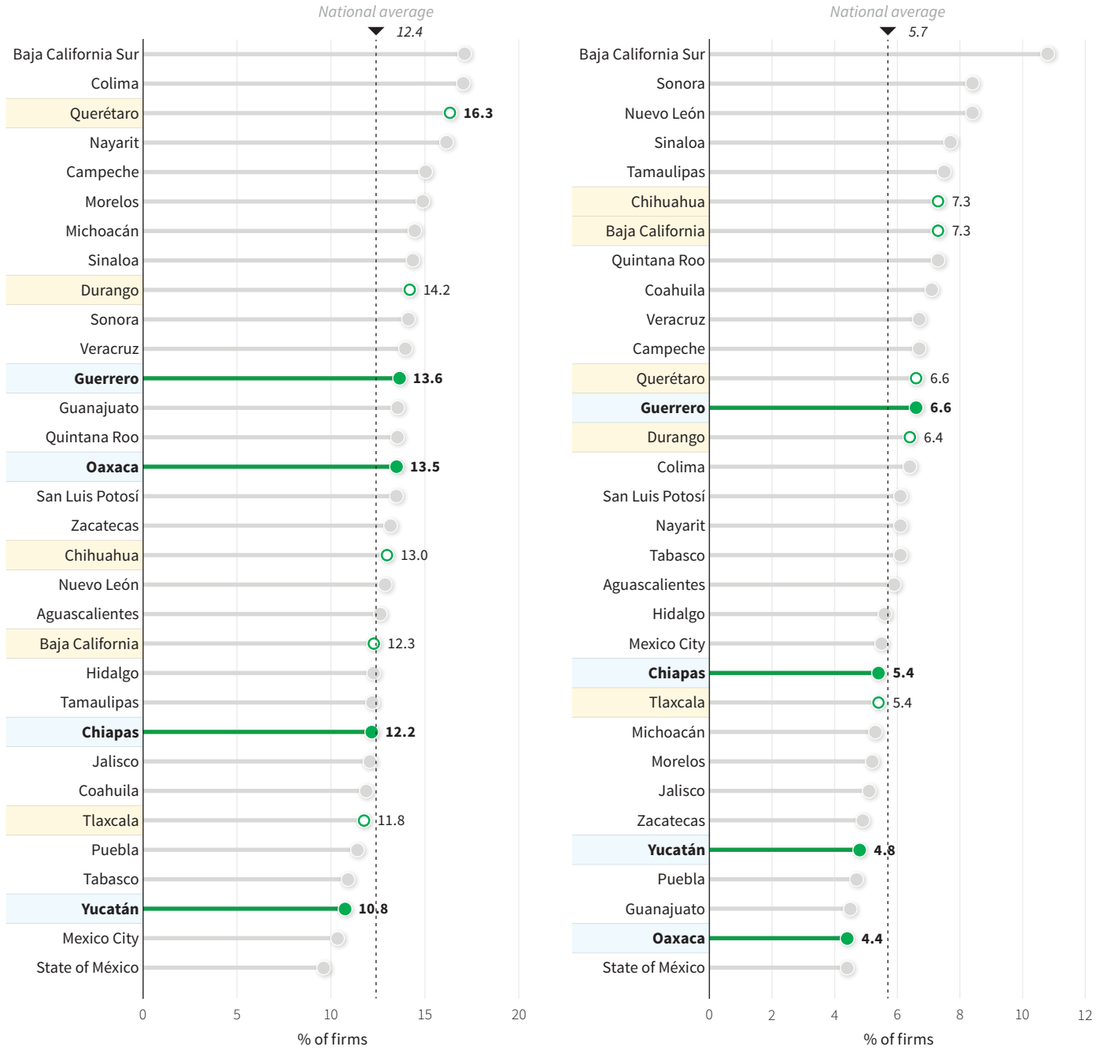


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FIGURE E.4

Firms' Access to External Financing, State Comparison, 2018 *(continued)*

b. Support services for forestry activities*

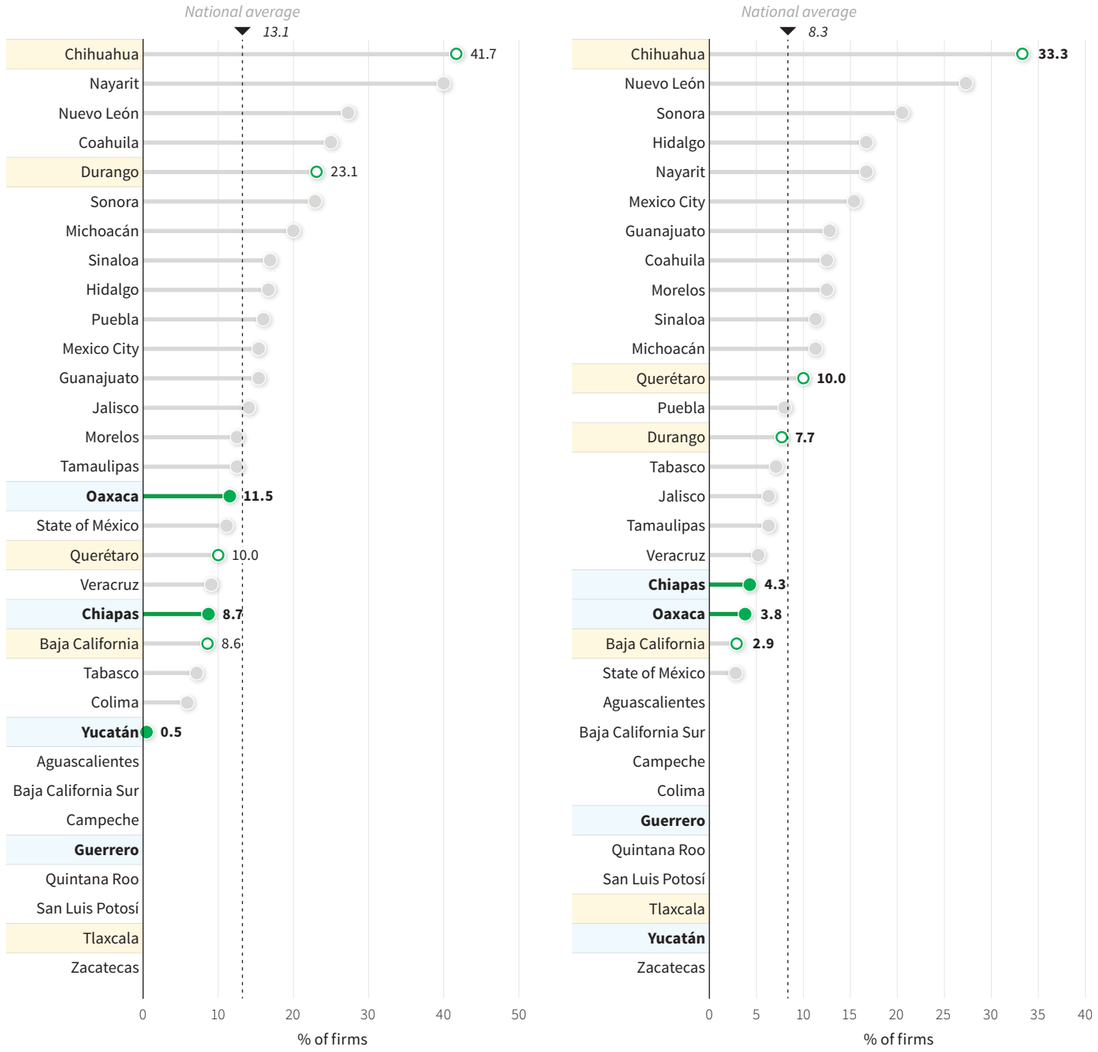

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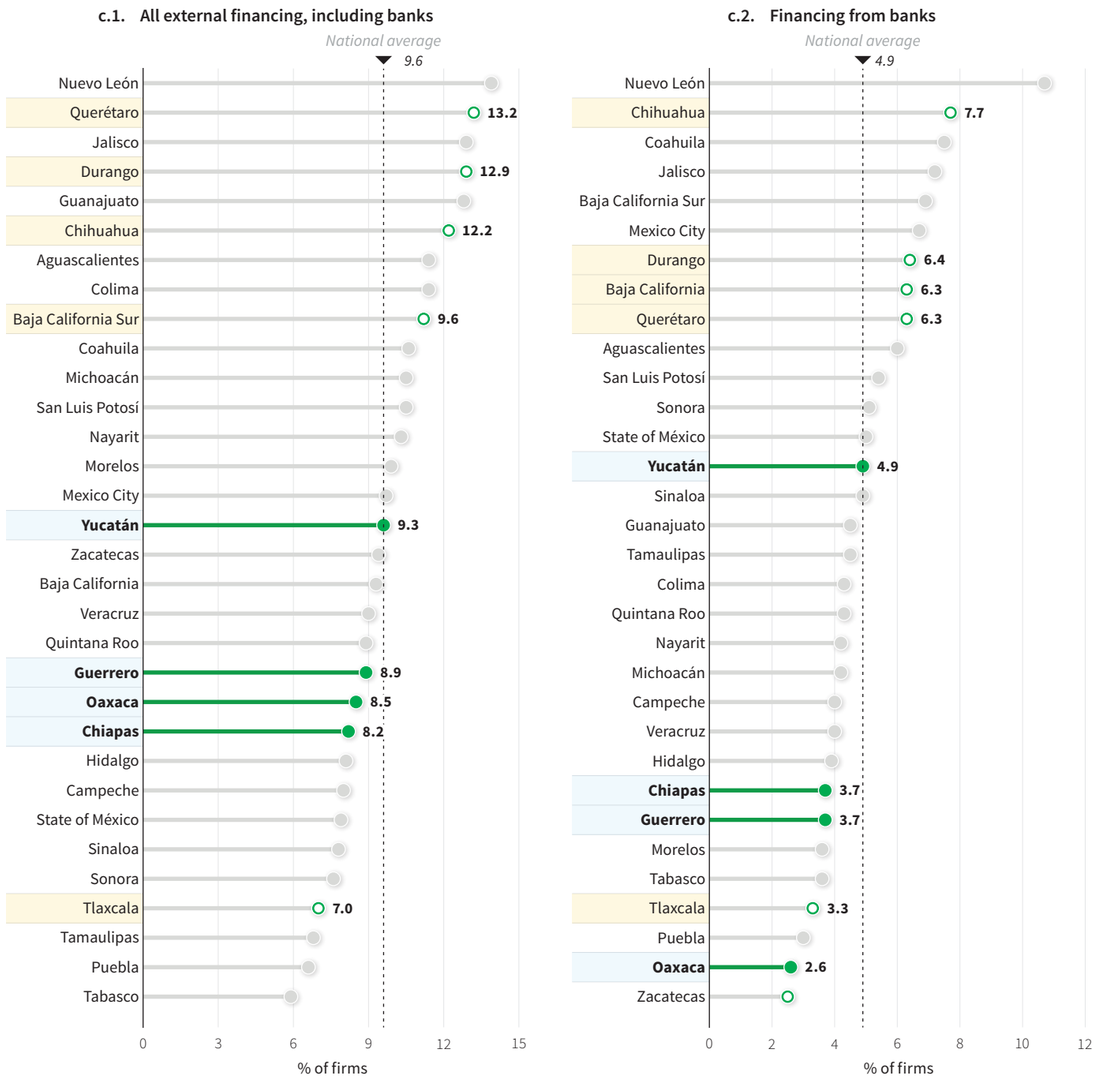
FIGURE E.4

