TRANSPORT GLOBAL PRACTICE

Corridors for Development and Growth

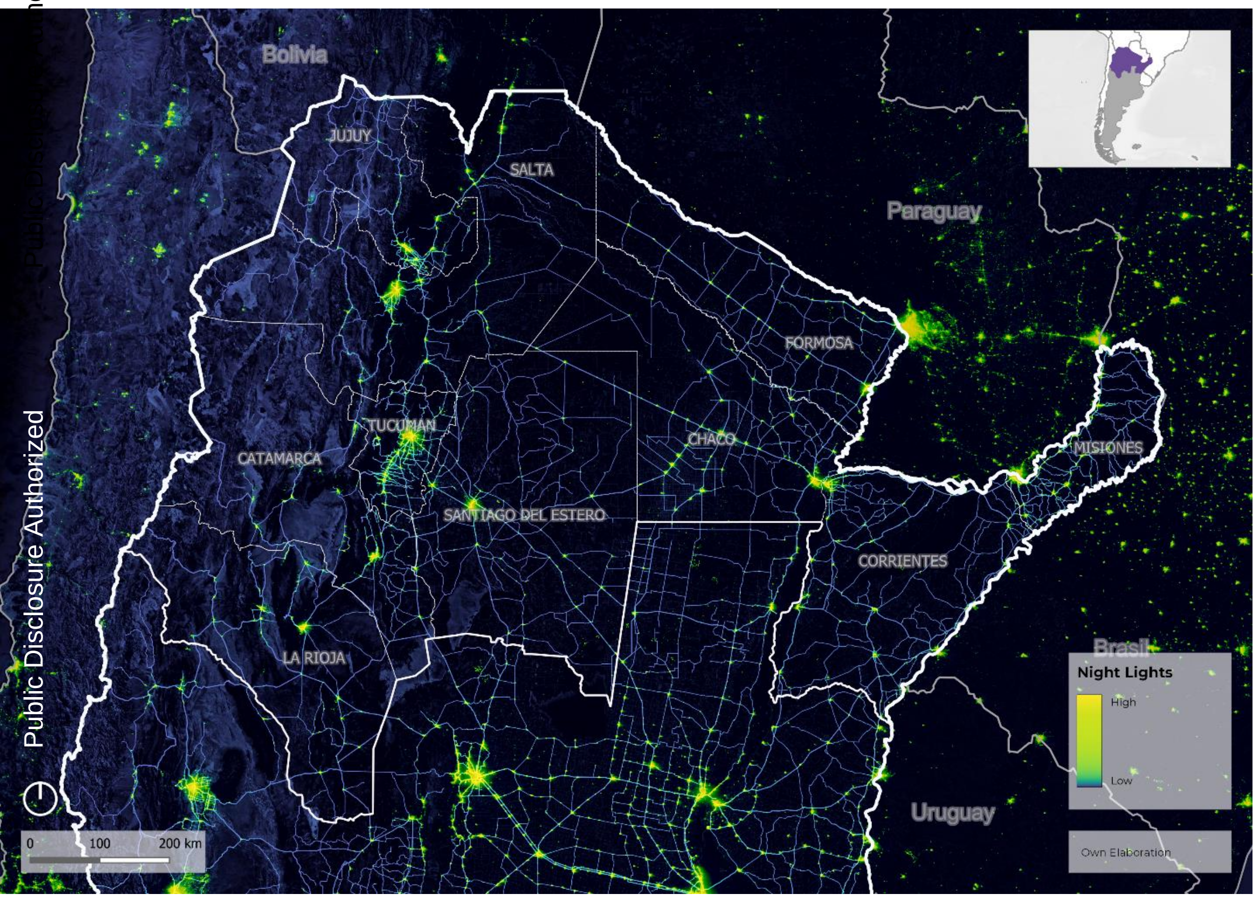

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Table of Contents

List of Figures

List of Tables

List of Boxes

Executive Summary

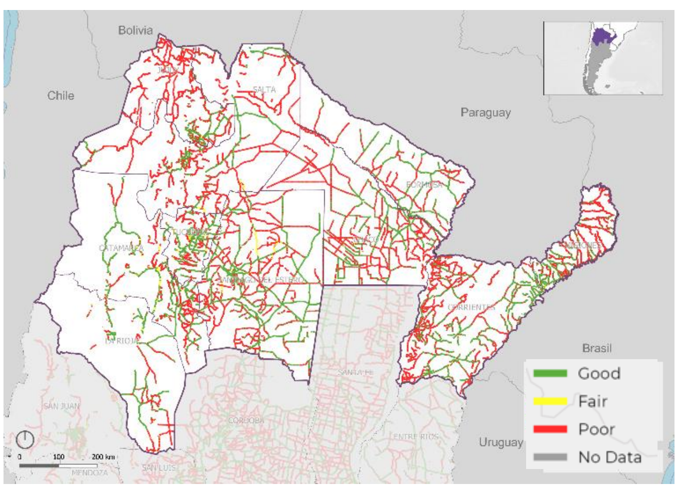
The Norte Grande lags on economic and poverty indicators, but its significant growth potential could be tapped if coordinated policy actions are taken to address connectivity gaps.

Argentina's economic activities are highly concentrated in Buenos Aires and the central and coastal areas, while its northern provinces are characterized by smaller and fewer firms and higher poverty. At the same time, these ten provinces (Catamarca, Salta, Jujuy, La Rioja, Tucumán, Santiago del Estero, Chaco, Formosa, Misiones, and Corrientes), collectively referred to as the Norte Grande, already play a strategic role in Argentina's agricultural exports, producing nearly 90 percent of sugar, vegetables, lemons and yerba mate; about half of the olive oil, olives, and wine; and significant volumes of grains. The Northwest (NOA) generates all of Argentina's lithium exports and holds significant potential in copper mining just as demand for both is expanding driven by the energy transition and transport electrification trends.

To harness the potential of its natural resources and value-added activities linked to agriculture, mining, and other sectors, the provinces of the Norte Grande need to solve their connectivity challenges. Less than one-third of the region's combined national and provincial road network is paved (CFI, 2023), and much of the provincial network is in poor condition (Figure 1a) – more than half in Santiago del Estero, Jujuy, and Chaco. Moreover, based on the combination of rainfall and slope conditions, an estimated 16 percent of the unpaved provincial network is at risk of flooding, impeding the flows of cargo and people. Provincial route 4 (PR4) in Catamarca as well as several national roads (NR51, NR9, and NR34 in Salta and NR60 in Catamarca and La Rioja) have the highest overall expected economic losses due to a combination of high risk exposure and cargo traffic volumes (World Bank/GFDRR 2021). In addition, over 15-20 percent of the tertiary network – the "last mile" to key production zones – is estimated to be at risk of being impassable during the rainy season in several provinces, such as Santiago del Estero, Catamarca, Salta, and La Rioja, limiting market access and social inclusion.

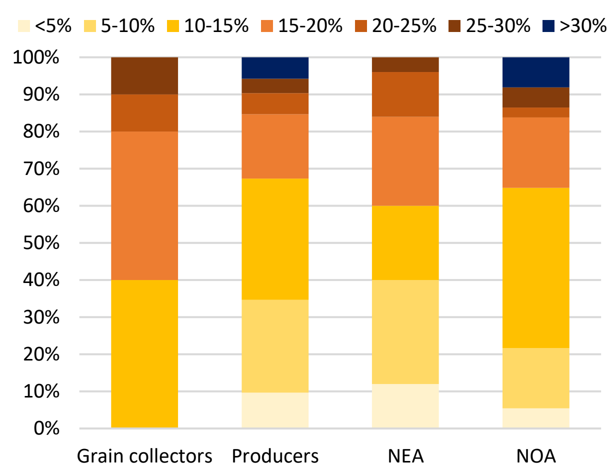
Figure 1: *Significant gaps in the condition of the provincial road network result in high transport costs*

a. *Most provincial roads are estimated to be in poor condition*



Source: Own estimate based on satellite imagery and machine learning

b. *Most firms pay over 10% of sales value on transport alone*



Source: Original survey of producers/grain collectors

The region's rail network is over 10,000 km long, but only about one-fourth of it is operational and in good condition (CFI, 2023). Factors hindering railway development and its ability to serve economic activity include: the poor state of the infrastructure, leading to low speeds, frequent derailments, and poor wagon rotation; the absence of cargo concentration centers; and the lack of clarity on the implementation of open access, generating uncertainty for potential private investors (World Bank, 2023a).

The Norte Grande is one of the regions with the most potential for shifting cargo from truck to rail, given the high share of productive zones located more than 200 km from the destination ports. Yet, a survey of cargo generators in the

Norte Grande (representing priority value chains contributing some 62 percent of the road freight originating in the region) implemented as part of the current study shows that in most value chains, production is transported entirely by truck, except for grains, sugar, and some other individual products that use rail or river transport in minor proportions. In NOA, 76 percent of the surveyed firms rely exclusively on trucks, while in the Northeast (NEA) the share reaches 84 percent, with most firms in both sub-regions fully outsourcing transport services.

Excessive reliance on road transport (which has a higher cost per ton kilometer than rail and fluvial transport) combined with large distances and the poor state of road infrastructure has implications for the region's competitiveness. Past studies estimated logistics costs in northern Argentina to be up to 50 percent higher than in the neighboring regions (World Bank, 2016), and the firm surveys conducted for the current study suggest that most firms in the Norte Grande's priority value chains pay between 10 and 20 percent of their product sales value on transport alone (Figure 1b). In addition, surveyed cargo generators – especially those operating in value chains with a higher level of processing (non-bulk general cargo) – noted issues related to customs and border crossings, which directly affects the Norte Grande's export competitiveness.

Shifting part of the cargo to rail and fluvial transport (the former concentrated in western and central Norte Grande and the latter in the east) would require making them more attractive. For rail, it would entail investing in the maintenance of the region's rail infrastructure and improving its accessibility to the key production areas, as well as addressing the level of service – availability, capacity, speed, and reliability. For fluvial transport, the lack of dredging and regulations are key bottlenecks as is the low quality (or lack of) port infrastructure.

A better understanding of the needs of priority value chains, combined with a multicriteria approach, can help set priorities for public investment in infrastructure: in the Norte Grande, this approach points to 15 road and 5 rail projects that are most likely to boost inclusive economic development.

The above makes clear that the needs are extensive, and likely to exceed available national or provincial resources. In this context, the aim of this report is to identify infrastructure investment priorities critical to boosting the economic development of the region. The spatial concentration of economic activity can serve as a primary lens for defining such priorities. Norte Grande has several de facto economic corridors – areas of high-density production in priority agricultural value chains, connecting production areas to processing centers and either domestic markets or export nodes (ports, border crossings), supported by several major national and provincial roads. In addition, new branches of economic corridors are beginning to emerge in the Northwest, as the lithium and copper value chains develop and as ancillary sectors grow with them.

Overlaying the infrastructure gaps with these economic corridors and detailed insights from the cargo generator surveys is a first step towards narrowing down the priorities, by allowing to identify the road and rail links that are particularly critical for production input and market access. Building on a long-list of transport and logistics priorities already identified in 2022-23 by the Norte Grande's provincial government with the help of the Federal Investment Council and applying a multi-criteria analysis (MCA) framework, the current study identifies a short-list of road and rail investments that are most likely to boost inclusive economic development. Key criteria include the carried annual freight traffic, relevance for priority value chains, likely implementation complexity, and the socio-economic context of the areas crossed. While specific social and environmental risks associated with the shortlisted projects are beyond the scope of this study, the MCA includes several indicators that aim to ensure the shortlisted projects would bring local socioeconomic or climate benefits.

The multicriteria approach selected 15 road and 5 rail projects from the long-list of over a hundred projects that could be geolocated proposed by the provincial governments. In terms of the investment amount, the projects range from less than US$10 million to over US$200 million. Among the prioritized road projects are two dual carriageway projects on NR9, the construction of a passing lane on NR34, and several pavement rehabilitation projects (Table 1). The shortlisted rail projects include the rehabilitation and upgrade of Belgrano lines C13, C15, and C, the Mitre line in Tucumán and Santiago del Estero, and the Urquiza line in Corrientes and Misiones. Most of the shortlisted projects involve more than one province, and some – such as segments of NR34, NR9, and NR157 and the improvement of the Belgrano rail line C branch – cross more than two. Given the multi-criteria approach for selecting the projects, they vary in terms of their economic versus other relevance. For example, the selection of the Urquiza line among the 20 most relevant projects is driven not by its cargo potential (which is relatively limited at least in the short term) but by the other criteria.

The potential economic benefits of the shortlisted investments are large, but reaching their full potential will require coordination across provinces.

To compare the relative importance of specific shortlisted interventions, the current study estimates the likely benefits associated with each investment, from the direct impacts on transport operating costs, to employment generation, to wider economic and welfare impacts (Table 1). The estimated impacts in terms of total transport operating cost savings range widely, exceeding US$50 million per year in the case of the rehabilitation of the NR9 and NR34 segments connecting Salta, Tucumán, and Santiago del Estero, but are much smaller for some others**.**

For both rail and road, benefits are much higher when coordinated across jurisdictions. In the case of the rail projects, the transport cost savings benefits are maximized by a network-level, comprehensive approach: improving the three shortlisted Belgrano branches simultaneously would deliver transport cost savings that are twice as high as the sum of improving each of them in isolation. Similarly, in the case of individual national and provincial roads, such as those connecting the lithium mining areas, investments should be spatially coordinated across provincial boundaries to ensure that the cargo generators are fully connected to input providers and markets.

Beyond the direct user benefits, the proposed road and rail works would generate thousands of direct, indirect, and induced jobs. In the case of several of the proposed road and rail works, upwards of 4,000 jobs would be created – including technical, professional, and unskilled – of which about 42 percent would be direct jobs, and the rest – indirect and induced. Women are expected to be employed in between 15 and 26 percent of all the jobs generated, depending on the type of project. Given that the considered works do not involve significant complexity and have already been carried out in the Norte Grande, it is likely that a large part of the direct employment will come from the local area, the province or neighboring provinces. The share of the indirect employment generated locally will depend on the availability of inputs in the region and the feasibility of those inputs reaching the specific works location.

Some of the shortlisted investments would likely deliver significant broader macroeconomic benefits in addition to increasing household wellbeing and income through both job creation and improved market access to goods the households consume. Based on the general equilibrium models developed as part of the study,[1] the following specific investments and the complex distribution of benefits across provinces (inherent to any network system) stand out:

- The rehabilitation of NR34 between the Santa Fe border and Rosario de la Frontera and between Cabeza de Buey and Pocitos would likely be the most impactful for the region and the country overall. In the case of the first segment, an overall national GDP increase of US$4.04 billion is estimated, and in the case of the latter, about US$675 million.
- The rehabilitation of NR157 between NR60 and San Miguel Tucumán would hold significant benefit for Catamarca, NR11 between Santa Fe border and Formosa City for Chaco and Corrientes, and NR14 between Entre Ríos border and Santo Tomé in Santa Fe province for Corrientes.
- The rehabilitation and improvement of the Belgrano railway line branch C between Tucumán, Salta, and Jujuy would generate significant benefits for Chaco (which the branch doesn't cross) but less so for Salta or Jujuy,[2] highlighting the important inter-provincial spillovers of infrastructure development.
- The rehabilitation and partial paving of NR51 connecting to the border with Chile is an example of an intervention with over 95 percent of overall GDP growth accruing outside the province (Salta) in which the road improvement would be made, in contrast to projects such as the rehabilitation of NR34 between Cabeza de Buey – Pocitos where the host provinces (Salta and Jujuy) would capture a more sizable share of the estimated benefits (Figure 2).

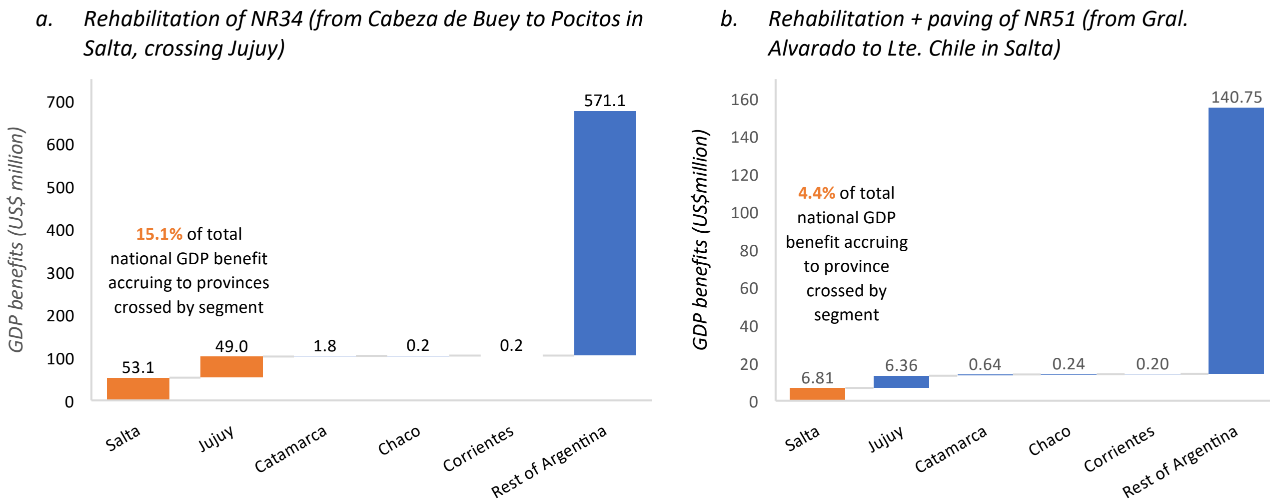
[1] Based on data availability, models were developed for the provinces of Catamarca, Salta, Jujuy, Chaco, and Corrientes, allowing to quantify the predicted impacts of each investment for each of these provinces as well as for Argentina overall.
[2] It was not possible to develop a model specific to Tucuman, but the province is likely to benefit from this investment.

Table 1: *The priority investments selected through multicriteria analysis will generate not only direct but also broader economic benefits*

	Location	Type	km	Investm. (US$M)	Carrier OPEX savings in segment (US$M/y)	Total jobs generated	National GDP increase (US$M)	Priority value chains most benefiting from investment
Road works segment								
NR34 - S. Pedro de Jujuy - Embarcación	Jujuy, Salta	Passing lanes	154	7.9	3.05	105	102.1	Wine, oranges
NR34 - Cabeza de Buey - Pocitos	Jujuy, Salta	Rehab.	360	124.1	29.95	2,885	675.4	Wine, oranges, sugar beans, soy, cotton
NR51 - Gral. Alvarado - Lte. Chile	Salta	Rehab., pave 136 km	289	309.9	4.17	4,674	155.0	Lithium
NR34 -Lte. Santa Fe-Rosario de la Frontera	Salta, Tucumán, S.d. Estero	Rehab.	576	196.5	62.68	4,569	4,038.0	Soy, cotton, beans, cattle
NR9 - City of Stgo. del Estero - City of Salta	Salta, Tucumán, S.d. Estero	Rehab.	461	202.9	51.65	4,716	15.6	Sugar, oranges, lemon
NR9 -ACC.A BANDA DEL RIO SALI - INT.PR306	Tucumán	Dual carriageway	2	8.2	0.19	110	-	Sugar, oranges, lemon
NR9 -INT.R.P.306 - B/N NR38	Tucumán	Dual carriageway	2	9.8	0.26	132	-	Sugar, oranges, lemon
NR157 - Emp. NR60 - SM. Tucumán	Catamarca, Tucumán, S.d. E.	Rehab.	310	105.7	15.41	2,457	171.6	Sugar, oranges, lemon
NR9 - Lte. Córdoba – City of S.d. Estero	S.d. Estero	Rehab.	239	81.4	31.47	1,892	91.4	Cotton
NR79 - Chamical - Emp. NR60	La Rioja	Rehab.	125	42.6	2.19	990	33.1	Olives
NR11 - Lte. Santa Fe - Formosa City	Chaco, Formosa	Rehab.	364	124.0	19.53	2,883	218.6	Rice, cattle
NR81 - Emp. RN95 - Emp. NR34	Salta, Formosa	Rehab.	498	169.9	1.05	3,949	33.8	Cattle, cotton, beans, oranges, sugar
NR14 - Lte. Entre Ríos -Santo Tomé	Corrientes	Rehab.	342	159.0	37.39	3,696	112.1	Yerba, rice, cattle, forestry, oranges
NR14 - Santo Tomé - Bdo. De Irigoyen	Corrientes, Misiones	Rehab.	442	150.8	11.94	3,505	17.5	Yerba, oranges, forestry, lemon
NR12 - Posadas - Puerto Iguazú	Misiones	Rehab.	298	182.16	16.40	4,235	31.9	Yerba, oranges, forestry, lemon
Rail works segment								
Belgrano (TAC) C13-Güemes - Cerillos	Salta	Improve*	63	21.6	0.02	362	-	Soy, lithium, cotton
Belgrano (TAC) C15-Perico - Pichanal	Salta, Jujuy	Improve*	167	57.3	0.04	962	74.2	Sugar, oranges, beans
Belgrano (TAC) C-Tucumán - Palpalá	Salta, Jujuy, Tucumán	Improve*, renew 40km	337	142.9	0.18	2,494	293.3	Soy, sugar, oranges, lemon, lithium
Belgrano (TAC) C13 + C15 + C	Salta, Jujuy, Tucumán	Improve*, renew 40km	567	221.8	0.47	3,817	-	Soy, sugar, oranges, lemon, beans, lithium
Mitre (NCA) G1-Tucumán - Santa Fe limit	Tucumán, S.d. Estero	Improve*	474	162.9	1.86	2,731	-	Cotton, sugar, oranges, lemon, lithium
Mitre (NCA) - G1-Tucumán - Rosario	Tucumán, S.d. Estero	Improve*	851	292.0	17.80	4,898	-	Cotton, sugar, oranges, lemon, lithium
Urquiza (TAC) Garupa – Lte. Entre Ríos	Corrientes, Misiones	Improve*	487	167.3	2.10	2,806	-	Yerba, rice, cattle, forestry
Urquiza (TAC) Garupá - Zarate	Corrientes, Misiones	Improve*	1,063	364.9	5.63	6,121	-	Yerba, rice, cattle, forestry

* Partial replacement of sleepers, fasteners and rails, stone aggregate
Note: all costs and benefits expressed in US$2024

Figure 2: *As expected with any network investments, much of the benefits of road projects would accrue outside the province where the improvement works would take place*



Source: Own estimates based on the estimated transport cost savings and province-specific general equilibrium model
Note: **Blue bars** denote GDP benefits accruing to provinces *not* directly crossed by the specific segment

Most of the projects are expected to disproportionately benefit the agriculture sector in addition to the transport sector itself (transport service providers). Individual projects, such as the rehabilitation of NR34, would also generate significant gross value added for the mining sector, expected to grow with the expansion of mining activity in NOA. Road and rail works that would particularly benefit manufacturing include NR34 between Santa Fe and Rosario de la Frontera, NR11 between Santa Fe border and Formosa City, and the Belgrano railway branch C between Tucumán and Palpalá.

Maximizing the benefits of improved transport connectivity will require complementing infrastructure investment with "soft" interventions and easing other infrastructure bottlenecks.

Transport corridors can act as the backbone of economic corridors; however, they need a comprehensive approach to be successful – including not only "hard" but also "soft" interventions. As summarized in Table 2, which reflects the priorities voiced by surveyed producers in priority value chains, infrastructure improvements need to be complemented by better transport services, currently characterized by inefficiencies, variable reliability, and high costs. Key suggestions to improve the supply of trucking services include reducing the current limits to Chilean truckers being able to serve demand in Argentina and working with trucker unions to reduce the informal barriers to competition. The pervasive issue of obsolete truck fleets can be addressed through the introduction of truck renewal schemes that can be combined with trucker professionalization programs. The implementation of rest areas for trucking service providers in strategic locations could be integrated into the design of future road rehabilitation and improvement projects. Concrete steps to improve the border crossing times and customs processing include the simplification of procedures, increasing the capacity of key agencies such as SENASA, and improving the coordination across the different involved agencies, including through digitization of procedures.

Moreover, steps can be taken to improve how infrastructure is planned and managed. For example, in NOA, the mining-related expected increase in truck loads warrants increasing attention to adequate road maintenance, including to mitigate road safety risks. In both NOA and NEA, climate risk information should be systematically considered in the spatial prioritization and design of road investments to ensure that the most critical routes continue functioning. More climate resilient roads can also help lower transport prices by reducing vehicle operating costs and the time spent on the road.

Table 2: *Both hard and soft transport interventions are needed to address Norte Grande's connectivity gaps*

	Transport infrastructure	Logistics and soft interventions
Salta	**Roads:** Construct passing lanes on NR34 (S. Pedro de Jujuy – Embarcación) and rehabilitate NR34 (Cabeza de Buey – Pocitos; Lte. Santa Fe-Rosario de la Frontera); rehabilitate and pave NR51 (Gral. Alvarado - Lte. Chile); rehabilitate NR9 (City of Stgo. del Estero - City of Salta); rehabilitate NR81 (Emp. RN95 - Emp. NR34) **Rail:** Improve Belgrano C13 (Güemes – Cerillos) and Belgrano C15 (Perico – Pichanal); improve and renovate Belgrano C (Tucumán – Palpalá) **Additional priorities (sugar, lithium, forestry):** upgrade NR34 to a highway (Pichanal - NR9); upgrade NR9 to a highway until Metán; improve Belgrano line C14 (Güemes-Puna); reconstruct bridges in Tartagal and Caraparí	▪ Improve hygiene services and service stations in Pichanal to improve conditions for haulers ▪ Construct a hub to consolidate and do redispatch – forestry ▪ Develop multimodal logistics nodes in Güemes, Pichanal, Lajitas/Metán/Rosario de la Frontera, and Acapato – grains, legumes, cotton, livestock ▪ Improve Customs and border crossings
Jujuy	**Roads**: Construct passing lanes on NR34 (S.P. de Jujuy–Embarcación), rehabilitate NR34 (Cabeza de Buey-Pocitos) **Rail**: Improve Belgrano C15 (Perico – Pichanal); Belgrano C improvement and renovation (Tucumán – Palpalá) **Additional priorities (lithium):** Asphalt NR40; pave and maintain RN51 and NR9; widen RP129 to improve safety; improve Belgrano line branch C14 from Güemes to Puna	▪ Expand capacity of bonded warehouses in AMBA – lithium ▪ Improve Customs and border crossings; digitalization ▪ Improve SENASA operating capacity
Cata-marca	<u>**Roads**</u> **:** Rehabilitate NR157 (Emp. NR60 - SM. Tucumán)	▪ Improve Customs and border crossings ▪ Develop logistics centers in La Paz, Tinogasta, Fiambala
Tucumán	**Roads :** Rehabilitate NR34 (Lte. Santa Fe-Rosario de la Frontera); rehabilitate NR157 (Emp. NR60 - SM. Tucumán); construct dual carriageway on NR9 (ACC.A BANDA DEL RIO SALI - INT.PR306 and INT. PR306 - B/N NR38); rehabilitate NR9 (City of Stgo. del Estero - City of Salta) **Rail:** Improve and renovate Belgrano line C (Tucumán – Palpalá); improve Mitre G1 line (Tucumán - Santa Fe limit) **Additional priorities (sugar):** increase capacity of NR34; improve rail condition to increase speeds	Reduce customs disruptions due to service outages; expedite customs clearance times
La Rioja	**Roads:** rehabilitate NR79 (Chamical - Emp. NR60)	Improve Customs and border crossings
Santiago del Estero	**Roads:** rehabilitate NR34 (Lte. Santa Fe-Rosario de la Frontera); rehabilitate NR157 (Emp. NR60 - SM. Tucumán); rehabilitate NR9 (City of Stgo. del Estero - City of Salta and Lte. Córdoba – city of Stgo. del Estero) **Rail:** improve Mitre G1 (Tucumán - Santa Fe limit) **Additional priorities (grains):** Improve road safety on rural roads	▪ Expand truck repair services ▪ Develop a multimodal logistics center in Beltran (on NR34)
Formosa	**Roads:** rehabilitate NR11 (Lte. Santa Fe - Formosa City); rehabilitate NR81 (Emp. RN95 - Emp. NR34) **Additional priorities (cattle):** improve NR11 between Clorinda and Resistencia; improve condition of rural roads	Improve Customs and border crossings
Chaco	**Roads**: NR11: rehabilitate (Lte. Santa Fe - Formosa City) **Additional sector-specific priorities (cattle, grains, cotton, rice):** improve NR11 (Clorinda-Resistencia); dredge Riacho Barranqueras river; improve port of Barranqueras; improve roads to spinning mills in Resistencia/Corrientes; improve condition of rural roads; develop train+barge transport in the Itá Ibaté and Curuzú area; build additional bridges and multimodal connections between production areas, mills, and export points - grains	Build/expand Las Palmas-La Leonesa port Logistics complex
Corrientes	**Roads:** rehabilitate NR14 (Lte. Entre Ríos -Santo Tomé; Santo Tomé - Bdo. De Irigoyen) **Additional sector-specific priorities (forestry, Yerba, rice, cotton):** rehabilitate NR12 from Corrientes capital city to NR118; improve level of service on NR14 between Paso de los Libres (Corrientes) and San José (Misiones); improve condition of rural roads (e.g., in Mercedes); construct a bridge between Goya and Reconquista – forestry, cotton	▪ Construct service stations and truck beaches on NR14 ▪ Construct a customs/ SENASA hub in the Mercedes area ▪ Improve Customs and border crossings – cotton, oranges ▪ Pass bitrain regulation for the Corrientes-Misiones area
Misiones	**Roads:** rehabilitate NR14 (Santo Tomé - Bdo. De Irigoyen); rehabilitate NR12 (Posadas - Puerto Iguazú) **Additional sector-specific priorities (forestry, Yerba):** upgrade NR14 to a highway from Paso de los Libres to San José (250 km) and improve road safety; pave provincial roads; improve condition of rural roads	Pass bitrain regulation for the Corrientes-Misiones area

However, the impact of improved transport connectivity can be muted by other bottlenecks in other infrastructure sectors, notably electricity which is critical to the Norte Grande's key value chains. This includes the cotton industry whose ginning, spinning, and weaving processes in Chaco, Santiago del Estero, Catamarca, and La Rioja consume significant amounts of electricity; the citrus fruit sector which needs electricity for refrigeration and processing; and the grains sectors – soy, corn, beans, and sorghum – that require it for grain movement and quality maintenance. Therefore, investments and policies that improve electricity access and quality will amplify any improvement in transport connectivity.