Firms' Access to External Financing, State Comparison, 2018 *(continued)*

c. Manufacturing of wood, paper and furniture products†



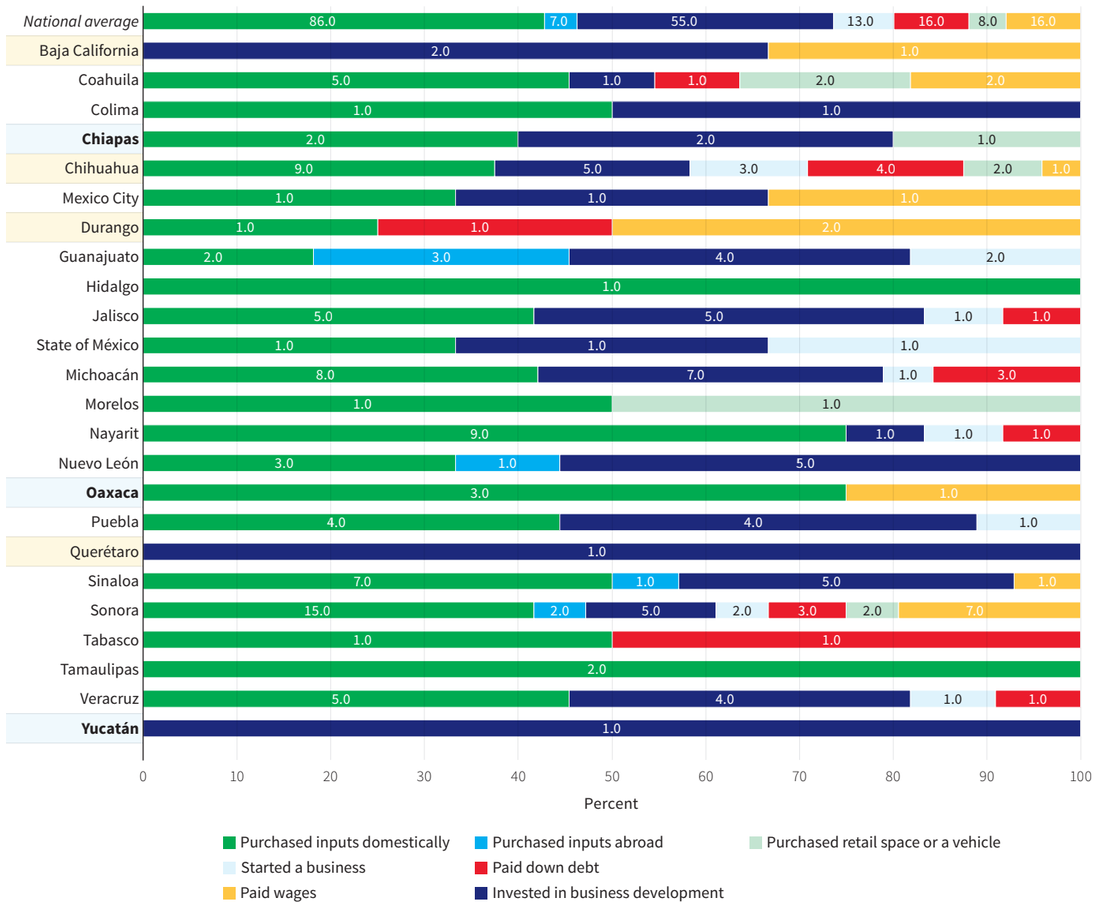
Source: 2018 Economic Census and INEGI's national account.
Note: Highlighted in yellow the states with the highest forest sector (support services [NAICS three-digit code 115], wood product manufacturing [321], paper manufacturing [322], and furniture and related product manufacturing [337]) contribution to their nonoil GDP: Durango (3.5 percent), Tlaxcala (2.4 percent), Querétaro (2.0 percent), Baja California (1.6 percent), and Chihuahua (1.4 percent). INEGI's Economic Census does not include information for the forestry and logging sector (NAICS 113). External financing refers to the percentage of firms (economic units) who used external sources of financing, while financing from banks refers to the percentage of firms who only used financing from banks. They are a percentage of total firms in the sector. If the state does not appear in the graphs, that is because it does not have any firms (economic units) reporting for that sector in the 2018 Economic Census. If the state appears in the graphs but does not have a bar, it means that no firms reported information on their use of external financing. GDP = gross domestic product; INEGI = Instituto Nacional de Estadistica y Geografia; NAICS = North American Industry Classification System.
*Includes support activities for agriculture activities, given that INEGI's Economic Census does not disaggregate beyond NAICS three-digit level.
†Includes manufacturing of mattresses and blinds, given that INEGI's Economic Census does not disaggregate beyond NAICS three-digit level.

trend is more evident when looking at financing from banks, where Oaxaca had the second lowest percentage of firms in the country despite it has a large number of firms operating in the manufacturing segment of the forest sector. Based on these elements, access to finance can be considered a constraint to further develop these segments of the forest sector in all the selected states, especially in Oaxaca.

Figure E.5 shows how firms in the primary segment of the forest sector use the funds they borrow, there is an overlap in firms from Chiapas and Oaxaca using these resources for purchasing inputs domestically and an overlap in firms in Chiapas and Yucatán investing in business development (purchase assets or

FIGURE E.5

Firms' Use of External Financing, Support Services for Forestry Activities, State Comparison, 2018



Source: Based on data from INEGI 2019.
Note: The absolute numbers on each bar represent the number of firms in that particular category. Acknowledging that all categories are presented in the same graph, it is worth noting that one firm could have requested finance for more than one category.

expand business). Chiapas was the only state where a firm borrowed funds to expand its retail space or purchase a vehicle, while Oaxaca was the only state where a firm borrowed funds to pay wages. No firm in this component of the forest sector in Guerrero had access to finance. Comparing firms in the selected states with those in the champion states, it seems firms in the latter group also used the money they borrowed to start their business and to pay debt. No firm in any of the states of interest reported having purchased inputs abroad. Like the analysis in the previous section (access to finance), these results are not sufficient to determine whether financing is a constraint to further develop the primary segment of the forest sector.

In the forest sector manufacturing segment, figure E.6 shows differences across firms' use of external financing. As of 2018, on average, firms in the selected states are more likely than those in the leading states to seek finance to

FIGURE E.6

Firms' Use of External Financing, Wood, Paper, and Furniture Products Manufacturing, State Comparison, 2018

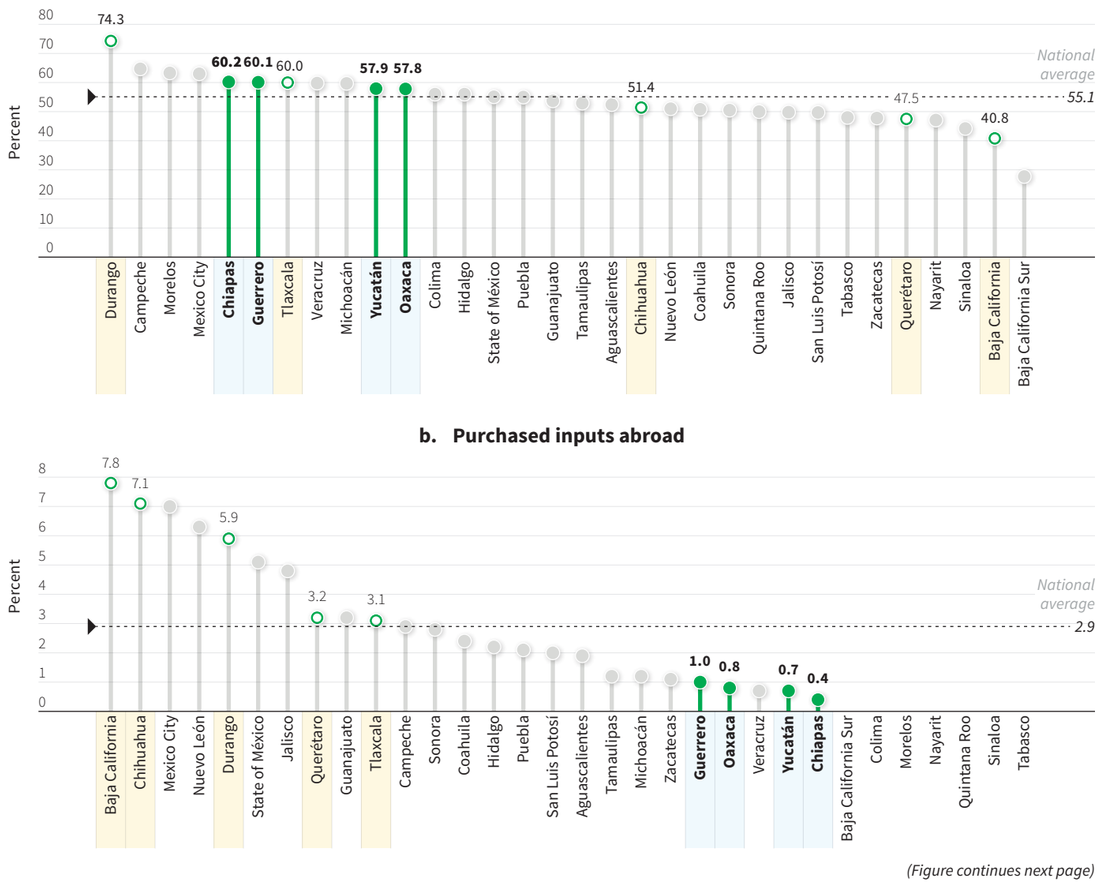


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FIGURE E.6

Firms' Use of External Financing, Wood, Paper, and Furniture Products Manufacturing, State Comparison, 2018
(continued)