Currently, however, firms in both NOA and NEA face high electricity costs, which affect their competitiveness. Forty-two percent of the surveyed producers flag this as the main challenge, followed by service quality (36%) and supply restriction (18%). Only 8 percent of firms consider electricity access quality to be very good. As a result, nearly half of the firms have implemented or are considering additional energy sources, especially in Catamarca, Jujuy, and La Rioja, three provinces with high solar photovoltaic generation potential.

Infrastructure modernization and the development of renewable energy are essential in both NOA and NEA and will require collaboration between the government and the productive sectors and among the provinces. Across The Norte Grande, there is a need to ensure transformation capacity and correct sizing of high voltage networks to guarantee service quality and to leverage the productive sectors' potential to generate energy through biomass as part of their value chain, particularly in the forestry and sugar industries. In NOA, the incorporation of renewable energy projects needs to be accompanied by an expansion in transmission capacity, while in NEA the priorities include the completion of the gas supply infrastructure projects, the utilization of renewable energy growth, and optimized dispatch with Yacyretá.

Digital connectivity is the other limitation that needs to be addressed to derive the full benefits of improved transport. It is critical to ensure efficient production and to improve the quality transport and logistics services, including continuous traceability of cargo while en route to destination. The Norte Grande's digital connectivity penetration rates, coverage, and quality of service are below the national average, both for mobile and fixed broadband. Few of the surveyed firms in priority value chains have good mobile connectivity: 61 percent of firms have poor-quality fixed broadband services, and only 22 percent have a stable mobile broadband service on the routes used to transport cargo. Specific investments are needed to ensure 4G access beyond the vicinity of the national roads. Formosa, Chaco, and Santiago del Estero are priority provinces for expanding broadband access, while the need to improve downloading speed is most urgent in Santiago del Estero, La Rioja, and Jujuy. Moreover, comprehensively addressing the Norte Grande's digital gaps will require more than just better infrastructure; further analysis is needed to better understand the needs of actors along the value chains in terms of digital skills and access to digital devices.

Finally, while identification of the investments needed in key nodes in the network (cities) connected by the Norte Grande's economic corridors is beyond the scope of the current study, it is clear that gaps remain, and regionally coordinated investments in local public goods could amplify the welfare gains of investments in connectivity.

Although many of the identified priority interventions can be addressed at the provincial level, several will need to be handled by national level entities. These include the policies needed to improve the conditions for competition in the transport services markets (further liberalizing trucking service provision and implementing railway open access), the rehabilitation and maintenance of strategically important national roads, and the improvement of the electricity transmission and mobile broadband infrastructure.

Box 1: *Tools developed to help prioritize investments, with applicability in other regions and countries*

1. Spatial tools and a cross-sectoral survey to identify connectivity gaps

Road condition: To estimate the condition of the provincial road network, the study leveraging open-source, satellite imagery, and machine learning, in collaboration with a specialized firm and in continuous technical collaboration with the National Roads Directorate (DNV). The analysis combines free Sentinel-2 optical imagery and Sentinel-1 SAR radar images with ground-truth data from NOA, allowing to compute a qualitative condition index using a machine learning algorithm. Given the cost-free nature of the data, the analysis could be repeated in a few years to track condition over time.

Road climate vulnerability: Also working with the DNV and integrating official data on the primary network with open-source datasets to better capture the vast tertiary network, the study developed a simple tool to help prioritize the segments of the unpaved roads that should receive particular attention due to their topographic and rainfall characteristics. The resulting Topographic Wetness Index measures how a certain area is affected by stagnant water and whether it may become impassable unless targeted mitigation measures (culverts, green infrastructure, etc.) are put in place.

Survey of cargo generators and collectors: The study implemented a detailed survey of producers in priority value chains to assess the transport and logistics costs, electricity and digital connectivity needs, and mode preferences receiving answers. Summarizing the findings at the province-value chain pair, a Logistics Vulnerability Indicator (LVI) was developed – an analytical tool in Excel format that summarizes the vulnerability of the domestic transport and logistics processes of each value chain/province pair on a scale from 1 (least vulnerable) to 5 (most). The LVI is composed of 9 sub-indicators, with the data sourced from the survey responses when available, supplemented by secondary information. The weight of each sub-indicator – such as logistics costs, multimodal options, or safety – can be interactively adjusted depending on the value chain and the decision-maker's own perspective.

2. Multi-criteria analysis (MCA) to select a shortlist of transport projects

Based on the log-list of transport infrastructure priorities identified by the Norte Grande provinces, reflected in the *Logistics Strategy for the Norte Grande* (124 spatially referenced potential investments), the current study developed a MCA methodology to propose a shortlist of road and rail projects that could be expected to bring the largest socio-economic benefits for the region. The MCA – presented in an interactive Excel format that allows for adjustments in values and weights, includes four dimensions and 14 attributes. The four dimensions include: (1) the likely local or regional impact based on the demand for infrastructure services in the project's area of influence, (2) likely contribution of the works to inter-regional connectivity, (3) Institutional complexity of implementation and budgeting, and (4) relevance for climate change mitigation or adaptation.

3. Modeling tools to estimate the direct and wider economic benefits of the shortlisted projects

Transport cost model: The current study estimates the impact of the specific shortlisted road (15) and rail (5) infrastructure projects on the transport carrier costs, considering without and with project scenarios. The corresponding costs were calculated in an Excel tool by applying the Railway Cost Model (COSFER) and the Road Cost Model (MCC), developed by the National Ministry of Transportation in 2017 and 2019, respectively, and updated as part of the current study. Both models allow estimating transport operating costs based on typical operating parameters, producing results in terms of ARS and US$ per ton, km, and ton-km.

Employment impacts model: The study applied the employment model developed by World Bank (2021), based on the Input-Output Matrix (IPM) methodology, to estimate the job generation potential of the shortlisted road and rail investments, including direct, indirect, and induced jobs. The IPM shows the interrelationship between activities, allowing to estimate the impact of the increase in aggregate demand of one sector on the rest of the sectors of the economy and to compute the change in employment because of the increase in production. The Excel format of the model allows changing the assumptions about the investment amounts needed and/or considering additional projects from the original longlist.

Wider economic impacts model: Within the framework of regional computable general equilibrium (CGE) models, the study estimated the potential broader economic benefits from sectoral efficiency improvements resulting from the shortlisted road and rail infrastructure works, with the predicted associated transport cost reductions representing the main "shock". Given the available data, 5 models were developed – for the provinces of Catamarca, Chaco, Corrientes, Salta, and Jujuy. The models allow obtaining welfare indicators for each of these provinces as well as for Argentina overall. The indicators obtained include GDP, household welfare, and tax collection, as well as the gross value added of productive sectors in each province (distinguishing between Transport, Manufacturing, Agriculture, Mining, and Other). Additional models – covering the other 5 provinces of the region or considering additional infrastructure works – could be developed in the future, depending on the operational priorities.

1. The Norte Grande's growth potential can be tapped by developing integrated economic corridors

Argentina has some of the lowest export and import shares of Gross Domestic Product (GDP) in the LAC region, partly due to significant transport and logistics gaps. The country's relative logistics performance has declined over the last two decades compared to other countries in the region. According to the World Bank's Logistics Performance Index, Argentina went from being the second-best country in Latin America in 2010 to ranking below Mexico, Chile, Brazil and Colombia in 2023. Moreover, Argentina is among the countries in LAC with relatively inefficient transport networks (e.g., roads not connecting strategically important areas or with capacity that does not correspond to the demand), with this misallocation associated with annual welfare losses of between 1.9 and 2.5 percent (Gorton and Ianchovichina, 2021).

Argentina's economic activities are highly concentrated in Buenos Aires and the central and coastal areas. More than a third of the population lives in the Metropolitan Area of Buenos Aires, which also contains approximately one third of the nation's firms (World Bank, 2021a). While most of the firms are microenterprises, 51 percent of the private employment is generated by large firms. Services dominate GDP, accounting for about one half, and there is high contribution of non-tradables to employment; the share of services in GDP is lower (39 percent) albeit growing in northern[3] Argentina specifically – in the provinces of the Norte Grande. Services in the northern regions also include tradables, and strong services sector growth has likely been driven by the surge in tourism.

The Norte Grande is home to 10 million people (CFI, 2023) and has the highest poverty incidence in Argentina, reaching 25.4 percent in the Northwest (NOA) and 33.2 percent in the Northeast (NEA) (World Bank, 2020a). The share of households with unmet basic needs exceeds one-fifth in most of NOA although is slightly lower on NEA. On the other hand, NEA concentrates a larger absolute number of such households, especially in the Province of Formosa. Despite experiencing rapid urbanization in the past two decades, the North's contribution to national GDP is still well below its population share. Firms in Argentina are mainly local and small, and firm density is particularly low in the Norte Grande, with just 6 firms per 1,000 inhabitants in both NEA and NOA, and there is a dominance of microenterprises that do not graduate to higher size groups.

Specialization in the North is weak and becoming weaker over time, pointing to connectivity challenges that translate into high logistics costs. Logistics cost for the northern regions has been estimated to be up to 50 percent higher than in the neighboring Center and Cuyo regions (World Bank, 2016), although the logistics costs from the shippers' perspective are not well documented at the value chain and/or corridor level. The Norte Grande accounts for approximately 15 percent of the country's road and rail freight transportation. The region has lower road density than the national average, and only 31 percent of the combined national (91%) and provincial (19%) road network is paved (CFI, 2023), suggesting that these provinces are relatively poorly connected internally to facilitate local-level trade, scale, and specialization[4] (World Bank, 2020a). Rural roads – representing "last mile" links to key production zones – have deficiencies or are in poor condition, limiting market access and social inclusion. In the Norte Grande, as in other parts of Argentina, state-of-the-art trucking service levels coexist with segments of high informality, corresponding to the load providers served.

The Norte Grande rail network is nearly 10,400 km long; however, just 4,100 km are operational, and of these 39 percent in poor or fair condition (CFI, 2023). Several bottlenecks hinder railway development and their role in serving economic activity poles: the poor state of the infrastructure, leading to low speeds and frequent derailments, mainly in the "sugar" corridor, which results in poor wagon rotation; lack of cargo concentration centers; and lack of a clarity for the implementation of open access, generating uncertainty for potential private investors (World Bank, 2023a). Considering that rail is more competitive for transporting freight over long distances, it is expected that the most

[3] The Northwest (NOA) includes the following provinces: Catamarca, Jujuy, La Rioja, Salta, Santiago del Estero, and Tucumán. The Northeast (NEA) includes Formosa, Chaco, Corrientes, and Misiones.

[4] The Norte Grande provinces with particularly low specialization (according to 2016 data) are Catamarca, Jujuy, Tucuman, and Misiones. Formosa is the only province in the region with a relatively high specialization index (World Bank, 2020a).

significant potential of the freight railway system lies in the Central, Western, and Northern regions that have a higher proportion of productive zones located more than 200 km from the destination ports, making rail transport a more viable and efficient option. The port system of the Norte Grande along the Parana and Paraguay rivers has high idle capacity together with numerous projects in execution, many of which compete to serve the same hinterland (CFI, 2023).

The Norte Grande is also one of the most disadvantaged regions in terms of access and quality of digital connectivity. For example, while the City of Buenos Aires has 122 fixed broadband access points per 100 households and an average connection speed of 182.9 Mbps; Formosa has a penetration of 39.4 access points per 100 households and an average connection speed of 72.0 Mbps, and in Jujuy the respective figures are 58.5 and 39.3 Mbps (ENACOM, 2022).[5] Moreover, the connectivity quality gap between rural and urban areas is almost 70 percent. This translates into gaps in the adoption of digital technologies and practices between companies and industries in different regions. The digital connectivity gaps not only affect actors along the value chain of priority goods but also present one of the main obstacles for the functioning of the Norte Grande's international border crossing points given the importance of digital connectivity for moving towards a paperless document management system, thus hindering the region's external trade and the economic development of Provinces with more externally oriented current and prospective value chains. Internet access gaps are also identified in the Norte Grande's airports, where it is essential in the cargo handling areas for cargo registration, tracking and management (CFI, 2023).

The above infrastructure and service gaps in the Norte Grande affect the competitiveness of many value chains of great importance to Argentina. Most of the minerals, regional products and grains that the country produces for consumption in domestic and foreign markets are produced in the Norte Grande. The region produces nearly 90 percent of the country's sugar, vegetables, lemons and yerba mate. It accounts for approximately half of the production of olive oil, olives and wine. In addition, its contribution to grains such as soybeans and corn complements production in the central region. With a strong mining presence, the NOA generates all of Argentina's lithium exports and has gold and silver production projects. In addition, the copper sector holds significant potential for economic growth, with the expansion in global demand driven by the energy transition and electrification trends. With several advanced projects potentially starting before 2030, the sector could reach export levels comparable to agriculture.

Economic corridors can be effective drivers of growth and development. Transportation corridors physically connect areas of a region, while economic corridors – or development corridors in their most advanced stage – integrate the region's economic activities. The transport corridor is the backbone of the economic corridor: it broadly defines the geographic space of the corridor and facilitates the flow of goods and services. Production centers produce goods both for consumption in the surrounding region and for international trade. Cities connected by the corridor represent important markets for consumption and also provide a critical source of labor, technology and innovation that is necessary to drive economic growth (Mitra *et al*., 2016). In the case of Norte Grande, most cities of significant size in the Norte Grande are "consumption cities", characterized by a disproportionately low employment share in the production of urban tradable goods, instead, mostly engaged in non-tradable activities such as retail and wholesale trade, construction, and personal services (Jedwab, Ianchovichina, and Haslop, 2022). A few cities, such as the capitals of Salta and Jujuy, are "neutral cities", with a moderate share of employment in urban tradables.

Economic corridors need a comprehensive approach to be successful, to ensure that development is not only concentrated in the large cities along them, such as the capital cities of the Norte Grande provinces,[6] but that investment and economic development spread to areas in the broad vicinity. In the more manufacturing oriented economic corridors, the main benefits accrue from economies of scale, knowledge spillovers, and the linking of complementary value chains to be able to produce higher value-added goods. Similarly, the development of agriculture production focused economic corridors ("agricultural corridors") is motivated by the fact that the economic benefits from developing integrated transport, logistics, and services will be greater in areas where they will serve a critical mass

[5] Data on downloading speeds may have a certain degree of bias, particularly in rural areas. Gor example, people with high digital skills may know more about the speedtest tool and have better connectivity.

[6] In five of the ten provinces – Chaco, Corrientes, Misiones, Salta, and Tucuman – the population of the capital cities in 2020 well exceeded one million inhabitants. The smaller provincial capitals, such as of La Rioja and Catamarca, have populations below half a million.

of producers. The introduction of such value-added services can also provide a first step for low-productivity family farms to shift to more market-oriented production. Examples from outside Argentina highlight the potentially significant socio-economic benefits of economic corridors as a lens through which infrastructure and policy priorities are framed. For example, in the Greater Mekong Subregion in Southeast Asia, which adopted the economic corridor approach in the late 1990s, intra-regional merchandise trade increased nearly 20 times between 2000 and 2017, and poverty reduction was particularly significant in the previously less well-connected countries (Stokenberga, Lancelot, Aguilera *et al*. 2022).

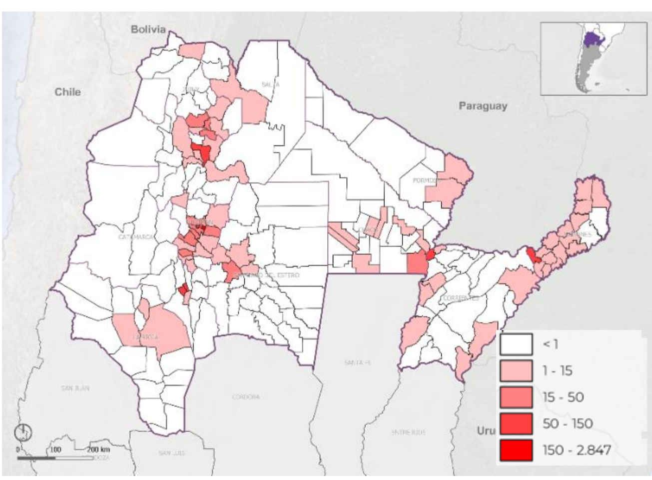
This study aims to identify key economic corridors across the Norte Grande and the transport infrastructure and logistics investments and policies that can support these corridors in a green and resilient manner. Secondly, it develops a set of tools to estimate the expected economic benefits from the specific proposed investments. Finally, with a view towards spatially coordinated "infrastructure bundles" rather than isolated investments, the study also identifies complementary interventions in electrification and digital connectivity that could amplify the benefits of transport and logistics investments.

2. The Norte Grande's economic activity is mostly concentrated along a few major transport routes

2.1. Current economic activity is concentrated along a few North-South and East-West axes

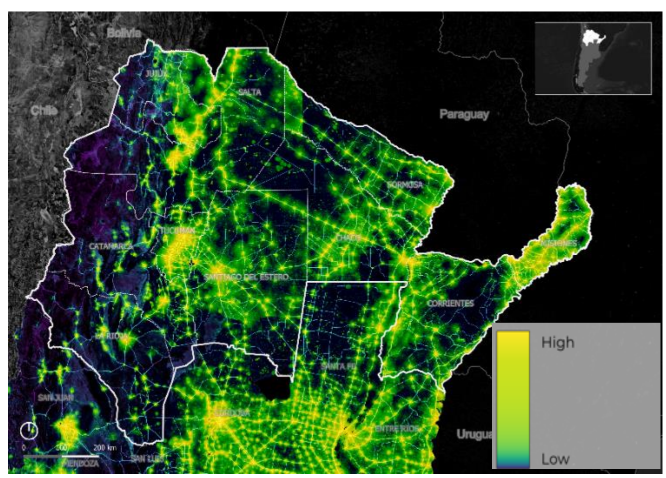
The provinces of the Norte Grande account for between 0.4 percent (Formosa) and 2.7 percent (Tucumán) of Argentina's overall registered employment.[7] Similarly, the shares of the provincial GDPs in the country's overall GDP reach at most 2.1 percent (Tucumán) but are as low as 0.6 percent (La Rioja). Overall employment density per land area suggests a few broad, spatially contiguous economic activity "poles" or corridors, namely (1) stretching from eastern Salta south to Tucumán and further to northern La Rioja and western Santiago del Estero; (2) eastern Chaco and Formosa; and (3) encompassing a large share of both Misiones and Corrientes. Formal registered employment is more narrowly concentrated in the first of these, with less continuous density in the other two (Figure 3). In large parts of the Norte Grande, especially in western Salta, Jujuy, and Catamarca and in most of the central part of the region, employment density is below 1 per km^2.

Figure 3: *Registered salaried employment per km^2 is concentrated in a few distinct corridors**



*Excludes self-employed and informal workers
Source: Own elaboration based on Open Data from the Ministry of Productive Development (2022)

Figure 4: *Clusters of higher population density (2020) also align along major East-West national roads*



Source: Own elaboration based on World Pop data

[7] https://www.argentina.gob.ar/produccion/cep/tableros-interactivos

Additional densely populated areas – key centers of demand, skills, and labor – are found in the direct vicinity of certain major roads connecting the East to the West of the region, such as the National Road (NR) 16 between Corrientes, Chaco, northern Santiago del Estero, and Salta, and NR81 stretching across the province of Formosa, from Salta to the border with Paraguay (Figure 4). As already mentioned, in some provinces such as Salta and Tucumán, much of the population is concentrated in the capital cities (Ciudad de Salta and San Miguel de Tucumán, respectively), with population exceeding a million inhabitants, while population density is low in large parts of the remaining area. San Miguel de Tucumán is the only city in the Norte Grande that is also among top five cities in the country; the capitals of Santiago del Estero, Salta, Jujuy, Chaco, Corrientes, and Misiones are characterized as large cities, while the capitals of Formosa, Catamarca, and La Rioja are small cities (Muzzini, Eraso Puig, Anapolsky, *et al*., 2017). Individual secondary cities, such as Perico, are emerging as industrial nodes.

There are differences across provinces on the extent to which internal connectivity (within-Province) or external linkages (from the province to the rest of Argentina and to external markets) should be developed, depending on the importance of internal vs. external cargo flows. In 2016-2021, the Norte Grande exported 10.25 million tons per year, on average, valued at US$ 5.19 billion FOB, with no clear growth pattern. Exports in 2021 were dominated by basic commodities: maize (31 percent of volume), solid sub-products of soy (22 percent), and wheat (9 percent). Much of the export volume, although less value, was concentrated in the Province of Santiago del Estero, followed by Salta and Chaco. Exports originating in Formosa, La Rioja, and Catamarca were the lowest, at less than 150,000 tons and US$200 million per year each.

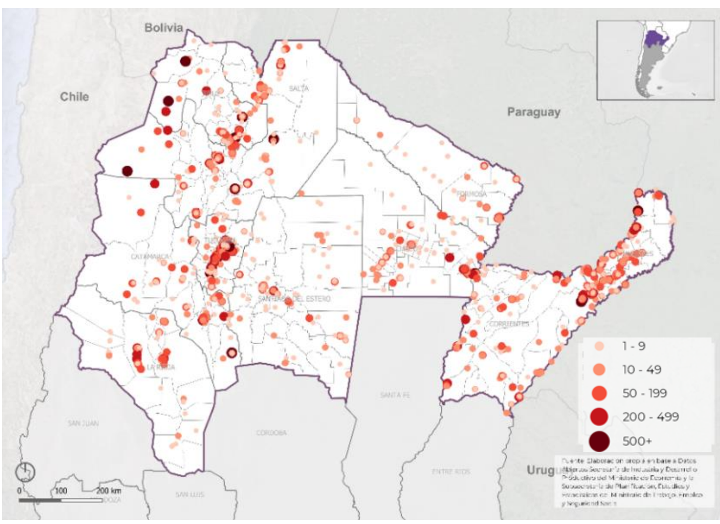


***Figure 5:** Exporting firms concentrate in the same areas as registered employment; additional large firms cluster in the mining areas*

Source: Own elaboration based on Open Data from the Ministry of Productive Development and Ministry of Work, Employment, and Social Security

The Norte Grande's exporting firms are concentrated in areas corresponding to high density of formal employment; however, among them, the largest individual employment generators are in the mining areas – in western Jujuy and Salta – quite distant from the main economic activity poles of the region. Export-oriented firms, even where present, are comparatively smaller in Chaco, Formosa, and most of Santiago del Estero (Figure 5).

In terms of domestic cargo, 22.15 million tons are shipped within the Norte Grande and another 31.97 million tons from the Norte Grande to the rest of Argentina; 47 percent of the domestic cargo originating in the Norte Grande is general cargo, and another 33 percent is solid agricultural bulk (CFI, 2023). The spatial patterns of domestic market focused firms are even more closely aligned with the overall population patterns as compared to those of the export-oriented firms. The largest domestic market-oriented firms are concentrated in Tucumán, eastern Salta and Jujuy, and Misiones; smaller ones concentrate along NR16 and NR81.

The spatial characteristics – planted area and production volumes – are distinct depending on the specific value chain. For example, cotton, beans, soy, and sugar are primarily grown in the central regions of the Norte Grande, and forestry products and Yerba in Corrientes and Misiones. Wine and olive production takes place in southwestern Norte Grande (La Rioja, Catamarca), while lithium and copper mining is distributed across the western part of the region

(Catamarca, Salta, Jujuy). The production of oranges, citrus, and beef is more spread out, with several different high-intensity areas (Annex 1). The overall aggregated density of production across the priority value chains is approximately aligned with the employment density patterns discussed earlier.

Lithium is one of the sectors that can bring economic benefits for the Norte Grande. Lithium-ion batteries are essential for electric vehicles and renewable energy storage, and decarbonization ambitions globally are increasing demand and prices, given the vital role electric mobility and energy storage will play to reach Net Zero targets for 2050. While production projects in the lithium-rich provinces in NOA (Salta, Catamarca, and Jujuy) are at an early stage, the recently completed Argentina Country Climate and Development Report (CCDR) finds that the lithium value chain could become a growth driver for the country and, especially, for NOA. The country's lithium resources represent 22 percent of worldwide resources but only 6-8 percent of global production. While only two projects are operating at an industrial scale, many more are in construction and planning stages, with the expectation that lithium carbonate exports could increase up to 5-fold in the next decade.

In addition, the Taca Taca copper mine in western Salta, expected to start producing copper concentrate in 2026, will generate a total traffic volume (inputs and outputs) of 1.35 million tons per year by 2028, vastly exceeding the total volumes that are expected from the lithium projects in the NOA. In total, production and input volumes expected to be transported to and from the copper, silver, gold, zinc, and lead mines in NOA are expected to increase from just over 8,500 tons in 2022 to about 1.15 million tons from 2030 onwards. Including lithium inputs and outputs, the total volume of mining goods transported to and from NOA will increase nearly ten-fold between 2022 and 2030. These expectations also drive the predicted cargo volume distribution in the coming decades,[8] with certain parts of the NOA region expected to generate significant flows compared to the rest of Norte Grande and compared to present.

2.2. Production in priority value chains tends to be spatially and economically concentrated

In May-July, 2024, the current study conducted a survey of cargo generators in the value chains prioritized by the Norte Grande provinces in their work with the Federal Investment Council in 2022-2023 (see CFI, 2023) to understand their spatial structure as well as the distinct transport and logistics costs, perceptions of the availability and quality of transport and logistics services, and digital connectivity and electricity access needs.

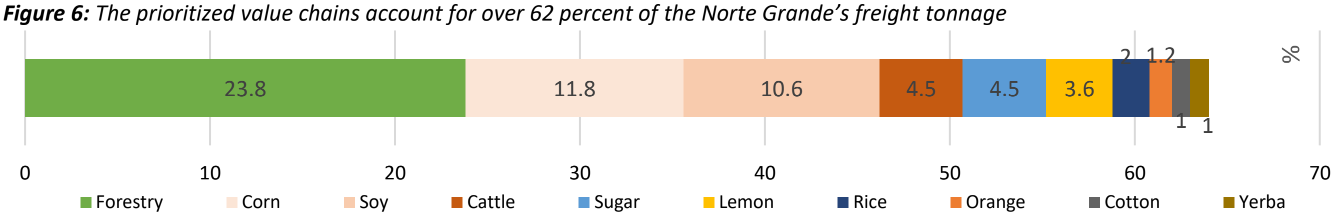
In several of the value chains, the Norte Grande contributes a significant portion of Argentina's overall cargo. Almost all the country's sugar and lemon production takes place in NOA (Tucumán, Jujuy, and Salta). These activities revolve around large vertically integrated companies along the entire chain. Sugar industrial activity is concentrated among 8 economic groups, owners of the country's 20 sugar mills, integrated in distilleries and bioethanol production plants. In lemon production, 4 companies contributed 50 percent and 7 industrial plants processed 70 percent of production in 2022 (Secretariat of Agriculture, 2023). Catamarca and La Rioja contribute half of the country's olive and oil production, and, together with Salta, 7 percent of grape and wine production. More than 80 percent of the cotton in the Argentine textile chain is produced in Chaco and Santiago del Estero. Misiones produces 90 percent of Argentina's yerba mate, while the rest of the activity takes place in northeastern Corrientes. These provinces also account for two thirds of the national exploitation of planted forests. Extensive grain chains – soybeans, corn, legumes, and rice – are the second largest cargo generators in the Norte Grande. The Norte Grande contributes 15 percent of the country's soybean and corn production and 25 percent of sorghum production. The NEA provinces produce almost half of the country's rice, while bean production is heavily concentrated in NOA. Finally, the Norte Grande holds 22 percent of the country's cattle stock and produces 10 percent of the country's beef.

An initial characterization of the 16 priority value chains in terms of their importance, spatial and economic structure, and market orientation allowed prioritizing the firms to be surveyed, by province and value chain. The 16 prioritized production chains contribute more than 62 percent of the road freight originating in the Norte Grande (Figure 6) and represent 22 percent of the region's GDP. The total share of cargo represented by these value chains ranges from 9 percent in Catamarca and 33 percent in Salta to 83-84 percent in Misiones and Santiago del Estero. Individual value chains represent a particularly high share of the total provincial cargo loads, such as livestock in Formosa and La Rioja

[8] World Bank (2023a), focusing on the NOA provinces of Salta, Catamarca, and Jujuy, updated the freight origin-destination matrix for Argentina overall to 2021 and predicted it to 2045 based on the expected increase in lithium, other mining, and agricultural production activities.

(23 percent and 20 percent, respectively), soybeans and corn in Santiago del Estero (34 percent and 43 percent, respectively) and Salta (10 percent and 13 percent), sugar in Jujuy and Tucumán (20 percent and 27.7 percent), lemon in Tucumán (24.9 percent), wine in La Rioja (23.1 percent), and forestry products in Formosa, Chaco, Corrientes, and Misiones (20 percent, 31 percent, 50 percent, and 80 percent, respectively).

Figure 6: *The prioritized value chains account for over 62 percent of the Norte Grande's freight tonnage*



Source: Own analysis based on the Origin-Destination freight matrices (2018) prepared by the National Ministry of Transportation

The spatial concentration is higher in the rice, bean, cotton, sugar, lemon, wine, olive, yerba mate, forestry, and mining value chains and lower in the case of cattle breeding, grains, and oranges. For example, Corrientes represents 88 percent of the rice originating in Norte Grande, and Misiones – 86 percent of the Yerba mate. Santiago del Estero accounts for much of the soy, corn, and sorghum (55 percent, 62 percent, and 42 percent, respectively). La Rioja concentrates most of the region's olive and wine production; Catamarca and Jujuy currently represent all the lithium production (62 percent and 38 percent, respectively).[9]

Table 3: *There is high spatial concentration in most value chains; economic concentration is higher for export-oriented value chains*

Value chain	Share in total cargo tonnage originating in Norte Grande	Spatial concentration	Economic concentration (primary stage)	Economic concentration (processing stage)	Share of production exported
Lithium	0%	High	High	High	100%
Copper	0%	High	High	High	~100%
Grains	22.4%	Low	Low	Low	70-90%
Olives	No data *	High	Medium	High	80%
Beans	No data *	High	High	High	75%
Lemon	3.6%	High	High	High	70%
Rice	2%	High	Medium	High	>50%
Orange	1.2%	Low	Medium	Medium	50%
Cotton	1%	High	Low	High	50%
Wine	0.1%	High	Medium	Medium	25%
Sugar	4.5%	High	Medium	High	19%
Forestry	23.8%	High	High	Low	10%
Yerba mate	1%	High	Low	Medium	10%
Cattle	4.5%	Low	Low	Medium	5%

*The 2018 Origin and Destination Matrices do not present disaggregated data on tons transported of beans and olives.