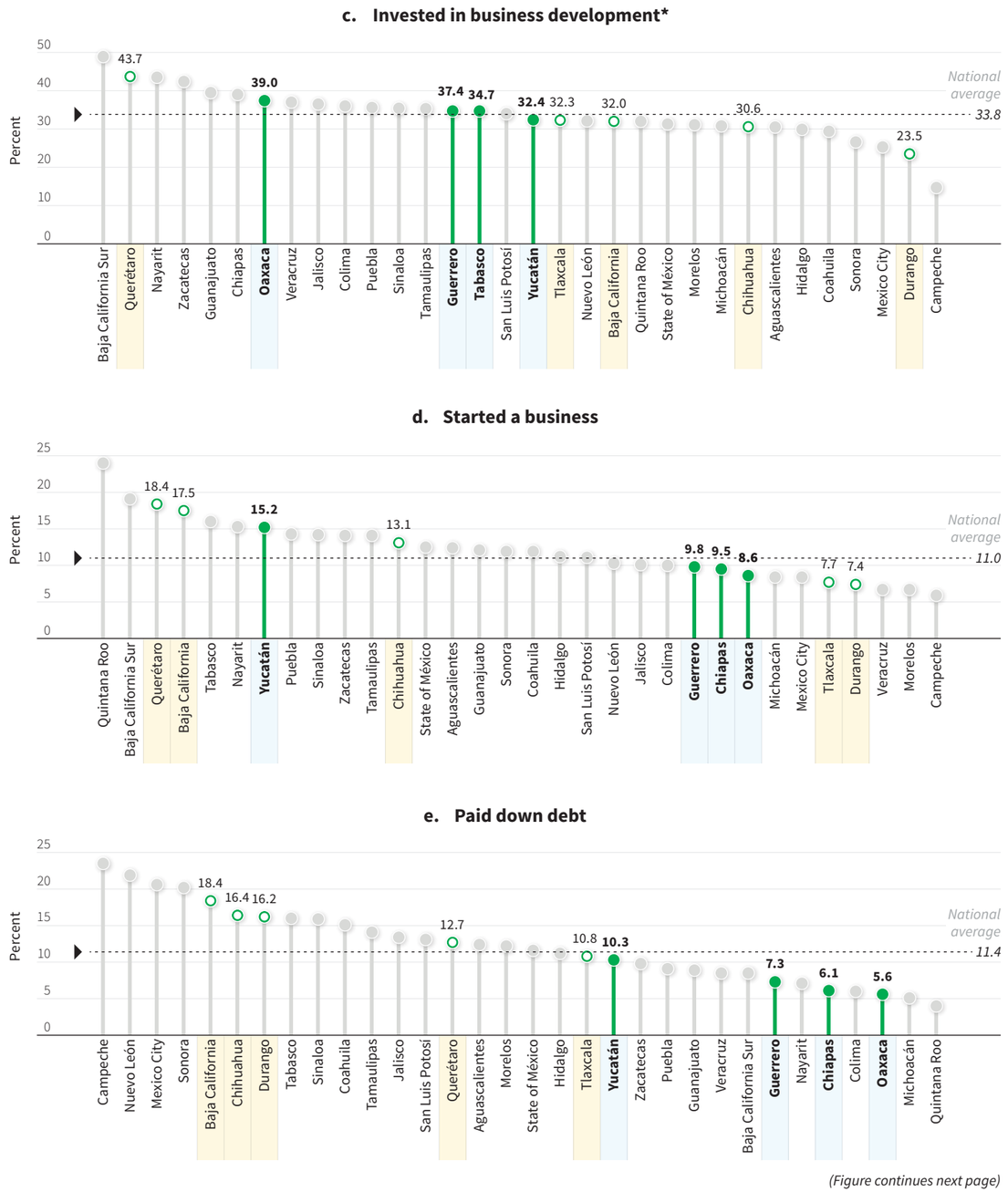

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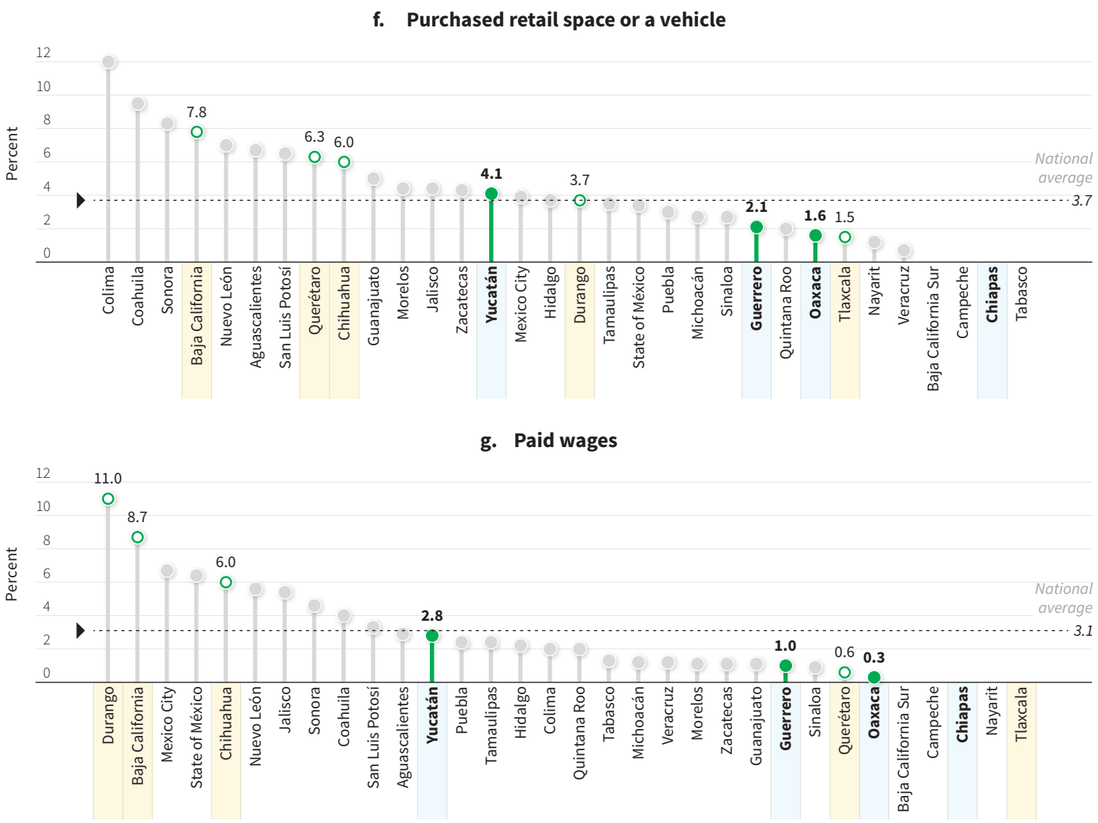
FIGURE E.6

Firms' Use of External Financing, Wood, Paper, and Furniture Products Manufacturing, State Comparison, 2018
(continued)



Source: Based on data from INEGI 2019 Economic Census, thematic results, financing.
Note: The figures show percentages out of the firms that had access to external financing.
*Refers to purchase equipment or expansion of business.

purchase inputs domestically and less likely to purchase inputs abroad. This difference could limit the price and quality of inputs that firms in the selected states have access to, as imported inputs could be more competitive in that regard. Firms in the selected states are also more likely than those in the leading states to invest in business development and less likely to seek finance to start a business or pay down their debt. This difference could be associated with additional barriers for new entrants. Nevertheless, further analysis to determine whether this is a binding constraint to further develop the manufacturing component of the forest sector is required.

In summary, the prevailing low rates of financial penetration in the selected states suggest that access to finance may be a binding constraint for forestry sector firms. However, for the primary component of the forest sector, evidence for access and use of external financing is not sufficient to determine wheth-

er this lack of access to finance is a binding constraint to develop the primary component. There are very few firms operating in this segment of the sector, but those in the selected states seem to have access to external sources of financing (except for Guerrero, which has the least number of firms in this segment). Nonetheless, given the small number of firms in the primary segment of the forest sector, a strategy to develop this sector may include access to finance programs to incentivize the participation of new entrants and also the merger of existing ones (for example, forming cooperatives). Regarding the manufacturing component of the forest sector, access to finance is considered a constraint, especially for firms in Oaxaca. Finally, introducing sector-specific financial products for new and existing firms could help the sector grow, as there are few financial products with longer terms aligned with the investment and return periods of forest projects, and unclear definition of property rights on communal land prevents its use as collateral.

APPENDIX F

Government Programs Supporting the Forest Sector and Other Support

As of 2020, the federal government of Mexico has four main programs that provide credit, grants, technical, and in-kind support to the forestry sector. The *Comisión Nacional Forestal* (National Forestry Commission) implements three of those programs, including the flagship *Programa Nacional Forestal* (National Forest Program). Another program is the *Sembrando Vida* (Sowing Life), which is considered a priority program by the administration and aims to restore more than one million hectares of timber resources in 19 different states, including Chiapas, Guerrero, Oaxaca, and Yucatán. The selected states also implement state-level programs and projects that provide technical and in-kind support to small producers and communities engaged in the forest sector. Table F.1 summarizes the programs available.

International agencies have also implemented programs in the selected states. Most of these programs support sustainable forest development while generating income for traditionally marginalized local communities (table F.2). Mexico is also involved in global efforts such as the United Nation's REDD+ (Reducing Emissions from Deforestation and Forest Degradation in Developing Countries) project and the World Resources Institute's Forest Legality Initiative, which seeks to increase transparency and accountability in the forest sector and promote its sustainable and inclusive development.

TABLE F.1

Main Forest Sector Programs At the Federal and State Levels

Institution	Name of program	Name of program in Spanish	Description
Federal level			
Comisión Nacional Forestal (National Forestry Commission)	Support Program for Sustainable Forestry Development	*Programa Apoyos para el Desarrollo Forestal Sustentable*	Provides financial and technical support in four different components: forestry community management and value chains, forestry restoration in micro-basins, payments of environmental services, and forest protection. The program is annual.
	Environmental Compensation	*Compensación Ambiental*	Provides support for the changes in land uses in forestry terrains.
	Biodiversity Heritage Fund	*Fondo Patrimonial de Biodiversidad*	Provides long-term support for payments in environmental services to preserve forest ecosystems.
Secretaría de Bienestar (Secretariat of Welfare)	Sowing Life Program	*Programa Sembrando Vida*	Encourages rural landowners to establish forestry productive systems through the production of timber and fruit trees. The program has coverage in the selected states and includes in-kind, financial, and technical support.
State Level			
Secretaría de Medio Ambiente e Historia Natural (Secretariat of Environment and Natural History of the State of Chiapas)	Project Strengthening Forestry Development	*Proyecto Fortalecimiento al Desarrollo Forestal*	Provides technical support for the management of forestry resources and establishment of forestry commercial activities.
Secretaría de Medio Ambiente y Recursos Naturales (Secretariat of Environment and Natural Resource of the State of Guerrero)	Strategic Program for the Forestry Sector	*Programa Estratégico para el Sector Forestal*	Promotes sustainable practices for production of timber and nontimber products by providing technical and financial support to small producers.
	State Program for the Production and Conservation of Forest Genetic Resources	*Programa Estatal para la Producción y Conservación de Recursos Geneticos Forestales*	Guarantees the availability of certified and good quality seeds.
Comision Estatal Forestal (State Forestry Commission of the State of Oaxaca)	Promotion of Projects for Productive Activities	*Impulso de Proyectos para Actividades Productivas*	Provides technical support for projects related with forestry activities.
	Forest Restoration	*Restauración Forestal*	Provides technical support for the prevention of soil erosion.
Secretaría de Desarrollo Sustentable (Secretariat of Sustainable Development of the State of Yucatán)	Program for the Production of Native Plants for the Purposes of Social and Productive Reforestation	*Programa de Producción de Plantas Nativas con Fines de Reforestación Social y Productiva*	Economic, technical, and in-kind support to communities that produce and maintain native forest plants.

Sources: CONAFOR 2020b; BIENESTAR 2020; Gobierno del Estado de Chiapas n.d.; Gobierno del Estado de Guerrero n.d.; COESFE n.d.; Gobierno del Estado de Yucatán. n.d.
Note: This list includes the main federal and state programs existing as of 2020.

TABLE F.2

Recent International Projects Supporting the Forest Sector in the Selected States

Institution	Project or program	Description
International Fund for Agricultural Development	Sustainable Development Project for Communities in Semiarid Areas (North and Mixteca Regions)	Supports forestry activities that increase economic engagement among local and indigenous communities while encouraging sustainable production. The project has been implemented by CONAFOR since 2012 and is intended to continue until 2022. Guerrero and Oaxaca are included in the project.
	Community-Based Forestry Development Project in Southern States (Campeche, Chiapas, and Oaxaca)	The project helped strengthen community-level capacities for resource management, enhance conservation practices, and implement mechanisms relevant to climate change. The project was implemented by CONAFOR between 2009–16.
Interamerican Development Bank and Climate Investment Funds - Forest Investment Program	Support for Forest Related MSMEs in Ejidos -Implementation of Forest Investment*	The program helped improve profitability and reinforce the social and financial sustainability of community forestry enterprises in five states, including Oaxaca and Yucatán.
World Bank	Food Systems, Land Use and Restoration (FOLUR)	The project not only focused on food and land-use systems, but also helped minimize the environmental footprint of the food system, including via deforestation by moving away from unsustainable sectoral approaches.
World Bank and BioCarbon Fund Initiative for Sustainable Forest Landscapes	Mexico Strengthening Entrepreneurship in Productive Forest Landscapes Project	The program has helped strengthen sustainable forest management and increase economic opportunities for forest-dependent people and businesses in 19 states in Mexico, including Chiapas, Guerrero, and Oaxaca. CONAFOR is implementing the project, which started in 2018 and is expected to end in 2023.
World Bank and Climate Investment Funds of the Forest Investment Program	Dedicated Grant Mechanism for Indigenous Peoples and Local Communities in Mexico Project	The program has helped strengthen the capacity of forest-dependent people in five states, including Oaxaca and Yucatán, to participate in local, national, and international REDD+ related processes. The project was from 2017 to 2022. The national executing agency was Rainforest Alliance.

Source: Based on information from the websites of each institution.
Note: CONAFOR = Comisión Nacional Forestal; REDD+ = Reducing Emissions from Deforestation and Forest Degradation in Developing Countries.
*Information availability for this program is limited.

APPENDIX G

Identification of Potential Locations for Developing Forest Sector Activities

To identify the regions in the selected states with potential to develop the raw materials required by industries and activities, four considerations were taken.

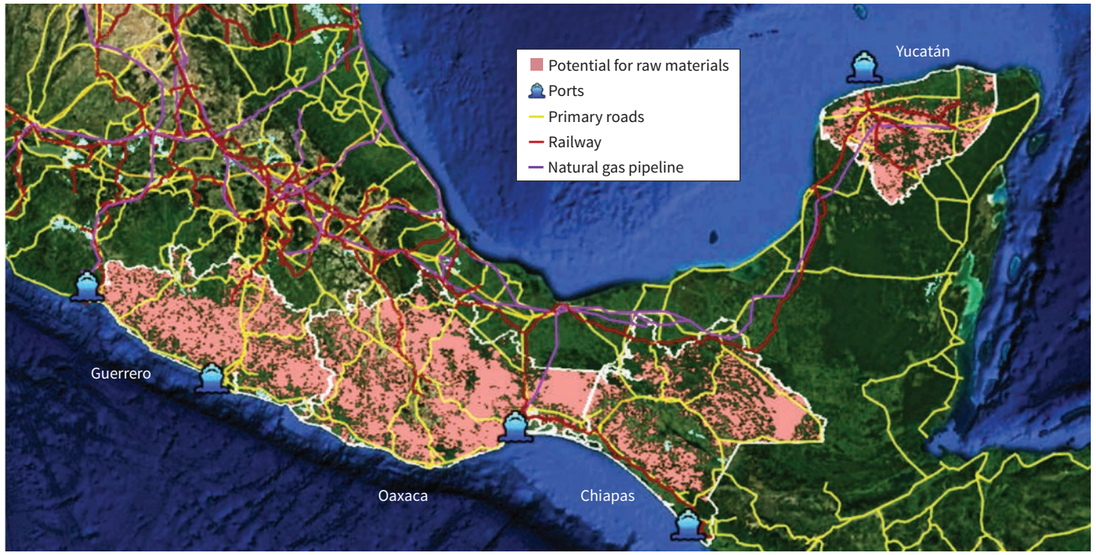
First, all areas eligible to receive support from the *Programa Nacional Forestal 2020* (National Forest Program; PRONAFOR)—a program offered by the *Comisión Nacional Forestal* (National Forestry Commission)—were identified. All areas in the first component of the program, *Manejo Forestal Comunitario y Cadenas de Valor*, were selected, taking the first, second, and third concepts for that component, namely, (1) regions for development of potential producers, (2) regions for development of products dedicated to timber sale, and (3) regions for development of raw materials. From these concepts, a gross area for production of raw materials were identified. Concepts two, four, five, and six of PRONAFOR's first component were combined. These concepts consider the regions with potential for primary and integral manufacturing in the forest sector (maps G.1 and G.2).

Map G.3 combines the criteria from maps G.1 and G.2, and hence the gross area for raw materials production was limited to the regions with potential for primary and integral manufacturing in the forest sector. Map G.4 identifies the protected areas in the region, which were excluded from the analysis to arrive at a net area for raw materials production.

Finally, access to utilities and transportation infrastructure was considered and by applying all those four dimensions, the final regions to develop the forest sector in the selected states were identified (maps G.5 and G.6).

MAP G.1

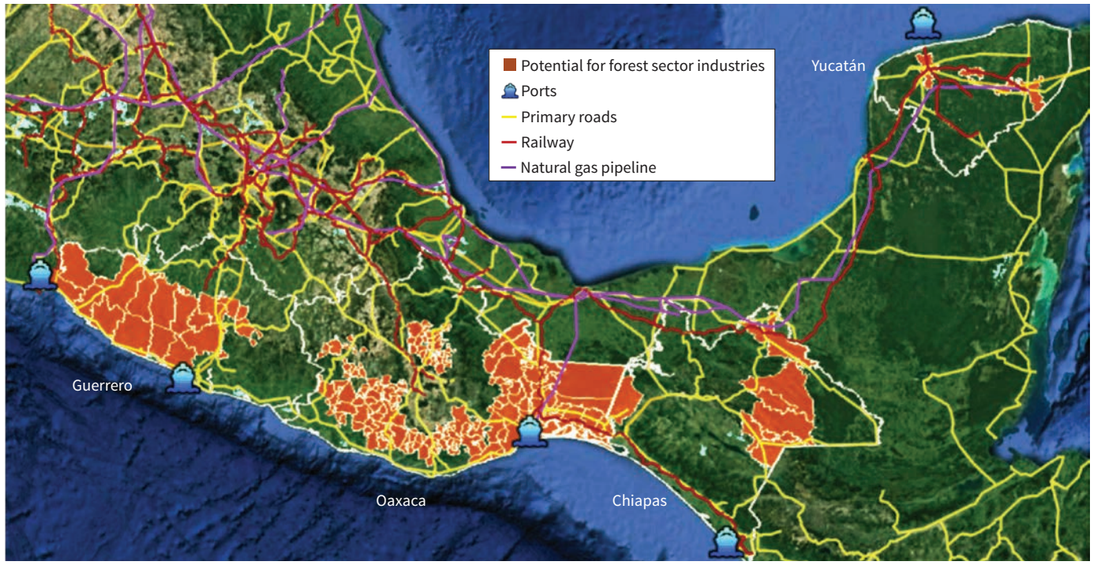
Potential Regions for Producing Raw Materials (Gross Area)



Source: Elaborated using Google Earth with information from INEGI 2017; CONANP 2019; CONAFOR 2019; SCT 2019; SENER 2018.
Note: The symbols are only indicative and are not meant to reflect exact locations, except for potential for raw materials.

MAP G.2

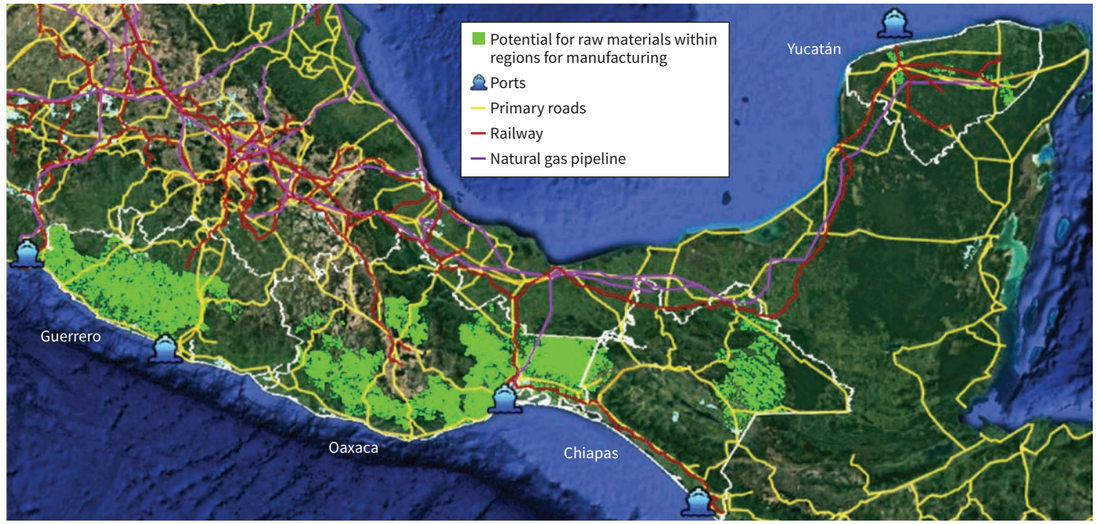
Regions with Potential for Primary and Integral Manufacturing in the Forest Sector (Municipal Level)



Source: Elaborated using Google Earth with information from INEGI 2017; CONANP 2019; CONAFOR 2019; SCT 2019; SENER 2018.
Note: The symbols are only indicative and are not meant to reflect exact locations, except for potential for raw materials.

MAP G.3

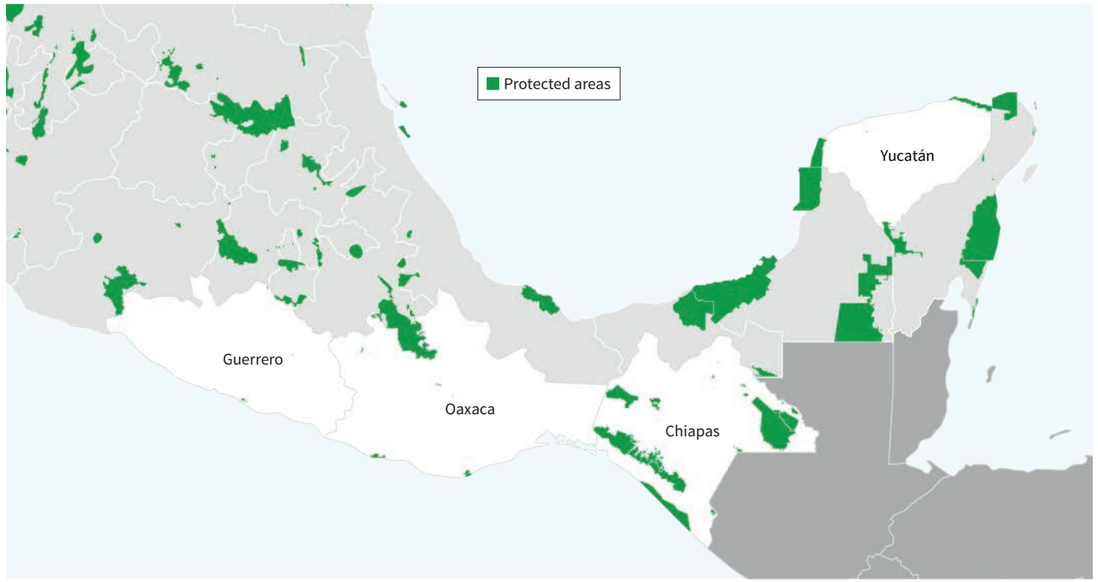
Regions with Potential for Primary and Integral Manufacturing in the Forest Sector



Source: Elaborated using Google Earth with information from INEGI 2017; CONANP 2019; CONAFOR 2019; SCT 2019; SENER 2018.
Note: The symbols are only indicative and are not meant to reflect exact locations, except for potential for raw materials.

MAP G.4

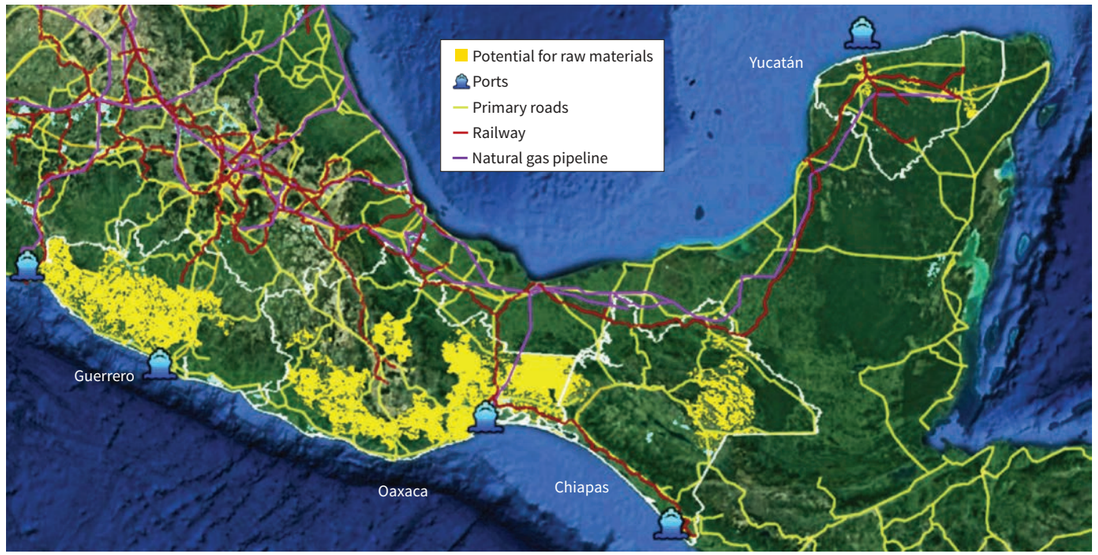
Protected Areas in the Selected States, 2019



Source: CONANP 2019.

MAP G.5

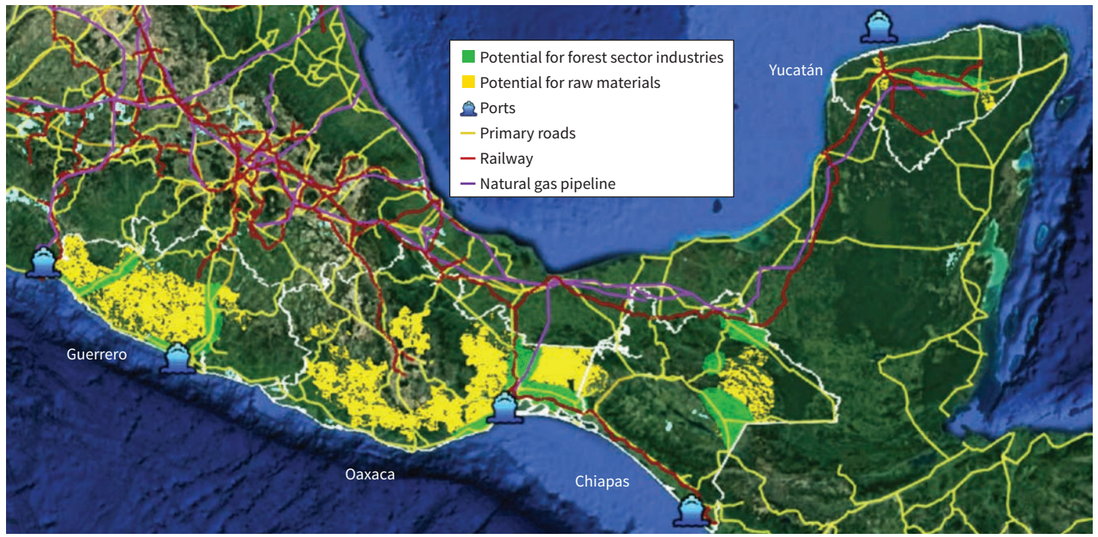
Potential Regions for Forest Sector Development Based on Raw Materials Availability in the Selected States



Source: Elaborated using Google Earth with information from INEGI 2017; CONANP 2019; CONAFOR 2019; SCT 2019; SENER 2018.
Note: The symbols are only indicative and are not meant to reflect exact locations, except for potential for raw materials.