Source: Own elaboration based on Origin and Destination of Cargo Matrices of 2018 prepared by the National Ministry of Transportation.

The priority value chains include several stages: primary production in farms, industrial processing, and transportation to consumption and export centers. With some differences, the primary stages are highly atomized, with heterogeneity in terms of size and technology. In general, producers in the primary links tend to be smaller in scale and more atomized than stockpilers or industrial producers, except in chains with a high level of vertical integration (such as lithium, sugar, lemons).

The industrial processing stages in most value chains are concentrated in a few economic groups, some vertically integrated. While some products are processed in the region, others are stockpiled in the region and then transported for industrialization in the central part of the country or as raw exports (such as soybeans, sorghum, and corn). Thus,

[9] Maps of production intensity of each priority good are shown in Table X in Annex 1.

there is evidence of two-stage transportation in all the value chains: short freight from primary production facilities to collection or processing centers, and short or long freight from there to consumption centers or export ports.

The priority value chains also differ in the degree of export orientation. Only 14 percent of road cargo and 17 percent of rail cargo from the Norte Grande remain within the region, while the rest travels to other provinces in Argentina and is exported to external markets. In the case of the priority value chains, export orientation is the highest in the case of the mining goods (lithium and, in the future, copper), grains, olives, and beans, where it exceeds 75 percent of all production. In contrast, much of the cattle, forestry products, sugar, and wine originating in the Norte Grande is consumed domestically. In the case of grains, some of the production is exported as raw grains and some after processing. Rice is exported either as brown or white rice.

These characteristics allowed prioritizing the targeting of the survey on the ground. Given the anticipated difficulties with ensuring a high response rate, the survey primarily targeted producers in value chains that account for a high share of cargo originating in each province and in the provinces with the highest share of each chain's cargo flows. The targeting also aimed to ensure that both domestically and export-oriented firms are surveyed to identify their specific transport and logistics priorities. A separate survey focused on grain cargo collectors – actors that are users of transport and logistics infrastructure and services through their role in the reception, storage, and shipment of loads.

Of the 148 contacted firms, responses were received from 62, including 52 producers and 10 grain collectors. Grain collectors are part of the grain chain, operating as intermediaries between primary producers and markets and working with thousands of atomized producers in the region: they concentrate a large share of the grains produced in approximately 2,800 soybean farms, 19,900 corn farms, and 490 sorghum farms.[10] By province, the number of responses range from 1 (Misiones) to 13 (Corrientes) and cover a large number of districts in the Norte Grande (see Annex 1). By value chain, they range from 2 (beans) to 9 (olives). The surveyed grain collectors are in eastern Salta, western Chaco, Tucumán, and Santiago del Estero.

Responses were obtained for all the target provinces and in 14 of the 16 prioritized chains. The only chains for which there were no responses were copper, since they are not yet in production,[11] and lithium, due to the firms' concerns with sharing confidential information. To complement the survey data, *s*ectoral chambers[12] and public officials were contacted to hold further discussions.

The firms that responded range in size from small firms with up to five employees to major players in the sector with over 100 employees, such as in the sugar, grain production, olive, and Yerba mate value chains. Almost half correspond to establishments with between 25 and 100 employees. The respondent firms' production volume in 2023 ranged from less than 1 ton to 380,000 tons, with an average of 24,743 (nearly identical among the NOA and the NEA cargo generators). Among the wine producers, production ranged from less than 300 liters to 1.8 million liters. Among the responding grain collectors, the volumes moved averaged 163,097 tons per firm, although individual firms report having moved about half a million tons. Together, the respondent grain collectors in 2022-23 moved 16 percent (~2.5 million tons) of all the extensive grain cargo produced in the Norte Grande. It is important to clarify that, because the Norte Grande is an important producer of livestock, a significant share of the sorghum and corn is consumed within the region (auto-consumed).

The origin of production inputs is mainly national: 52 percent of cargo generator firms indicated that their main inputs originate in other Argentine provinces and 37 percent in the same province where they produce; only 12 percent indicated that they import their inputs. The share of firms that source their primary input domestically is slightly higher among the NOA firms than NEA firms; NOA firms are also more likely to source the input directly from within the

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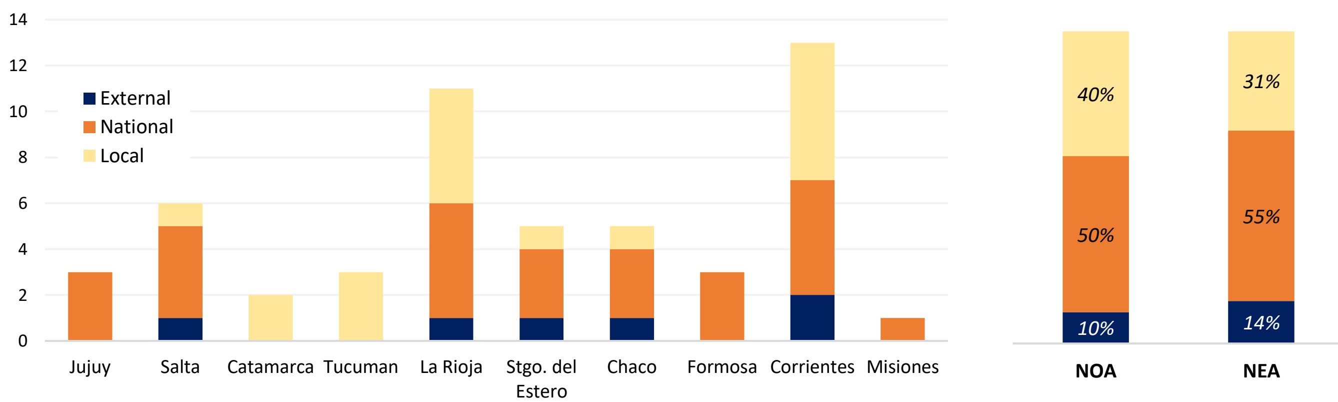
[10] According to the National Agricultural Census (CNA) conducted by INDEC in 2018, agricultural and livestock farms (*explotaciones agropecuarias*, or EAP) are production units of agricultural, livestock or forestry goods destined for the market with an area of at least 500 m2. More than one crop may be grown in each EAP; therefore, the sum of EAPs per crop may be greater than the total number of EAPs in the Norte Grande region.

[11] Even so, a semi-structured interview was conducted with the firm First Quantum Minerals (in charge of the Taca Taca project located in the Salta highlands), in which questions related to the prospects of the project and the sector, and its needs and possible future bottlenecks were addressed.

[12] Cámara Industriales Arroceras, Cámara Algodonera Argentina; Federación Argentina Industria Maderera y Afines (FAIMA) – forestry; Argentine Forestry Association (AFOA - Corrientes & Misiones) – forestry; Government of Salta and provincial chambers (mining - agriculture - sugar); Registry of gatherers and dismantlers – cotton; Chamber of Rice Industries – Rice; Chamber of Sugar Industries - Ledesma – Sugar; Taca Taca (mining project) - Copper

province (Figure 7). Local inputs predominate in the case of the surveyed cargo generators in Catamarca and Tucumán; in contrast, the firms based in Formosa, Jujuy, and Misiones all firms report other Argentine provinces as the origin of their key inputs. Only in the case of Chaco, Corrientes, La Rioja, Salta, and Santiago del Estero are there firms for which the primary inputs are imported from abroad.

Figure 7: *For most Norte Grande producers, primary inputs are sourced from within Argentina*



Source: Own elaboration based on original survey

Cargo destinations are concentrated in the provinces that host the major domestic consumption centers and the country's main port hubs: Buenos Aires (35 percent) and Santa Fe (32 percent), distributed between Rosario (in the province of Santa Fe) and the city of Puerto San Martin (about 30 km from Rosario). The province of Corrientes is the primary domestic destination of goods for 8 percent of the surveyed firms, including for local consumption and exports abroad.

3. Supporting productive sectors requires addressing both transport infrastructure and service gaps

3.1. Cargo traffic tends to concentrate on a few routes connecting production areas to domestic and international markets

Argentina's freight transport matrix shows an excessive dominance of road transport. The country has more than 500,000 kilometers of roads (national network and secondary and tertiary networks, including dirt roads), almost 30,000 kilometers of railroads (of which 53 percent are operational), and 100 ports. However, in the modal distribution of freight transport 88 percent corresponds to road, with rail representing 4 percent of total tonnage per kilometer and maritime transport 8 percent (World Bank, 2023a). The Norte Grande accounts for approximately 15 percent of the country's road and rail freight transportation.

Similar patterns are observed specifically in the Norte Grande and among the surveyed priority cargo generators. In most value chains, production is transported entirely by truck, except for grains (soybeans, corn, and sorghum), sugar, and some other individual products that use rail or river transport in minor proportions (75 percent of production is transported by truck to storage centers, ports and industries in the central zone, 20 percent by railroad, and only a marginal portion by river from the ports of Chaco). The grain collectors use rail transport more than the producer firms. Refrigerated trucks are used by some producers, such as to transport lemon, while container trucks are used to transport beans. In NOA, 76 percent of the surveyed firms (producers and grain collectors) rely exclusively on trucks, while the remaining 24 percent combine road and rail transport. Companies operating in grain collection are the ones that use rail the most. In NEA, the share of firms who exclusively use trucks to transport their production amounts to 84 percent. Only the remaining 16 percent combine road and rail transport. The lower proportion of rail use in the NEA can be explained partly by lower rail coverage and by a lower presence of grain chains. Finally, while not yet operational, all planning for the Taca Taca copper mining project about 50 km from the Chilean border considers exports entirely through Chilean ports (mainly Mejillones but also Antofagasta) by rail.

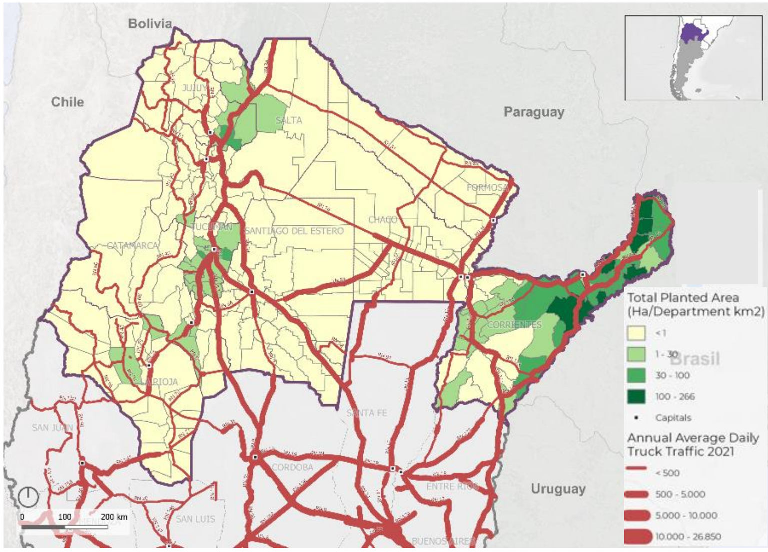
The most critical transport corridors per province and value chain are determined largely by their market orientation. The national roads connecting NOA to the port of Rosario are critical for the producers of soy, corn, sorghum, sugar, lemon. Rosario is also the destination for all the surveyed grain collectors, the specific destinations located withing the 40-km stretch from Arrollo Seco all the way to Puerto San Martin; the region is also home to the largest soybean crushing plants in Argentina. The roads connecting NOA and NEA to Buenos Aires are key both for exports and domestic consumption/ processing (Table 4).

Table 4: *The priority value chains in Norte Grande tend to use common routes to access domestic and external markets*

Value chain	Processing or consolidation centers	Main mode	Transported products	Main routes used
Lithium	Lithium carbonate, chloride, and hydroxide plants	trucks (containers)	Soda ash (input), liquid brine, lithium carbonate and chloride	Catamarca – Salta for production of chloride and exports (via Chile); Jujuy – Buenos Aires for exports
Grains	collection centers in Norte Grande; processing plants in Rosario	truck; for soy, rail (20%) and fluvial (3%) transport also used	soybeans, corn, sorghum	NOA - Rosario
Beans	sorters	truck (containers) (90%), rail (10%)	legumes	NOA – Buenos Aires/ Zarate; NOA – Iguazu for exports to Brazil
Lemon	processing and packaging plants	refrigerated truck for fresh fruit and juice; container truck for oils	lemon and derivatives	NOA – Buenos Aires/ Rosario, mostly to export to the U.S.
Olives	Oil mills, olive processing centers	truck	olives, oil	Olives: NOA – Buenos Aires for distribution in domestic market and NOA – Iguazu for exports to Brazil Oil: NOA – Buenos Aires/Iguazu for exports; NOA – Rosario for fractioning
Rice	dryers, mills	truck	bagged rice	NEA – Buenos Aires for exports/ consumption; intraregional for exports via Las Palmas or Iguazu
Orange	processing and packaging plants	truck	oranges	Corrientes-Entre Rios for processing; NOA – Buenos Aires for exports; intraregional (to hub markets)
Wine	wineries	truck	grapes, bottled wine	Cafayate/Chilecito – Buenos Aires
Sugar	sugarcane mills; bioethanol plants	truck (94%), rail (6%)	sugar, bioethanol	NOA – Buenos Aires for internal consumption and exports; NOA – Rosario for exports
Forestry	sawmills	truck	logs, sawmill products	NEA – Buenos Aires
Yerba mate	drying centers, mills	truck	Yerba mate	Obera – Buenos Aires; intraregional for local consumption
Cattle	Slaughterhouses, cold storage	truck	meat	NOA – Buenos Aires for exports; intraregional for domestic consumption
Cotton	ginning, spinning, and weaving mills	truck	cotton fiber, spinning and weaving products	Intraregional (from point of production to ginning/ spilling/ weaving center); NOA – Buenos Aires to produce clothing

Source: Own elaboration based on an original survey of producer and grain collector firms and interviews with sectoral chambers

Figure 8: Annual Average Daily Traffic (2021) is more intense on roads crossing districts with high intensity of agricultural production

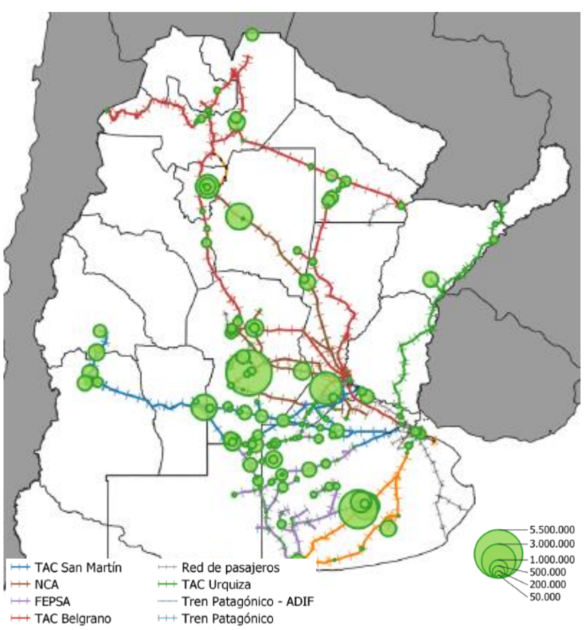


Source: Own elaboration based on CFI (2022/2023) and data from DNV

Accordingly, while the traffic levels on the Norte Grande road network are low, traffic pressure is higher on specific segments (Figure 8). These include, for example, NR9 in Jujuy and Tucumán in NOA and RN12 in NEA that connects Corrientes with other regions. A key point in this network is the General Belgrano Bridge, which links Corrientes with Chaco, significantly improving the flow of goods and people. Spatially, the mining and the other sectors do not directly overlap; however, they do share some of the main access corridors to gateway ports (World Bank, 2023a).