MAP G.6

Potential Regions for Forest Sector Development Based on Products and Inputs Availability and Existing Transportation and Logistics Infrastructure in the Selected States



Source: Elaborated using Google Earth with information from INEGI 2017; CONANP 2019; CONAFOR 2019; SCT 2019; SENER 2018.
Note: The symbols are only indicative and are not meant to reflect exact locations, except for potential for raw materials.

APPENDIX H

Potential Investors

Based on the products identified in chapter 3, table H.1 lists relevant sector-leading firms that may be a starting point for potential investments.

TABLE H.1

Key Players in the Forest Sector in Mexico

Company	Description
Kimberly Clark Mexico S.A.B. de C.V.	The company operates mainly in the Valley of Mexico City and in the state of Veracruz. However, it is interested in expanding in the south of Mexico to satisfy Central American markets.
Bio Pappel S.A.B. de C.V.	The Mexican firm is interested to continue expanding its operations across the country, as well as in North America and potentially Central America. It already has presence in Chiapas and Oaxaca.
Smurfit Cárton y Papel de México S.A. de C.V.	The firm is present mainly in the north of Mexico. It has developed more than three new plants in the last 10 years. With the right strategy, it might look into Southern Mexico to expand operations.
Inter Ikea Systems B.V.	The firm has expanded around the world with an innovative production and delivery system for furniture. In 2020, it opened its first online shop in Mexico and Latin America, and in April 2021 a store in Mexico City. Potential production may be transferred from Europe to Mexico to satisfy its new market.
El Puerto de Liverpool S.A. de C.V.	The firm not only produces but also has other activities across the entire value chain of the furniture industry. It started a growth plan in the last five years, but the company still has no relevant presence in the south of the country.

Source: Based on information from PwC 2016; Expansión 2019; Euromonitor Consulting 2019.
Note: The list is only indicative and not meant to be exhaustive.

There are other relevant firms already operating in the selected states. They were identified as important actors at the local level because of the employment they generate (each recording at least 251 employees). Their relevance could be leveraged at an initial phase to further develop the forest sector in the region and at later phases to create supplier development strategies with local actors (table H.2).

TABLE H.2

Key Local Players in the Forest Sector with 251 Workers or More, Selected States

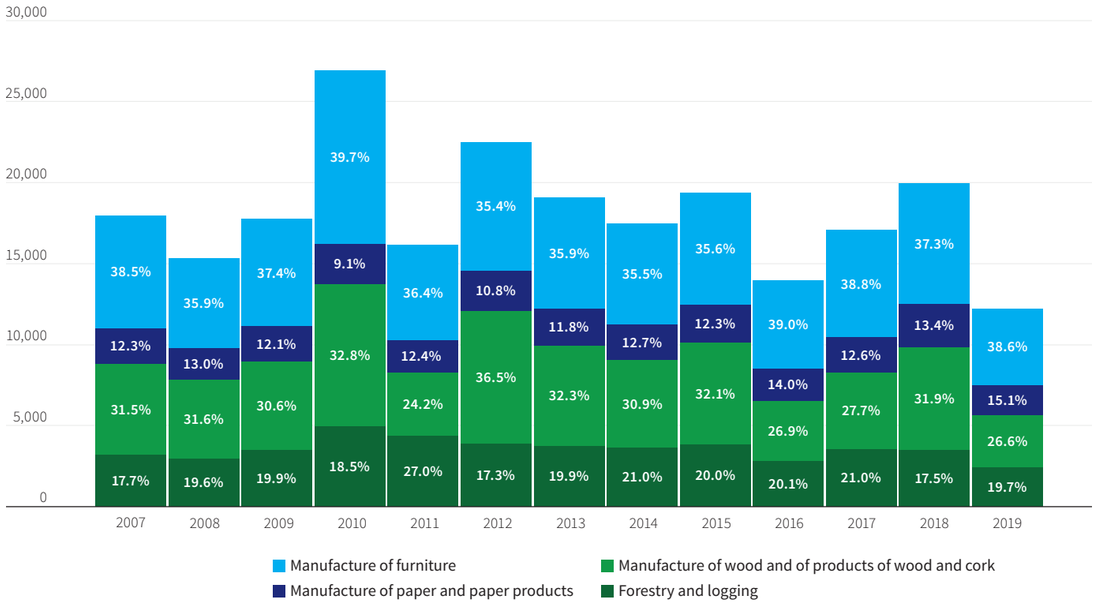
NAICS six-digit code	Sector	Enterprise	Municipality
		Chiapas	
322210	Paperboard container manufacturing	Bio Pappel S.A.B. de C.V.	Tapachula
		Guerrero	
321210	Veneer, plywood, and engineered wood product manufacturing	Tableros y Chapas de Guerrero S.A. de C.V.	Zihuatanejo de Azueta
		Oaxaca	
321910	Millwork	Puertas Finas de Madera Montealban S.A. de C.V.	Santa Lucía del Camino
322122	Newsprint mills (newsprint and uncoated groundwood paper from pulp manufacturing)	Bio Pappel S.A.B. de C.V.	San Juan Bautista Tuxtepec
		Yucatán	
322210	Paperboard container manufacturing	Empaques Nova S.A. de C.V.	Umán
337110	Fitted kitchens and modular bathroom furniture manufacturing	Woodgenix S.A. de C.V.	Kanasín
337120	Household and institutional furniture manufacturing	Marbol Industria Mueblera S.A. de C.V.	Mérida

Source: Based on information from INEGI's DENUE database.

APPENDIX I
Additional Information and Statistics on the Forestry Sector

FIGURE I.1

Trends in Forest Sector Employment in Various Countries



Source: Calculations based on data from ILOSTAT database.
Note: The number of countries grouped vary each year. The most recent year with the highest count of country-level data points (78 countries) is 2017.

TABLE I.1

Comparative Advantage of Forest Sector Activities in the Selected States, 2018*

NAICS code	Description	Chiapas		Guerrero		Oaxaca		Yucatán		*National average*
		Labor productivity (Mex$, thousands per worker)	RCA	Labor productivity (Mex$, thousands per worker)	RCA	Labor productivity (Mex$, thousands per worker)	RCA	Labor productivity (Mex$, thousands per worker)	RCA	Labor productivity (Mex$, thousands per worker)
321112	Sawing of boards and planks	–	–	95.1	1.9	217.6	7.4	–	–	152.7
321910	Manufacturing of wood products for construction	46.7	1.3	55.3	1.4	93	5.6	76	1.6	103.9
321920	Wood Container and Pallet Manufacturing	–	–	–	–	415.2	2.9	395.5	1.1	244.6
321991	Manufacturing of plaited materials products except palm	–	–	15.2	5.8	18.7	8.7	–	–	23.9
321992	Prefabricated wood building manufacturing	26.3	1.2	20.2	3.5	25.1	14.5	42.1	2.7	46.9
321993	Manufacturing of wood products for industrial use	70.2	1.6	59.5	1.0	–	–	25.4	1.3	94.3
337110	Manufacturing of fitted kitchens and modular bathroom furniture	–	–	–	–	–	–	159.0	2.8	153.9

Source: Calculations based on data from INEGI 2019.
Note: The RCA of NAICS 321112 (sawing of boards and planks) in Oaxaca with productivity above the national level could not be calculated because of confidentiality restrictions. RCA = revealed comparative advantage; NAICS = North American Industry Classification System.
*For NAICS 322 (paper manufacturing), most of the information at NAICS six-digit is confidential for the selected states.

TABLE I.2

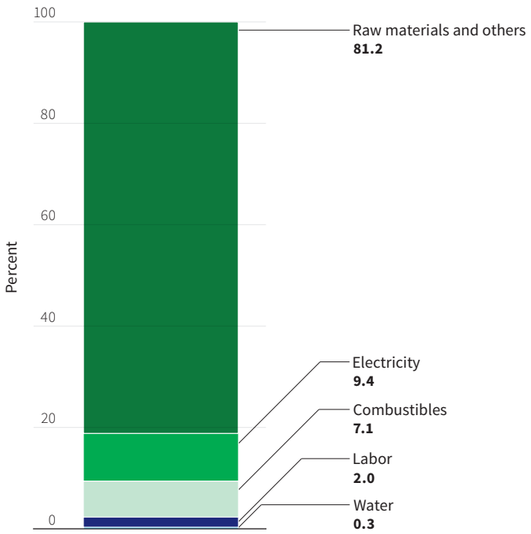
Use of Capital and Labor in the Forest Sector, Selected States, 2018

NAICS code	Description	Chiapas	Guerrero	Oaxaca	Yucatán	*National average*
		Capital per firm (Mex$, thousands)				
31-33	Manufacturing	933.11	90.67	489.16	860.51	5,116.07
321	Wood product manufacturing	151.8	n.a.	220.0	305.6	354.3
322	Paper manufacturing	n.a.	12.9	1,582.4	793.8	17,985.1
337210	Manufacturing of office furniture and shelving	463.3	–	159.6	838.5	4,258.5
337110	Manufacturing of fitted kitchens and modular bathroom furniture	69.2	133.2	154.7	**1,996.9**	388.3
337120	Manufacturing of other furniture	132.7	119.7	132.3	279.8	484.6
	Overall	1,017.8	392.1	491.5	884.8	2,413.3
		Capital per worker (Mex$, thousands)				
31-33	Manufacturing	310.1	42.6	254.7	207.5	456.9
321	Wood product manufacturing	73.9	n.a.	92.8	107.1	110.6
322	Paper manufacturing	n.a.	7.7	451.9	147.3	743.6
337210	Manufacturing of office furniture and shelving	85.6	–	60.3	65.7	187.2
337110	Manufacturing of fitted kitchens and modular bathroom furniture	33.1	62.4	65.1	**86.5**	80.8
337120	Manufacturing of other furniture	74.3	68.9	80.1	72.4	103.5
	Overall	343.2	134.4	195.5	192.6	426.9
		Number of workers per firm				
31-33	Manufacturing	3.0	2.1	1.9	4.1	11.2
321	Wood product manufacturing	2.1	n.a.	2.4	2.9	3.2
322	Paper manufacturing	–	1.7	3.5	5.4	24.2
337210	Manufacturing of office furniture and shelving	5.4	n.a.	2.6	12.8	22.7
337110	Manufacturing of fitted kitchens and modular bathroom furniture	2.1	2.1	2.4	**23.1**	4.8
337120	Manufacturing of other furniture	1.8	1.7	1.7	3.9	4.7
	Overall	3.0	2.9	2.5	4.6	5.7

Source: Calculations based on data from INEGI 2019.
Note: Outlined cells highlight capital and labor that is higher than the national average. NAICS = North American Industry Classification System; n.a. = not available.

FIGURE I.2

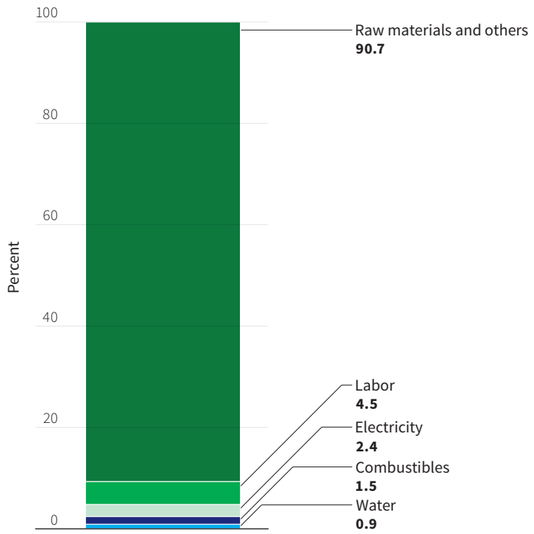
Cost Structure for Cellulosic and Paper Industries, National Level



Source: Based on data from SHCP 2017b.

FIGURE I.3

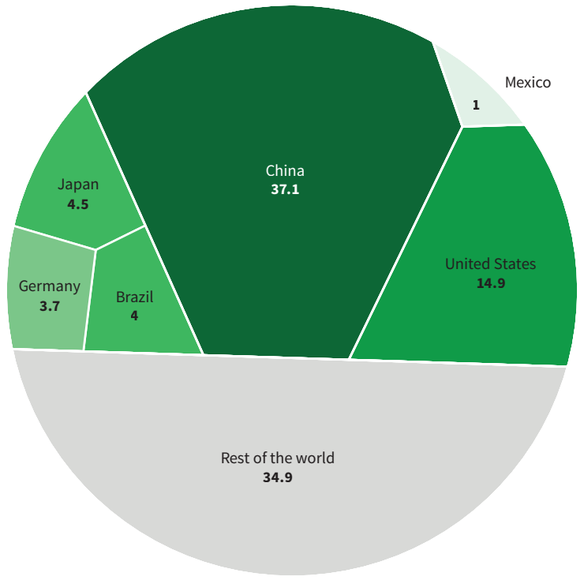
Cost Structure for Furniture Industries, National Level



Source: Based on data from SHCP 2017b.

FIGURE I.4

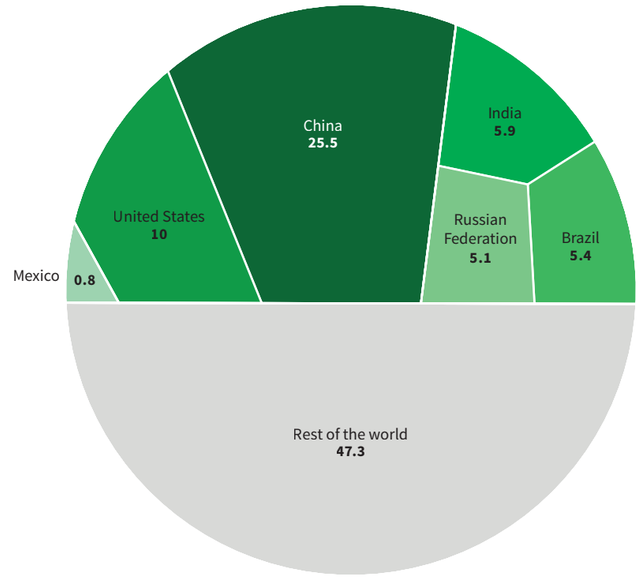
Market Share of Production of Wood-Based Products by Weight in Tons, 2018 (%)



Source: Based on data from FAOSTAT database.

FIGURE I.5

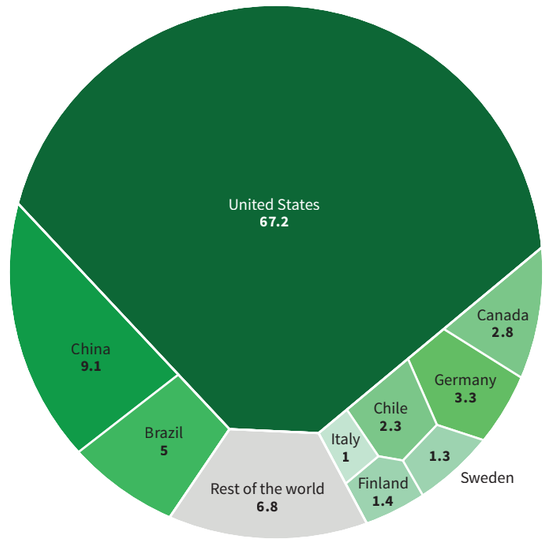
Market Share of Production of Wood-Based Products by Volume in Cubic Meters, 2018 (%)



Source: Based on data from FAOSTAT database.

FIGURE I.6

Mexico's Main Forest Sector Import Partners, 2021 (%)



Source: Based on data from UN Comtrade database.
Note: Forest sector corresponds to commodities using a Harmonized System (HS) of codes: HS 44 (wood and articles of wood, wood charcoal); HS 48 (paper and paperboard, articles of paper pulp, of paper or paperboard); HS 45 (cork and articles of cork); HS 47 (pulp of wood or other fibrous cellulosic material, recovered [waste and scrap] paper or paperboard); HS 940330 (furniture, wooden, for office use); HS 940340 (furniture, wooden, for kitchen use); HS 940350 (furniture, wooden, for bedroom use); and HS 940360 (furniture, wooden, other than for office, kitchen, or bedroom use).

TABLE I.3

Mexico's Top 20 Forest Sector Imports, by Contribution to the Country's Forest Sector Imports, 2021*

Rank	HS code	Description	Value (US$, millions)	Share (%)	CAGR, 2003–21 (%)
1	481910	Paper and paperboard; cartons, boxes, and cases, of corrugated paper or paperboard	766.0	9.1	0.7
2	480411	Kraft paper and paperboard; kraftliner, uncoated, unbleached, in rolls or sheets, nes	604.9	7.2	7.3
3	480810	Paper and paperboard; corrugated, whether or not perforated, in rolls or sheets, nes	367.2	4.4	7.8
4	481920	Paper and paperboard; folding cartons, boxes, and cases, of noncorrugated paper or paperboard	322.4	3.8	3.5
5	482390	Paper pulp, paper, paperboard, cellulose wadding, or webs of cellulose fibers; articles nes	299.0	3.5	2.3
6	481092	Paper and paperboard; multi-ply, coated with kaolin or other inorganic substances only, for nongraphic purposes, nes, in rolls or sheets	238.2	2.8	12.3
7	480511	Paper and paperboard; uncoated, semichemical fluting paper, rolls or sheets	231.0	2.7	11.7
8	470710	Paper or paperboard; waste and scrap, of unbleached kraft paper or paperboard or corrugated paper or paperboard	230.8	2.7	8.5
9	482110	Paper and paperboard; labels or all kinds, printed	202.1	2.4	−0.3
10	470720	Paper or paperboard; waste and scrap, paper or paperboard made mainly of bleached chemical pulp, not colored in the mass	196.8	2.3	6.8
11	481190	Paper, paperboard, cellulose wadding, and webs of soft cellulose fibers; coated, impregnated, covered, surface-decorated or surface-colored, nes, in rolls or sheets	179.6	2.1	7.4
12	481032	Kraft paper and paperboard; uniformly bleached throughout, coated with inorganic substances, more than 95% of chemically processed wood fibers, weight more than 150 g/m², for nongraphic purposes, in rolls or sheets	167.7	2.0	3.8
13	481159	Paper and paperboard; coated, impregnated, or covered with plastics (excluding adhesives), other than bleached and weighing more than 150 g/m², other than goods nes	151.0	1.8	5.0
14	480525	Paper and paperboard; uncoated, testliner (recycled linerboard), weight over 150 g/m², in rolls or sheets	146.9	1.7	11.4
15	481141	Paper and paperboard; self-adhesive, in rolls or sheets, nes	146.7	1.7	4.2
16	481013	Paper and paperboard; coated with kaolin or other inorganic substances, for printing and writing, graphics, containing no, or not more than 10% by weight of total fibers obtained by mechanical or chemi-mechanical process, in rolls	111.8	1.3	4.3
17	480421	Kraft paper and paperboard; sack kraft paper, uncoated, unbleached, in rolls or sheets, nes	107.4	1.3	6.7
18	440799	Wood; sawn or chipped lengthwise, sliced or peeled, of a thickness exceeding 6 mm, whether or not planed, sanded or finger-jointed, nes	107.1	1.3	2.3
19	481019	Paper and paperboard; coated with kaolin or other inorganic substances, for printing/writing/graphics, having 10% or less by weight of total fibers got by mechanical/chemi-mechanical process, sides exceeding 435mm and 297mm, unfolded, sheets	98.1	1.2	2.8
20	482190	Paper and paperboard; labels of all kinds, unprinted	83.2	1.0	−0.4

Source: Based on data from UN Comtrade database.
Note: CAGR = compound annual growth rate; HS = Harmonized System; g/m2 = grams per square meter; mm = millimeter; nes = not elsewhere specified.
*The import substitution analysis looks at a narrower time horizon (starting 2003) to capture more recent trends in imports.

TABLE I.4

Top 15 Forest Sector Imports of the Selected States, by Contribution to Region's Forest Sector Imports, 2014

Rank	HS code	Description	Value (US$, thousands)	Share (%)	CAGR, 2004–14 (%)
1	4802	Uncoated paper and paperboard, of a kind used for writing, printing, or other graphic purposes, and nonperforated punch-cards and punch tape paper, in rolls or rectangular (including square) sheets, of any size, nes	11,730.2	16.5	16.7
2	4819	Cartons, boxes, cases, bags, and other packing containers, of paper, paperboard, cellulose wadding, or webs of cellulose fibers; box files, letter trays and similar articles, of paper or paperboard of a kind used in offices, shops, or the like	11,464.4	16.1	1.9
3	4412	Plywood, veneered panels, and similar laminated wood	7,604.7	10.7	14.3
4	4804	Uncoated kraft paper and paperboard, in rolls or sheets, nes	7,553.6	10.6	5.2
5	4408	Sheets for veneering (including those obtained by slicing laminated wood), for plywood or for similar laminated wood and other wood, sawn lengthwise, sliced or peeled, whether or not planed, sanded, spliced or end-jointed, of a thickness not exceeding 6 mm	5,659.9	8.0	8.7
6	4801	Newsprint	5,429.4	7.6	−1.2
7	4821	Paper and paperboard labels of all kinds, whether or not printed	4,742.8	6.7	−3.3
8	4407	Wood sawn or chipped lengthwise, sliced or peeled, whether or not planed, sanded or end-jointed, of a thickness exceeding 6 mm	3,456.8	4.9	−11.9
9	4415	Packing cases, boxes, crates, drums, and similar packings, of wood; cable-drums, of wood; pallets, box-pallets, and other load boards, of wood; pallet collars of wood	2,427.7	3.4	27.1
10	9403	Other furniture and parts thereof	2,295.5	3.2	−4.0
11	4823	Other paper, paperboard, cellulose wadding, and webs of cellulose fibers, cut to size or shape; other articles of paper pulp, paper, paperboard, cellulose wadding, or webs of cellulose fibers	1,848.0	2.6	0.7
12	4811	Paper, paperboard, cellulose wadding, and webs of cellulose fibers, coated, impregnated, covered, surface-colored, surface-decorated or printed, in rolls or rectangular (including square) sheets, of any size, nes	1,478.8	2.1	9.4
13	4416	Casks, barrels, vats, tubs, and other coopers' products and parts thereof, of wood, including staves	1,371.3	1.9	16.6
14	4820	Registers, account books, notebooks, order books, receipt books, letter pads, memorandum pads, diaries and similar articles, exercise books, blotting pads, binders (looseleaf or other), folders, file covers, manifold business forms, interleaved carbon set	806.0	1.1	28.7
15	4816	Carbon paper, self-copy paper and other copying or transfer papers (nes), duplicator stencils and offset plates, of paper, whether or not put up in boxes	524.1	0.7	4.0

Source: Based on data from the Mexico Atlas of Economic Complexity database.
Note: cm = centimeter; CAGR = compound annual growth rate; HS = Harmonized System; mm = millimeter.