The provinces of the Norte Grande have access to rail transport through the active branches of the Mitre, Belgrano and Urquiza lines. Key origins of rail cargo, exceeding 1 million tons, are in Tucumán and Santiago del Estero (Mitre and Belgrano lines); Corrientes, Chaco, and central Salta have several additional origin points that generate at least 200,000-500,000 tons (see Figure 9). Generally, traffic flows are very unbalanced, with much of the return traffic returning empty (Sant, 2024).

Figure 9: The most important rail cargo origin points (2022) are in Santiago del Estero and Tucumán



Source: Sant (2024)

The Belgrano and Mitre lines serve significant grain and sugar flows, such as between Salta and Jujuy and the port of Rosario. Trains to Rosario use the renovated Belgrano line "cereal" branches (1,670 km) that were financed by the China Machinery Engineering Corporation (CMEC), the Latin America Development Bank (CAF), and the National Treasury. Products such as sugar and general cargo destined for Buenos Aires use the conventional route of the Belgrano line's "sugar corridor" (branches C, C15, and CC) that crosses Salta, Jujuy, Tucumán, Catamarca, Córdoba, Santa Fe, and Buenos Aires and that still awaits renovation (World Bank, 2023a).

Finally, there is "circular traffic" between the provinces of Chaco and Jujuy, with cement transported from El Carmen (Jujuy) to Resistencia (Chaco) and wood and thinning shipped from Chaco to (Palpalá). Currently only 12,500 tons per year are transported on the C13 and C14 mining branches, mainly within the Province of Salta (traveling a distance of about 260 km).

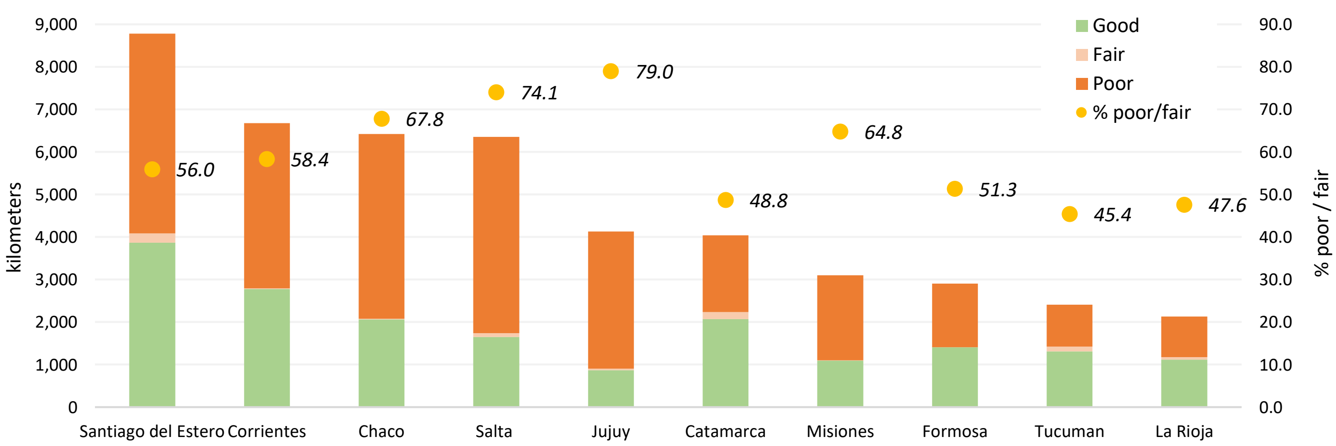
3.2. Most provincial roads are in poor condition and many roads are vulnerable to climate risks

The main roads in the Norte Grande are under national jurisdiction, of which approximately 95 percent are paved. However, a few stretches, such as NR40 in Jujuy and NR51, remain unpaved, which limits their functionality. Most of the routes are single carriageway roads (95 percent of the paved sections). Routes with dual carriageways are concentrated in strategic areas, such as NR14 in Corrientes and NR16 (Resistencia to Makalle).

There is no up-to-date, comprehensive information on the condition of the overall road network, especially for the provincial network or more minor roads. However, the National Roads Directorate (DNV) maintains a database on the "serviceability" levels of the national roads that is relatively recent (2021). To complement this data, the current study leveraged satellite imagery and machine learning methods to estimate the condition of the entire road network, focusing on the national and provincial roads that are mostly paved. The methodology[13] takes advantage of the fact that radar imagery – as obtained from the Synthetic Aperture Radar (SAR) – records a differentiated signal depending on the roughness of the surface such as of a road. In turn, the signal allows distinguishing between roads in poor and good condition based on its statistical distribution (the distinction of "fair" is less robust). The analysis focuses on the assessment of the condition of the provincial road network, given that this network lacks information on its condition, while for the national network the DNV maintains relatively recent and comprehensive records. The focus on the provincial roads is also motivated by the fact that the specific methodology has limitations for distinguishing good from fair and poor roads in the case of the national network, where the range of the International Roughness Index (IRI) corresponding to "good" condition roads as defined by the DNV is very narrow.

The analysis suggests that provincial roads are in relatively poor condition across the Norte Grande. The total length of provincial roads in poor condition is the highest in Santiago del Estero, Salta, and Corrientes, in each case exceeding 4,000 km. It exceeds 3,000 km also in Corrientes and Jujuy (Figure 10). As a share of total length, the provincial road condition is estimated to be the worst in Jujuy, Salta, and Chaco, where over two-thirds of the length of the provincial road network is estimated to be in poor condition. The highest share of provincial roads in good condition – over half of the total length – is assessed to be in Tucumán, La Rioja, and Catamarca.

Figure 10: *Over half of the total length of the provincial road network in the Norte Grande is estimated to be in poor condition*



Source: Own estimate based on satellite imagery and machine learning

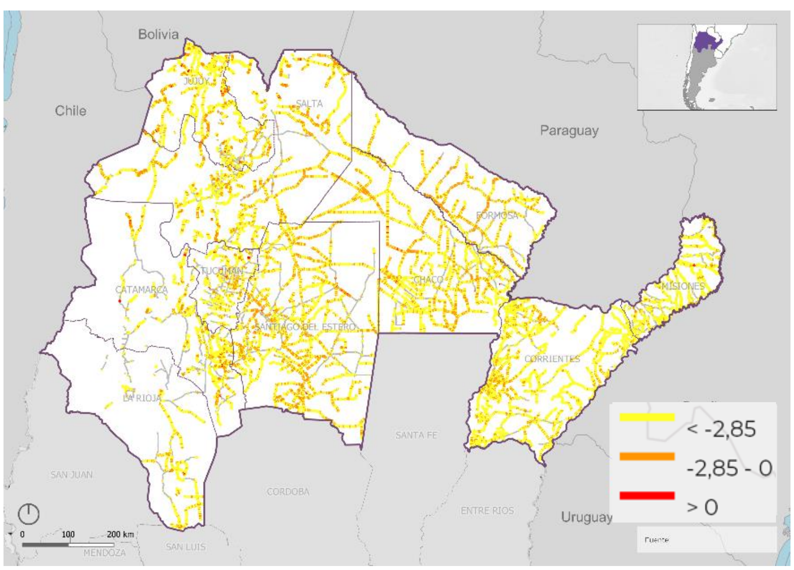
The variable quality of many roads means that some stretches may not be passable during rain. In eight Argentine provinces high levels of poverty coincide with high exposure to floods, most of them in the Norte Grande: Chaco, Formosa, Santiago del Estero, La Rioja, Corrientes, and Salta. Chaco is the province most affected by floods in terms of poverty: 1.7 percent of its population would fall into poverty assuming a 10-year return period flood (flood of intensity that has a 10 percent probability of occurring in a given year) (World Bank, 2022a).

[13] See Annex 2 for details on the methodology.

Climate change–induced hydrological extremes can disrupt road travel and raise logistics costs, with several national and provincial roads in the Norte Grande expected to have some of the highest damages and losses associated with climate related disruptions of 10 days or fewer (World Bank/GFDRR, 2021). Based on an approach that combines road criticality and vulnerability analysis, the same study concludes that the specific roads most affected in Argentina– with damages and losses exceeding US$2 million in the event of a disruption – also include NR51 in Salta, PR4 in Catamarca, and NR60 in Catamarca and La Rioja. In terms of the estimated benefit-cost ratio of upgrading to climate resilient standard, NR9 and NR34 in Salta are also at the top of the list.

The current study complements this work to identify the *unpaved* provincial and tertiary roads that are most vulnerable to flooding in the Norte Grande by combining topographic and rainfall data to calculate a Topographic Wetness Index (TWI). The objective of the analysis is to provide a simple complementary prioritization tool for investments in climate resilience, in particular, for the tertiary road network that often represents the "last mile" to production areas but which was not explicitly covered in World Bank/GFDRR (2021). The exact road condition of this network is generally not known and is variable depending on the season. However, it is also relevant for the unpaved segments of the provincial network, equivalent to about 75 percent of the total provincial network length. The NASA Shuttle Radar Topography Mission (SRTM) provides a raster digital surface model of the entire earth's surface at a 30-meter resolution. The rainfall maps are computed using the open-source weather API. Argentina is divided into 100-m^2square tiles, with two different statistics queried for each tile: the average annual rainfall from 2020 to 2022 and the maximum daily rainfall from 2003 to 2022. The TWI measures how a certain area is affected by stagnant water.[14] TWI above -2.85 in the case of unpaved roads is considered to be sufficiently high as to have a risk of forming water ponds; in turn, the roads are likely to become impassable in the absence of interventions such as improved drainage infrastructure. Norte Grande's tertiary network was mapped as part of the analysis, integrating data from DNV as well as open-data sources (Open Street Maps, Meta, and others).

Figure 11: *Unpaved provincial road segments in areas with a high propensity to form water pools (as captured by the TWI) are common in most provinces*

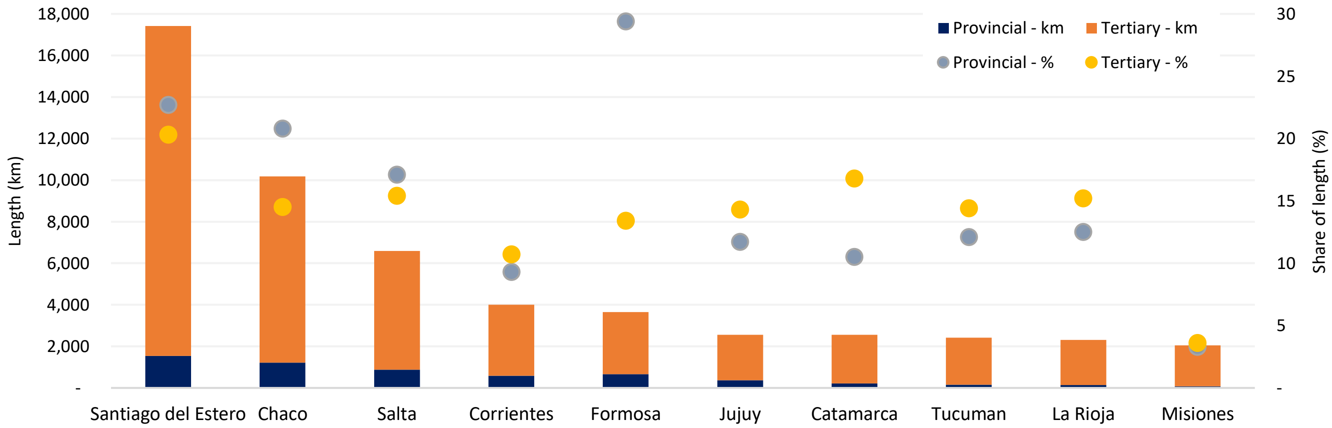


Source: Own estimate based on SRTM and rainfall data

Of the total unpaved provincial network, about 5,870 km (16 percent) are assessed as being at relatively high risk of forming water ponds due to the combination of rainfall and slope conditions, although the exact alignment of the roads vis-à-vis the incline needs to be considered to confirm the risk of each individual road. While most provinces have many at-risk segments, the provincial networks in Misiones and Corrientes have a smaller share of at-risk segments. In absolute terms, the longest at-risk provincial networks are in Santiago del Estero and Chaco, while the highest incidence of at-risk segments as a share of the provincial unpaved network is in Formosa, at over 29 percent (Figure 12).

[14] TWI = ln(flow accumulation / tan(Slope)).

Figure 12: *The TWI is estimated to be above the critical threshold for >20% of provincial road length in several provinces*



Source: Own estimate based on SRTM and rainfall data

The length of the tertiary network with TWI above the defined threshold of -2.85 is 52,698 km, or about 14 percent of the total. By far the highest total length of segments with high TWI values is concentrated in Santiago del Estero (nearly 15,900 km), followed by Chaco (nearly 9,000 km). Also as a share of the province-specific tertiary network, Santiago del Estero appears to have the highest incidence of risk, with about 20.3 percent of the total length of the tertiary network estimated to have TWI values above the defined threshold. The share of at-risk tertiary network is also high in Catamarca (16.8 percent) and Salta and La Rioja (about 15.3 percent in each). In contrast, less than 4 percent of the tertiary network in Misiones is estimated to be at risk. Overall, in nine of the ten provinces over 10 percent of the tertiary network is *a priori* at risk of extended water retention due to the combination of rainfall and slope conditions.

3.3. Good rail connectivity is available to only some parts of Norte Grande

At present, different actors coexist in Argentina's rail sector under different operating modes and regulatory frameworks: on the one hand, the private concessionaires NCA, FERROSUR and FEPSA, which have been operating since the beginning of the 1990s and whose contracts have been temporarily extended; on the other hand, the state-owned company Trenes Argentinos Cargas (TAC - Belgrano Cargas y Logísticas S.A.), which operates the Belgrano, San Martín and Urquiza lines. With the enactment of Law 26,352 in 2008, the "Railway Reorganization Law", the model of vertical separation between operation and infrastructure implemented in most European Union countries was introduced in the country, complemented by Law 27,732 of 2015, the "Argentine Railways Law", which incorporated Open Access as a rule of operation. However, key elements of the regulatory model are facing difficulties, such as the access charge private operators will have to pay to the SOE managing the rail network and an investment plan to enhance infrastructure condition to allow for a complete open access model (World Bank, 2023b). Law 27,132 has not been regulated[15] in its basic articles, and the new management model has not yet materialized in practice. Moreover, significant investment in infrastructure – such as in the Belgrano line branches connecting the Norte Grande to Chile and the rest of Argentina – will need to be made as a precondition for implementing the open access to ensure safe, efficient, and reliable operations.

The Mitre, Belgrano, and Urquiza line active branches serving the Norte Grande each have a different gauge, so there is no continuity between them, and the infrastructure has significant gaps. The Belgrano Railway connects the capital of Salta with the North-Central and NOA Provinces. The Belgrano line has undergone a reduction of its route over time and has sections where the speed is limited. It originally had almost 11,000 km, but currently only 4,013 km are operational, of which 21 percent have been renewed. Many sections only allow speeds below 30 km/h, and there are frequent derailments. Connectivity between the Norte Grande and Chile is operational via the Socompa crossing, based

[15] The only regulated aspect was the creation of a "Registro de Operadores Ferroviarios" (Railway Operators Registry). This regulation requires that all operators wishing to provide railway services on the national network must be registered. The purpose is to ensure that operators meet the necessary legal, technical, and safety requirements to operate on the country's railway infrastructure. This registry is a crucial step in implementing the open access scheme, ensuring transparency and oversight of who operates within the national railway network.

on commercial agreements between Trenes Argentinos Cargas (TAC) and Chile's FERRONOR; the connections to the Bolivian border are non-operational. The Urquiza line connects Corrientes and Misiones in NEA to the Buenos Aires region; the network on the Paraguay side of the border has been dismantled. The Urquiza line has less than half of its operational track and great variability in its condition and maximum speed. Only 40 percent of the 2,741 km under its administration are operational. The quality of the tracks is variable, with 30 percent in poor condition and maximum speeds not exceeding 45 km/h in most sections.

3.4. Most priority value chain firms outsource transport and logistics services

The surveyed producer firms vary widely in terms of the frequency of transport of inputs, from daily, to weekly, to monthly. The number of trucks used per shipment of inputs is typically 1 to 3 with an average capacity of 20-30 tons, but in the case of some larger firms, such as in the cotton and grain production sectors, over 20 trucks are needed. The shipment of production also varies between daily to monthly, depending on the firm, but the typical number of trucks used per shipment is higher than in the case of inputs.

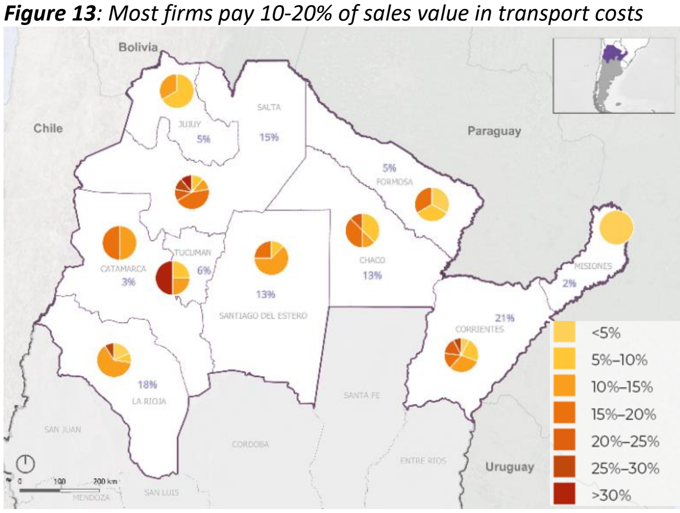
Fifty-three percent of the surveyed producer firms fully outsource transport services; another 27 percent outsource over ¾ of the needed transport services. While most producer firms report having a choice of 4-5 transport service providers, the choice seems to be smaller for NOA firms where in several cases only 2-3 options are available. The surveyed grain collectors report having a choice of 5 or more trucking service providers.

In contrast, most of the surveyed producer firms do not outsource warehousing services to any significant extent. Nearly half of the firms do not outsource at all, while another third of firms outsource up to 25 percent of their demand storage. Only one-fifth of producer firms outsource over half of their storage demand, all of them located in NEA. The low outsourcing of warehousing is consistent with the low reported supply of warehousing providers, with most producer firms indicating that they own their own warehouse space. Only about one-fourth of producer firms have a choice of more than one warehousing services provider to choose from. In turn, almost all respondents own their warehouses (instead of renting), all in the same province as their production location. In the case of the largest producer firms, the storage space reaches 10,000-30,000 m^2, able to store up to 40,000 tons. In the case of the grain collectors, the associated storage space and capacity is often several times larger.

Most of the surveyed firms do not outsource any other logistics services except for individual larger-size firms that report using third-party services for repackaging (1), bundling (1), invoicing (1), and tracking (2). Grain collectors do not report outsourcing any logistics services. The low level of outsourcing can be explained by the limited availability of such services, with nearly half of the responding firms indicating having no suppliers in their area of operation, and only a third of firms reporting having a choice of more than one logistics service provider.

3.5. Most firms spend >15% of product sales value on transport services

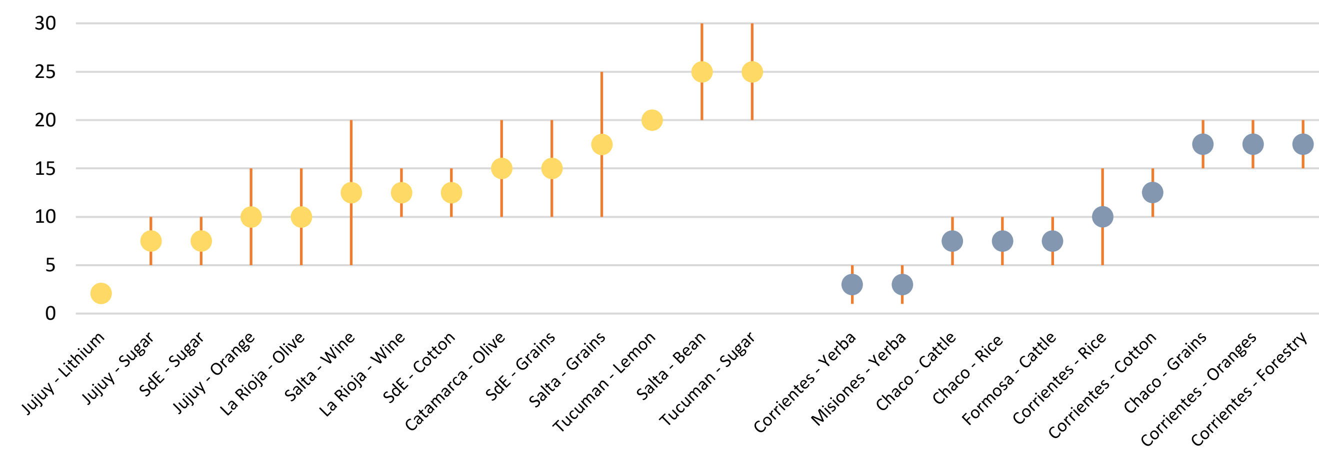
***Figure 13**: Most firms pay 10-20% of sales value in transport costs*



Source: Original survey of producers/grain collectors

According to the firm survey, transport costs vary greatly by subregion and value chain. In NOA, about 35 percent of firms pay over 20 percent of sales value for transport, compared to 40 percent of the firms in NEA. Transport costs incurred by the Norte Grande's firms are high compared to available international benchmarks. For example, while in Chaco and Corrientes firms in the rice milling sector pay 10-15 percent of sales value on transport alone, in Bangladesh, firms in the same sector pay less than 10 percent of product value for all the logistics costs combined (Herrera Dappe et al. 2020). Similarly, bean producers in Salta pay 20-30 percent of the sales value on transport, compared to 14 percent in El Salvador (World Bank, 2022b).

***Figure 14:** Producers in individual value chains pay >20% of sales value on transport*



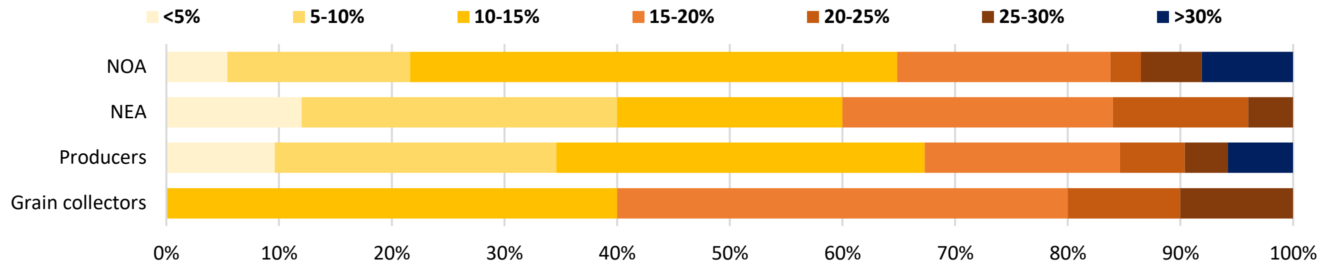
Source: Original survey of producers and grain collectors

Transport costs are the highest in the case of the sugar and beans produced in NOA (Salta and Tucumán).[16] With some exceptions, such as cotton, the costs are higher in more externally oriented value chains, where at least 10 percent of the overall production is marketed outside Argentina. They are the lowest in the case of Yerba Mate (Corrientes, Misiones), almost entirely sold in the domestic market, at below 5 percent of sales value. In some value chains, such as sugar and oranges, the costs appear to be quite different for firms in different provinces (Figure 14). Small and medium-sized companies, such as in the rice production in NEA, handle lower production volumes and face higher costs due to lack of economies of scale. In some value chains, such as rice producers in Corrientes, spatial dispersion complicates logistics and increases transport costs, as products must travel long distances to be processed and marketed.

[16] In the case of lithium in Jujuy and lemons in Tucuman, the reported transport cost is as a share of the FOB export price.

Transport costs tend to be higher for the grain collector firms than for the producer firms in the various value chains, with the share of firms reporting transport costs above 15 percent of sales being nearly double among the first category of firms (Figure 15).

Figure 15: *Transport costs vary by sub-region and type of cargo generator; grain collectors generally pay more as a share of sales value*



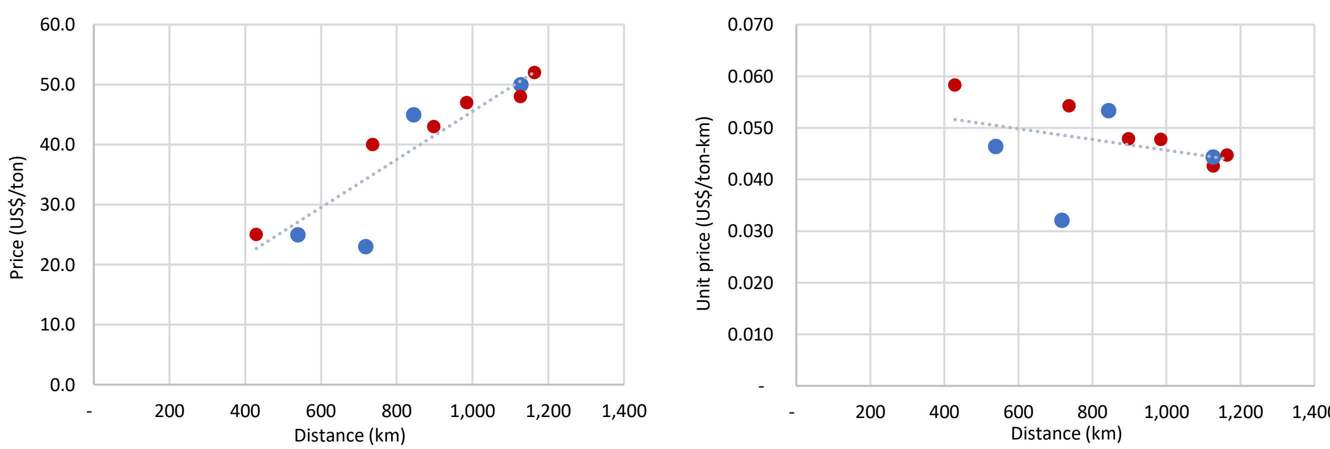
Source: Original survey of producers and grain collectors

In the case of the surveyed grain collector firms, where the destination is the Rosario port area in all cases, the total transport price, measured in US$/ton, tends to increase with distance to Rosario, whether considering those firms for whom road transport is the main mode or those that primarily use rail. The transport price ranges from about US$25 per ton at a travel distance of 400 km to about double that for grains coming from 1,100-1,200 km away (Figure 16a). There is less variation in terms of the unit price, at between US$0.03 and US$0.06 per ton-km, with cargo traveling from further away paying less (Figure 16b). The unit price appears to be slightly higher for grain shipments that primarily use rail transport (US$0.043-US$0.058 per ton-km) as compared to those that primarily use road transport (US$0.032-US$0.053 per ton-km).

Figure 16: *Cargo (grains) traveling from further away from Rosario tends to incur a higher total transport price but a lower unit price*

a. Transport price vs. distance to Rosario (km)

b. Transport unit price vs. distance to Rosario



Note: **Red dots** denote grain collectors for whom the main mode of transport is rail; **blue dots** denote those for whom the main mode is road transport
Source: Source: Own elaboration based on original survey of grain collectors

The surveyed producer firms pay, on average, nearly US$15,000 per year on storage infrastructure, mostly its maintenance and operating costs (given that most firms own it). In individual cases, such as for the largest firms in Salta and Jujuy, these costs exceed half a million dollars per year. Intuitively, the storage costs incurred by grain collectors tend to be even higher, typically upwards of US$100,000 per year.

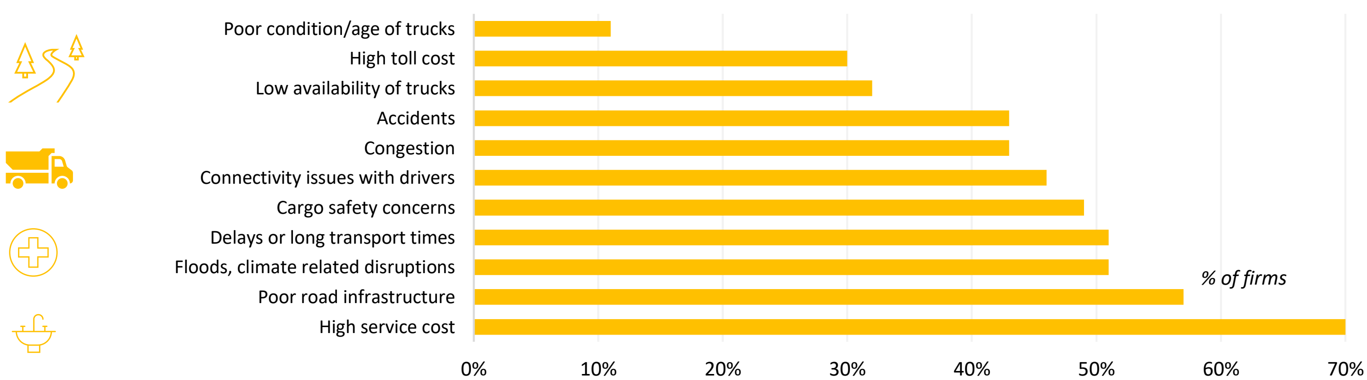
3.6. Across the region, gaps in transport infrastructure and services affect firms in priority value chains

Consistent with the high reliance on road transport by the surveyed firms, the most common logistics issues are related to road transport. In addition to the infrastructure related gaps (see below), most producer firms report having inventories "always" or "sometimes" affected by inconsistent deliveries or stock-outs, the share being higher among producers than grain collectors. Among producers, the share of firms who report that delays in shipments are common is higher in NOA than NEA. Similarly, nearly all firms – including producers and grain collectors – report that road transport takes longer than expected and that road transport costs are high. Less than half of the producer firms find that the vehicles used by the transport service providers are in an adequate condition to provide the service (and less than one-third of firms in NOA specifically); only 7 percent of the producer firms indicate that the quality of the service provided is fully aligned with the price (the perception again being worse in NOA specifically).