TABLE I.5

Top 15 Forest Sector Imports of Neighboring States, by Contribution to Combined Forest Sector Imports, 2014

Rank	HS code	Description	Value (US$, millions)	Share (%)	CAGR, 2004–14 (%)
1	4810	Paper and paperboard, coated on one or both sides with kaolin (China clay) or other inorganic substances, with or without a binder, and with no other coating, whether or not surface-colored, surface-decorated or printed, in rolls or rectangular sheets	402.5	16.1	3.4
2	9403	Other furniture and parts thereof	325.0	13.0	5.6
3	4703	Chemical wood pulp, soda, or sulfate, other than dissolving grades	256.4	10.3	2.6
4	4802	Uncoated paper and paperboard, of a kind used for writing, printing, or other graphic purposes, and nonperforated punch-cards and punch tape paper, in rolls or rectangular (including square) sheets, of any size, nes; hand-made paper and paperboard	183.7	7.3	7.9
5	4804	Uncoated kraft paper and paperboard, in rolls or sheets, nes	172.5	6.9	3.2
6	4707	Recovered (waste and scrap) paper and paperboard	139.9	5.6	4.9
7	4819	Cartons, boxes, cases, bags, and other packing containers, of paper, paperboard, cellulose wadding, or webs of cellulose fibers; box files, letter trays, and similar articles, of paper or paperboard of a kind used in offices, shops or the like	131.6	5.3	1.1
8	4823	Other paper, paperboard, cellulose wadding, and webs of cellulose fibers, cut to size or shape; other articles of paper pulp, paper, paperboard, cellulose wadding, or webs of cellulose fibers	122.6	4.9	10.9
9	4811	Paper, paperboard, cellulose wadding, and webs of cellulose fibers, coated, impregnated, covered, surface-colored, surface-decorated or printed, in rolls or rectangular (including square) sheets, of any size, nes	99.4	4.0	0.1
10	4412	Plywood, veneered panels, and similar laminated wood	89.5	3.6	0.3
11	4818	Toilet paper and similar paper, cellulose wadding or webs of cellulose fibers, of a kind used for household or sanitary purposes, in rolls of a width not exceeding 36 cm, or cut to size or shape; handkerchiefs, cleansing tissues, towels, tablecloths	68.5	2.7	2.3
12	4801	Newsprint	63.3	2.5	7.3
13	4407	Wood sawn or chipped lengthwise, sliced or peeled, whether or not planed, sanded or end-jointed, of a thickness exceeding 6 mm	61.6	2.5	−0.3
14	4805	Other uncoated paper and paperboard, in rolls or sheets, not further worked or processed nes	49.4	2.0	6.5
15	4803	Toilet or facial tissue stock, towel or napkin stock and similar paper of a kind used for household or sanitary purposes, cellulose wadding, and webs of cellulose fibers, whether or not creped, crinkled, embossed, perforated, surface-colored, surface décor	40.0	1.6	1.8

Source: Based on data from the Mexico Atlas of Economic Complexity database.
Note: The nine neighbor states are: Campeche, Mexico City, Michoacán, Morelos, Puebla, Quintana Roo, State of México, Tabasco, and Veracruz. cm = centimeter; HS = Harmonized System; nes = not elsewhere specified.

TABLE I.6

Forestry Sector's Contribution to Production in Other Sectors, 2013

NAICS code	Description	Share (%)
3222	Converted paper manufacturing	38.1
3221	Pulp, paper, and paperboard mills	26.4
3211	Sawmills and wood preservation	14.7
3219	Other wood product manufacturing	5.9
1133	Logging	4.7
3212	Veneer, plywood, and engineered wood product manufacturing	3.9
3371	Household and institutional furniture and kitchen cabinet manufacturing	3.4
1132	Forest nurseries and gathering of forest products	2.2
3372	Office furniture (including fixtures) manufacturing	0.4
1153	Support activities for forestry	0.3
1131	Timber tract operations	0.1
Total value of forest sectors contribution to other sectors (Mex$, millions)		289,524

Source: Based on data from INEGI's Input-Output Matrix, https://en.www.inegi.org.mx/programas/mip/2013/.
Note: The highlighted cells represent 85.1 percent of total contribution to other sectors. NAICS = North American Industry Classification System.

TABLE I.7

Main Timber Raw Materials, Selected States, 2017

State	Pine	Sacred fir	Other conifers	Oak	Other broadleaved species	Precious species	Tropical comuna	Total
				By volume				
Oaxaca								
Volume (m^3r)	627,678	–	–	34,113	6,299	–	63,703	731,794
Share (%)	85.8	–	–	4.7	0.9	–	8.7	100.0
Guerrero								
Volume (m^3r)	169,510	1,081	–	4,847	20	–	8,739	184,197
Share (%)	92.0	0.6	–	2.6	0.0	–	4.7	100.0
Chiapas								
Volume (m^3r)	128,051	–	1,059	11,997	505	252	26,905	168,768
Share (%)	75.9	–	0.6	7.1	0.3	0.1	15.9	100.0
Yucatán								
Volume (m^3r)	–	–	–	–	–	–	8,532	8,532
Share (%)	–	–	–	–	–	–	100.0	100.0
				By value				
Oaxaca								
Value (Mex$)	766,326,513	–	–	15,893,303	2,239,800	–	28,646,037	813,105,654
Share (%)	94.2	–	–	2.0	0.3	–	3.5	100.0
Guerrero								
Value (Mex$)	120,546,737	781,814	–	1,786,690	9,581	–	6,473,881	129,598,704
Share (%)	93.0	0.6	–	1.4	0.0	–	5.0	100.0
Chiapas								
Value (Mex$)	76,815,764	–	582,086	4,198,871	176,582	276,914	17,474,918	99,525,134
Share (%)	77.2	–	0.6	4.2	0.2	0.3	17.6	100.0
Yucatán								
Value (Mex$)	–	–	–	–	–	–	4,603,083	4,603,083
Share (%)	–	–	–	–	–	–	100.0	100.0

Source: Based on data from CONAFOR 2017.

TABLE I.8

Main Timber Products by Volume, Selected States, 2017

State	Scantling	Cellulosic	Wood veneer or plywood	Posts, piles, and andirons	Firewood	Charcoal	Crossties (sleeper)	Total
				By volume				
Oaxaca								
Volume (m^3r)	677,165	9,890	–	1,424	43,316	–	–	731,794
Share (%)	92.5	1.4	–	0.2	5.9	–	–	100.0
Guerrero								
Volume (m^3r)	161,905	14,478	–	230	583	7,001	–	184,197
Share (%)	87.9	7.9	–	0.1	0.3	3.8	–	100.0
Chiapas								
Volume (m^3r)	167,417	–	–	–	123	1,228	–	168,768
Share (%)	99.2	–	–	–	0.1	0.7	–	100.0
Yucatán								
Volume (m^3r)	69	–	–	1,400	223	6,839	–	8,532
Share (%)	0.8	–	–	16.4	2.6	80.2	–	100.0
				By value				
Oaxaca								
Value (Mex$)	789,758,133	5,503,662	–	780,499	17,063,360	–	–	813,105,654
Share (%)	97.1	0.7	–	0.1	2.1	–	–	100.0
Guerrero								
Value (Mex$)	120,914,580	2,575,132	–	115,150	243,273	5,750,570	–	129,598,704
Share (%)	93.3	2.0	–	0.1	0.2	4.4	–	100.0
Chiapas								
Value (Mex$)	99,052,326	–	–	–	43,008	429,800	–	99,525,134
Share (%)	99.5	–	–	–	0.0	0.4	–	100.0
Yucatán								
Value (Mex$)	86,050	–	–	1,120,376	55,805	3,340,852	–	4,603,083
Share (%)	1.9	–	–	24.3	1.2	72.6	–	100.0

Source: Based on data from CONAFOR 2017.

TABLE I.9

Main Nontimber Raw Materials, by Volume, Selected States, 2017

State	Resins	Fibers	Rubbers	Tree wax	Rhizomes or rootstock	Other species*	Tierra de Monte	Total
				By volume				
Guerrero								
Volume (tons)	–	1,032	–	–	–	2,493	21	3,546
Share (%)	–	29.1	–	–	–	70.3	0.6	100.0
Chiapas								
Volume (tons)	100	–	–	–	–	1,762	–	1,862
Share (%)	5.4	–	–	–	–	94.6	–	100.0
Oaxaca								
Volume (tons)	89	–	–	–	–	587	–	676
Share (%)	13.2	–	–	–	–	86.8	–	100.0
								By value
Chiapas								
Value (Mex$)	948,955	–	–	–	–	15,995,123	–	16,944,078
Share (%)	5.6	–	–	–	–	94.4	–	100.0
Guerrero								
Value (Mex$)	–	2,269,369	–	–	–	6,277,069	21,000	8,567,439
Share (%)	–	26.5	–	–	–	73.3	0.2	100.0
Oaxaca								
Value (Mex$)	902,646	–	–	–	–	1,885,775	–	2,788,421
Share (%)	32.4	–	–	–	–	67.6	–	100.0

Source: Based on data from CONAFOR 2017.
*Other species include: Polytrichum spp., Guadua spp., Agave spp., Sabal palmetto, Yucca schidigera, Lippia spp., Nolina cespitifera, Chamaedorea elegans, Dasylirion leiophyllum, Euphorbia antisyphilitica, Turnera diffusa, Opuntia spp., Otatea acuminata, Tillandsia usneoides, Cycas revoluta, Brahea dulcis, Rumfordia spp., and Arctostaphylos pungens.

TABLE I.10

Champion Products for the Forest Industry: Timber Raw Materials, by Unit Value, Selected States, 2017 (Mex$ per m³r)

State	Pine	Sacred fir	Other conifers	Oak	Other broadleaved species	Precious species	Tropical Comuna
Oaxaca	1,221	–	–	466	356	–	450
Guerrero	711	723	–	369	479	–	741
Chiapas	600	–	550	350	350	1,099	650
Yucatán	–	–	–	–	–	–	540

Source: Based on data from CONAFOR 2017.
Note: m³r = cubic meters of roundwood.

TABLE I.11

Champion Products for the Forest Industry: Timber Products, by Unit Value, Selected States, 2017 (Mex$ per m³r)

State	Scantling	Cellulosic	Wood veneer or plywood	Posts, piles, and andirons	Firewood	Charcoal	Crossties (sleeper)
Oaxaca	1,166	556	–	548	394	–	–
Guerrero	747	178	–	501	417	821	–
Chiapas	592	–	–	0	350	350	–
Yucatán	1,247	–	–	800	250	489	–

Source: Based on data from CONAFOR 2017.
Note: m³r = cubic meters of roundwood.

TABLE I.12

Champion Products for the Forest Industry: Nontimber Raw Materials, by Unit Value, Selected States, 2017 (Mex$ per m³r)

State	Resins	Fibers	Rubbers	Tree wax	Rhizomes or rootstock	Others	Tierra de Monte
Chiapas	9,490	–	–	–	–	9,078	–
Guerrero	–	2,199	–	–	–	2,518	1,000
Oaxaca	10,142	–	–	–	–	3,213	–

Source: Based on data from CONAFOR 2017.
Note: m³r = cubic meters of roundwood.

Notes

1. Wooden furniture includes kitchen, bed, office furniture, and other wooden furniture.

2. INEGI's Input-Output Matrix, https://en.www.inegi.org.mx/programas/mip/2013/.

3. García Aguirre (2014).

4. Based on data from INEGI 2019.

5. INEGI's Economic Census does not include forestry and logging (NAICS 113) economic activities. Further, for economic activities under household and institutional furniture and kitchen cabinet manufacturing (NAICS 3371) and office furniture (including fixtures) manufacturing (NAICS 3372), Mexico's adaptation of the NAICS does not distinguish between wood-based and nonwood-based furniture.

6. Based on information from SEMARNAT's National System of Environmental Indicators database and CONAFOR (2021).

7. Campos (2019).

8. Employment-to-output ratio is defined as the number of workers per million pesos of revenue.

9. INEGI (2019).

10. See the analysis on productivity, labor and capital intensiveness, and wages.

11. These programs allow forest owners to make a profit through a marketplace where companies purchase permits or rights to emit a certain amount of carbon dioxide.

12. Based on interindustry transactions (sales and purchases) between this sector and the rest of economic activities.

13. Based on INEGI's Input-Output Matrix, https://en.www.inegi.org.mx/programas/mip/2013/.

14. IISD (2018).

15. CEPAL (2014).

16. Kaplinsky, Readman, and Memedovic (2008).

17. FUMEC/USMFS (2006).

18. For an in-depth analysis, see https://forestlegality.org/risk-tool/country/mexico.

19. *Ejidos*, a type of collective rural property, were established following the Mexican Revolution as a means to redress land-tenure inequity. Defined by the Agrarian Law, each *ejido* operates under its internal regulation. *Ejidos* comprise land for human settlement, common-use land (owned by all members of the *ejido*), and parceled or individually owned land. The governance structure of ejidos include an assembly, which is the highest authority in which all land-owning members or *ejidatarios* participate, a council, and a supervisory board. Any changes to the private plots and common land within the *ejidos* cannot happen without the consent of the Ejido Assembly.

20. See the Forest Stewardship Council Mexico webpage, https://mx.fsc.org/en/node/18794.

21. INEGI uses the NAICS for the TFP calculations, which are mainly for three digits subsectors. For that reason, the TFP for support activities for forestry is not available but is reasonable to expect that it performed similar to the overall subsector.

22. INEGI uses the NAICS for the TFP calculations. So, unlike the HS it is not possible to differentiate wood products from this subsector. However, it is reasonable to expect that wood furniture manufacturing's TFP performed similar to the overall subsector (manufacturing of mattresses, blinds, and curtains represented 18.6 percent of the subsector's production according to the INEGI [2019] Economic Census).

23. There is no information in the INEGI [2019] Economic Census for the primary sector activities related to the forest sector at subnational level.

24. NAICS six-digit codes from 321, 322, and 337. For NAICS 322 (paper manufacturing), most of the information at NAICS six-digit level is confidential for the selected states.

25. Calculated as the ratio of the value added or export of an industry or product to the total value added or export in a state, over the average contribution of that industry or product in Mexico's total value added or exports. This indicator of a location's competitive strengths is based on Ricardian trade theory, which claims that patterns of production or trade among regions are defined by their relative differences in productivity.

26. A differentiation on formal and informal jobs is relevant because, on average, salaries in the former were around 30 percent lower than the latter in 2019, and even lower for the selected states: Chiapas (–41 percent), Guerrero (–30 percent), Oaxaca (–46 percent), and Yucatán (–36 percent).

27. SHCP (2017b).

28. Lange (2004).

29. Okutmus, Kahveci, and Kartasova (2015).

30. See CSI Market's total market profitability, https://csimarket.com/Industry/industry_Profitability_Ratios.php.

31. PwC (2016).

32. Calculations were based on the classification of products by FAO (2020) and data from FAOSTAT database.

33. Data constraints on exports at the subnational level for the forest sector are more severe than for other economic activities. Consequently, information from the Mexico Atlas of Economic Complexity is used, although it only covered up to 2014. The data comes from cross-registers of the *Servicio de Administración Tributaria* (Tax Administration Service; SAT) and the *Instituto Mexicano del Seguro Social* (Mexican Social Security Institute; IMSS). Customs data by product from SAT is presented using the HS. Values of exports by state may not perfectly adjust to the official statistics from INEGI because of a mechanism of imputation of exports by location using data by establishment from IMSS. For this reason, the analysis is made only in relative and not absolute terms.

34. The Mexico Atlas of Economic Complexity has a four-digit HS code disaggregation, which prevents the isolation the wooden furniture subsector. As a workaround, the "other furniture and parts" subsector is used as a proxy. At the national level, exports from this proxy subsector are around half of those from the wooden furniture subsector.

35. A product is said to have a comparative advantage if its revealed comparative advantage is greater than one.

36. To identify the products, four-digit HS codes (selected states) are matched with the six-digit HS codes (national) to determine if there is an overlap (product appears in three out of the four tables). Products are listed with the corresponding HS six-digit codes in an effort to be as specific as possible, considering the limitations in state-level data. The rest of the analysis can be found in appendix I.

37. The neighbor states refers to Campeche, Michoacán, Morelos, Puebla, Quintana Roo, the State of México, Tabasco, and Veracruz.

38. The "others" category in the forest production statistics yearbook of the *Comisión Nacional Forestal* (National Forestry Commission) includes: Polytrichum spp., Guadua spp., Agave spp., Sabal palmetto, Yucca schidigera, Lippia spp., Nolina cespitifera, Chamaedorea elegans, Dasylirion leiophyllum, Euphorbia antisyphilitica, Turnera diffusa, Opuntia spp., Otatea acuminata, Tillandsia usneoides, Cyca revoluta, Brahea dulcis, Rumfordia spp., and Arctostaphylos pungens.

39. Koenig (2019).

40. Koenig (2019).

41. El Financiero (2019).

42. Based on World Resources Institute's Global Forest Watch database.

43. Based on INEGI's DENUE database.

44. Based on UN Comtrade for codes HS 47 (pulp of wood) and 48 (paper and paperboard).

45. See https://www.camaradelpapel.com.mx/.

46. According to Mexico's Chamber of Paper this industry already operates with 90 percent recycled raw materials at the national level, as the result of an effort to incorporate into a circular economy model that involved an investment of more than US$1 billion in recycling infrastructure and sustainable production.

47. Jaakko Pöyry Consulting (2006).

48. EPN (2018). For the estimation of energy and water savings, it refers to the use of 1 metric ton of 100 percent recycled paper, or of 100 percent recycled newsprint, respectively, instead of virgin paper.

49. One of the main projects of the current federal administration aims to enhance the economic and social infrastructure around the corridor that represents the shortest distance between the Pacific and Atlantic Oceans in Mexico (approximately 300 km, from the Port of Salina Cruz, Oaxaca to the Port of Coatzacoalcos, Veracruz) and to consolidate up to 10 industrial parks (special economic zones) along it. It plans to benefit 79 municipalities from Oaxaca (46) and Veracruz (33) with a population of 2.4 million inhabitant.

50. A federal project will connect or construct 1,500 km of railway linking 190 sites across the Mayan Peninsula, primarily to incentivize tourism in the states of Campeche, Chiapas, Tabasco, Quintana Roo, and Yucatán, but with freight capacity as well.

51. Hausmann, Klinger, and Wagner (2008).

52. That is, instead of focusing on country- or state-level economic growth, we focused on investment and growth of a specific industry in each state.

53. The analysis was carried out following a methodology implemented by Barrios and others (2018a; 2018b), using data from INEGI's ENOE database and the *Sistema Nacional de Clasificación de Ocupaciones* (National Classification System for Occupations (INEGI 2011). The results for the forestry and logging subsector are not presented because the information for those occupations were not sufficiently disaggregated. However, given the high predominance of its workforce in the primary sector, it is reasonable to expect that if a binding constraint related to human capital existed, it would prevail in the more advanced phases of the value chain. In each case, we calculate the deviation between the share of occupations existing at the national and state levels, using the symmetric mean absolute percentage error to measure the availability of workers performing the occupations required. In addition, the labor cost in each subsector for each state is calculated and compared to the national level to measure the relative availability or scarcity of qualified human capital using a weighted average of the hourly wage. The ratio uses the ponderations of occupations at national level in the numerator and denominator. In case a state has no workers in some occupation, the highest salary among the states for that occupation is assigned (to reflect the scarcity of workers in that activity).

54. To identify infrastructure-related constraints hindering the development of the sector, the assessment of coverage and quality of infrastructure services are combined with measures of usage intensity of key inputs. A detailed analysis of coverage and quality of infrastructure services and their usage intensity is presented in appendices C and D.

55. The analysis approach and assumptions are similar to that used by Barrios and other (2018a; 2018b). This section includes all industry groups NAICS sector 31–33 (manufacturing) at four-digit level, except classified ones, according to INEGI's 2014 and 2019 Economic Censuses.

56. Oaxaca is the largest producer of wind energy in Mexico, generating approximately 2,758 megawatts in 2022, which constitutes 38 percent of the nation's total. The state has around 6,600 square kilometers of land categorized as having "good-to-excellent" wind resource potential, which makes up 7 percent of the state's total area.

57. Development of the natural gas pipeline would depend on the potential demand by (nonexistent) industries around the state and potentially from Central America, with a connection from Ciudad Hidalgo, Chiapas, to Tecun, Guatemala.

58. SENER (2018).

59. Defined as a specimen selected by its genotype and phenotype used as a precursor for the production of plants.

60. According to SEMARNAT, other causes of deforestation are forest fires, other activities (livestock, agriculture, urbanization) and illegal logging.

61. CONAFOR (2020).

62. Based on SEMARNAT's SNIARN database.

63. Anta Fonseca (2016).

64. García Aguirre (2014).

65. CEDRSSA (2019).

66. Alarcón and Corona (2017).

67. The state of Chihuahua ranks first with 231 inquires (Monroy 2019).

68. Monroy (2019).

69. CEDRSSA (2019).

70. Tomaselli (2006).

71. Financial access points refer to bank, sociedades cooperativas de ahorro y crédito popular (savings and credit cooperative societies) and sociedades financieras populares (popular financial companies) branches, as well as bank agents, and automated teller machines.

72. CNBV's publicly available data only shows aggregated information for agriculture, forestry, fishing, and animal breeding. Further, it does not include other activities that comprise the forest sector, however, it includes a broad category "rest of industrial activities" that we considered as an umbrella category for the rest of forest-related manufacturing activities and other manufacturing activities as well.

73. The primary segment refers to support services to forest and agriculture, as data is not available for forestry activities.

74. For the complete analysis, see appendix E.

75. Based on World Resources Institute's Global Forest Watch.

76. Porter (2008).

77. For more details, see appendix A.

78. Public-private dialogue should not be limited to local actors but should also include leading firms, potential investors, and even other

governments that have succeeded in attracting and retaining investments in the sector. The focus should not only be to increase the competitiveness to develop the sector but also to maximize the benefits and spillover effects and minimize any potential negative externality.

79. The *Catálogo de Empresas Forestales* prepared by CONAFOR, SEMARNAT, United Nations Development Programme, and the World Bank could be the base of such directory.

80. The European Union (EU) is the founder of the Forest Law Enforcement, Governance and Trade, which promotes signing Voluntary Partnership Agreements with non-EU members in an effort to reduce illegal logging.

81. The results for the forestry and logging subsector are not presented because the information on occupations is not sufficiently disaggregated. However, given the high predominance of its workforce in the primary sector, it is reasonable to expect that if a binding constraint related to human capital existed, it would prevail in the more advanced phases of the value chain.

82. A weighted average of the hourly wage is used for the national and state levels. The ratio uses the ponderations of occupations at the national level in the numerator and denominator. In case a state has no workers in some occupation, the highest salary among the states for that occupation is assigned (to reflect the scarcity of workers in that activity).

83. Yucatán has another airport in Tizimín, but it has no operations yet.

84. Units for germplasm production are defined as forest plantations or plant incubators with specimens selected by their genotype or phenotype and are used as a precursor for production of fruits, seeds and other forest materials (CONAFOR 2019a).

85. Units for germplasm storage are seed banks with the required climate conditions to storage germplasms (CONAFOR 2019a).

86. Community seed banks (*bancos comunitarios de semillas*) are defined as an alternative model for management of seeds endemic to some regions with the objective to preserve special plants and trees (SNICS 2018).

87. An accession is a group of related plant material from a single species which is collected at one time from a specific location. Each accession is an attempt to capture the diversity present in a given population of plants (for more information, see https://opgc.osu.edu/node/88).

88. The analysis approach and assumptions are similar to that used by Barrios and others (2018a; 2018b).

89. Includes all industry groups NAICS sector 31–33 (manufacturing) at four-digit level, except classified ones, according to the INEGI's 2014 and 2019 Economic Censuses.

90. Defined as a specimen selected by its genotype and phenotype used as a precursor for the production of plants.

91. Financial access points refer to bank, *sociedades cooperativas de ahorro y crédito popular* (savings and credit cooperative societies) and *sociedades financieras populares* (popular financial companies) branches, as well as bank agents, and automated teller machines.

92. Data from CNBV's *Bases de Datos de Inclusión Financiera* (Financial Inclusion Dataset) for December 2021.

93. CNBV's publicly available data only shows aggregated information for agriculture, forestry, fishing, and animal breeding. Further, it does not include other activities that comprise the forest sector, however, it includes a broad category "rest of industrial activities" that we considered as an umbrella category for the rest of forest-related manufacturing activities and other manufacturing activities as well.

94. INEGI's National Accounts does not have disaggregated data at the state level for forestry and logging (NAICS 113), so these activities were grouped under agriculture, forestry, fishing, and hunting (NAICS 11). Given that forestry and logging only represents 3.4 percent of agriculture, forestry, fishing, and hunting's GDP (for 2018, at the national level), we exclude NAICS 11 from the financing analyses, as it might mislead the results. Therefore, we only looked at the manufacturing and industrial activities in the forest sector. INEGI's Economic Census does not have dates for forestry and logging. Given that this is a sector whose magnitude is significant, the analyses looked at two groups, high-performing states in the forest sector including NAICS 11 and high-performing states in the forest sector excluding NAICS 11. Durango and Chihuahua appear in both groups (in both cases as first and fifth place, respectively) and they are highlighted in green.

95. Primary refers to support services to forestry and agriculture (NAICS 115) and manufacturing to wood product manufacturing (NAICS 321), paper manufacturing (NAICS 322), and furniture and related product manufacturing (NAICS 337). Data for this particular module of the INEGI's 2018 Economic Census does not disaggregate beyond NAICS three-digit level.

96. For the selected states: in Chiapas two firms received financing from external sources, in Oaxaca three, in Yucatán oine, and in Guerrero none. For the champion states: in Baja California, three firms received financing from external sources, in Chihuahua fifteen, in Durango three, Querétaro one, and in Tlaxcala none.

97. Although 274 firms in the selected states for NAICS 115 support activities for agriculture and forestry were considered for this analysis, table 1.1 shows that only five firms in these states were part of the NAICS 1153 support activities for forestry sector.

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