Multiple-choice survey of key transport constraints - NOA

In NOA, high land transport costs, inadequate road infrastructure, interruptions caused by floods or other climate related hazards, and delays are each mentioned by over 50 percent of the respondents. In the respective multiple-choice question in the survey, 51 percent of the firms report road flooding and other climate hazard related interruptions as being among the key issues for their operations. One-third of respondents note the low availability of trucks. 57 percent report the deficient road infrastructure as a key challenge for their operations, 43 percent mention congestion, and 43 percent – road safety issues. However, several "soft" gaps in road transport were also pointed out, including low truck availability and connectivity issues with drivers (Figure 17). Over 40 percent of the respondents identify deficiencies or lack of rail infrastructure, which hinder its use. In relation to fluvial transport, for many firms this option is not available due to lack of rivers in their area; however, an equal number of firms (14 percent) mention the deficient port infrastructure as an obstacle to shipping goods via internal waterways. In terms of customs on the national borders, 35 percent note delays. These answers are also consistent with the assessments obtained in meetings held with sectorial chambers, highlighting significant hard infrastructure gaps.

Figure 17: *High costs, poor road infrastructure, and climate related disruptions are common challenges with using road transport in NOA*

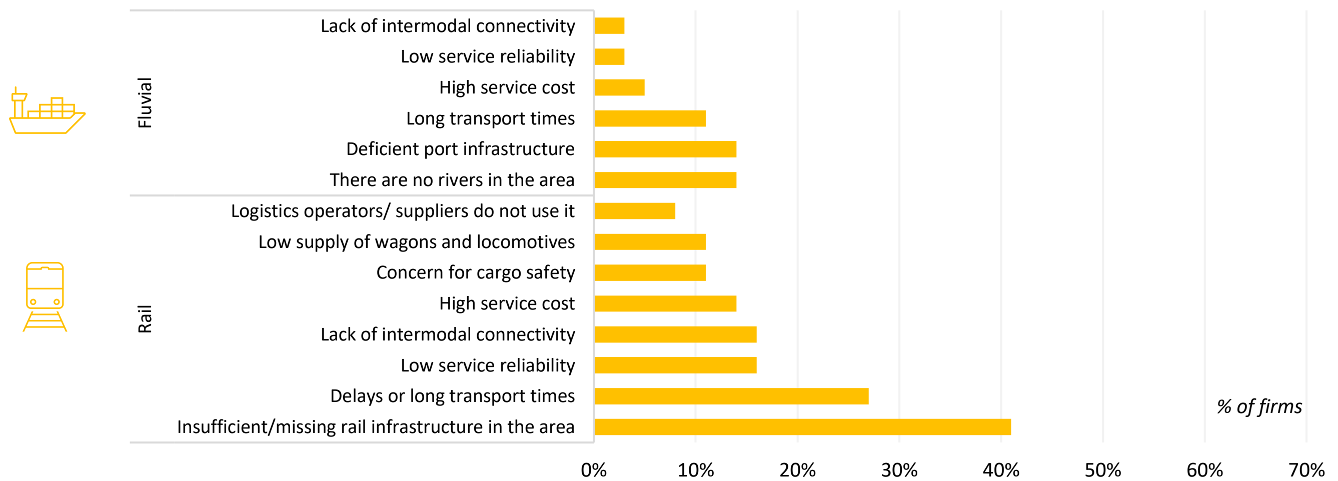


Source: Original survey of cargo generator - multiple choice question

Firms pointed out that the road infrastructure is poorly maintained and lacks paving, as in the case of key routes such as RN51 in Salta - crucial for tourism and lithium production - which has unpaved and poorly maintained stretches from Campo Quijano to San Antonio de los Cobres (134 km); PR5, which needs increased maintenance despite being completely paved (from Pichanal to Metan); or NR34, which the firms in the bean and sugar value chains noted is in need of rehabilitation and increased level of service. For the transport of lithium inputs and outputs, there is a need to improve the access roads to the salt flats, asphalt RN40, maintain and pave RN51 and RN9, and widen RP129 for heavy traffic to improve safety. The surveyed firms and sectoral chambers also note the lack of road drainage infrastructure that causes frequent road closures during the rainy season; these concerns are voiced by producers across NOA. PR5 is an example where cuts and delays occur due to the lack of the necessary infrastructure.

Limited truck availability, especially during harvest season, is a common challenge, as reported by firms in the sugar, orange, bean, wine, cotton, grains, and lemon value chains across NOA. There are difficulties with finding trucks willing to go to northern Chile and union regulations that restrict the loading of foreign trucks. Concerns with cargo safety are reported by sugar and orange producers in Jujuy, bean and wine producers in Salta, olive producers in La Rioja, sugar producers in Santiago del Estero, and sugar and lemon producers in Tucumán. On the other hand, issues with poor road safety are reported by firms in Jujuy (orange), Salta (wine), La Rioja (olives), and Santiago del Estero (grains). In several areas, including Pichanal (Salta), there are deficiencies in hygiene services for truckers.

***Figure 18:** Insufficient/missing infrastructure and long transport times are the main gaps in rail and fluvial transport in NOA*

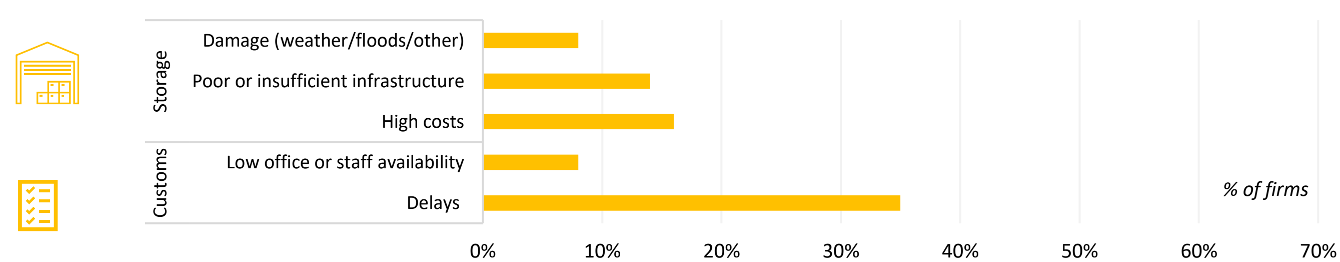


Source: Original survey of cargo generators - multiple choice question

In relation to rail infrastructure, the sectoral chambers in NOA highlight the need to improve connectivity to Chile, in particular, for lithium, and the difficulty of using the existing infrastructure due to lack of maintenance or collapsed bridges, such as in Tartagal and Caraparí. Deficiencies in the existing rail infrastructure – such as slow speeds and inadequate rolling stock – are noted by sugar producers in Jujuy, grain producers in Salta, wine producers in La Rioja, cotton and grain firms in Santiago del Estero, and sugar and lemon producers in Tucumán. Low availability of containers and maritime transport for exports is noted by Jujuy's orange producers**.** Overall lack of multimodal transport options is reported by grain firms in Salta and Santiago del Estero and olive producers in La Rioja.

Storage infrastructure limitations are also a concern for several value chains across NOA, such as among wine producers in La Rioja. In the case of lithium coming from Jujuy, an issue is the insufficient capacity of bonded warehouses in the Buenos Aires Metropolitan Area. The lack of customs integration generates delays and additional costs (particularly with the Chilean border after the COVID-19 crisis). Firms across the olive (Catamarca, La Rioja), sugar (Jujuy), orange (Jujuy), bean (Salta), wine (Salta), and lemon (Tucumán) value chains note customs and border crossing delays as a key issue. The limited operational capacity of the National Food Safety and Quality Service (SENASA) is noted by Jujuy's orange producers.

***Figure 19:** About 1/3 of firms in NOA are burdened by customs delays*



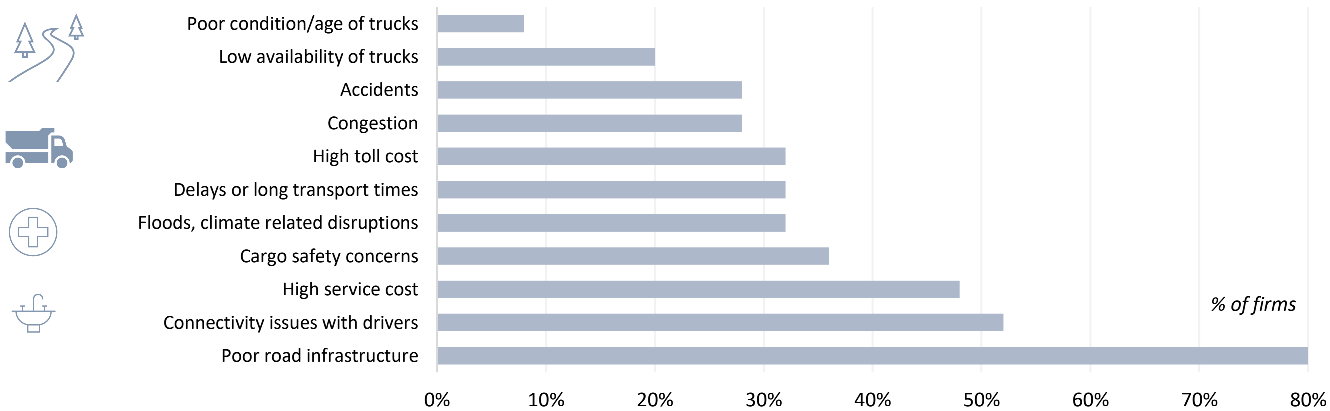
Source: Original survey of cargo generators - multiple choice question

Multiple-choice survey of key transport constraints - NEA

In NEA, 80 percent of those surveyed point to the road infrastructure as a problem, 48 percent note high road transport costs, while one-third point to issues related to climate risks affecting the connectivity of the road network

(Figure 20). The hard infrastructure gaps are combined with several issues related to processes and transport service providers, such as the connectivity issues with truck drivers, and insufficient/ obsolete trucks. In relation to rail transport, 36 percent highlight the lack of- or deficient railway infrastructure, and 32 percent – lack of infrastructure for multi-modal connectivity (road-rail). Regarding fluvial transport, similarly, lack of intermodal connectivity is noted by several firms, while the key obstacle for using this mode is deficient port infrastructure (see Figure 21).

Figure 20: *Poor road infrastructure is a challenge for 4 out of 5 firms in NEA*



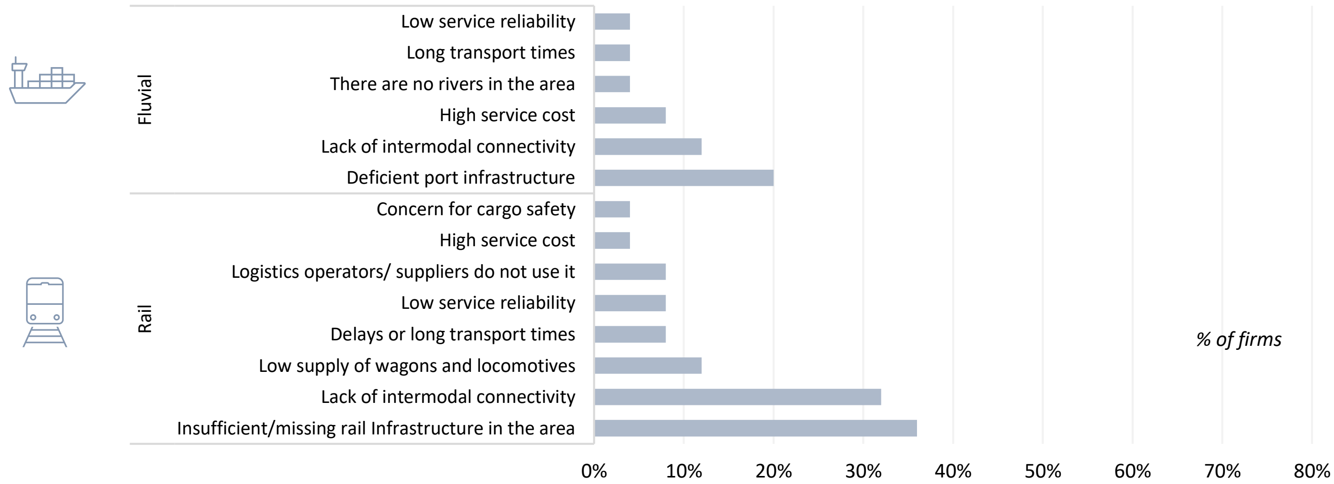
Source: Original survey of cargo generators – multiple choice question

There is a need for increased road capacity and/or paving of currently unpaved roads in several provinces. For example, in the case of NR14, firms and sectoral chambers across several value chains highlighted the need for a highway from Paso de los Libres (Corrientes) to San José (Misiones) for approximately 250 km. From the perspective of firms in the forestry value chain, NR12 requires a highway from the capital city of Corrientes to the intersection with NR218, frequently used by Brazilian trucks. The level of service of the road infrastructure is unable to support the volume and weight of soybean transport from Chaco. The need to pave provincial roads to facilitate transport and reduce maintenance costs was identified in Misiones.

Also the condition of the road network is a common concern: NR11, the main corridor for cotton traveling to Buenos Aires, is not passable in Formosa between Clorinda and Resistencia, which also affects cattle producers in Chaco and Formosa. Rural roads are in poor condition, such as in the region between NR89 and NR95; similarly, in Corrientes, rice producers note the poor condition of the rural roads in Mercedes, while rice producers in Chaco highlight the need to develop transport infrastructure to connect the mills in Resistencia. During meetings with sectoral chambers and associations, producers indicated that transportation companies generated a price premium due to the condition of the routes to reach the destination. They estimated that for the same distance but different road conditions the cost could double. Related to the poor condition of some of the roads, the climate vulnerability of the road network is noted as an issue by grain and rice firms in Chaco, and firms across all priority value chains in Corrientes and Formosa. The need for a bridge connecting Goya and Reconquista is noted by the cotton and forestry firms in Corrientes; currently, 465 km must be traveled (in 6 hours), which could be reduced to 30 minutes.

The interviews across all provinces and value chains highlighted the lack of road transport services supply, especially during harvest season, which results in the transport price to the user being double the cost faced by the carriers. In the case of rice producers in particular, the limited truck availability also affects access to production inputs. The truck fleets are obsolete, which increases costs and impacts safety, as noted by cattle producers in Chaco and Formosa, Yerba mate firms, and forestry firms in Corrientes. Union regulation also does not allow loading foreign trucks, affecting the flow of goods. Pending regulation of bitrains in the Corrientes-Misiones area affect the efficiency of freight transport, such as for forestry firms. Concerns with cargo safety are most salient for the interviewed orange and Yerba mate producers in Corrientes and cattle firms in Formosa. Poor road safety is reported by firms in Corrientes (oranges, Yerba mate) and Formosa (cattle).

Figure 21: Insufficient/missing infrastructure and lack of intermodal connectivity limit the use of rail and fluvial transport by NEA firms



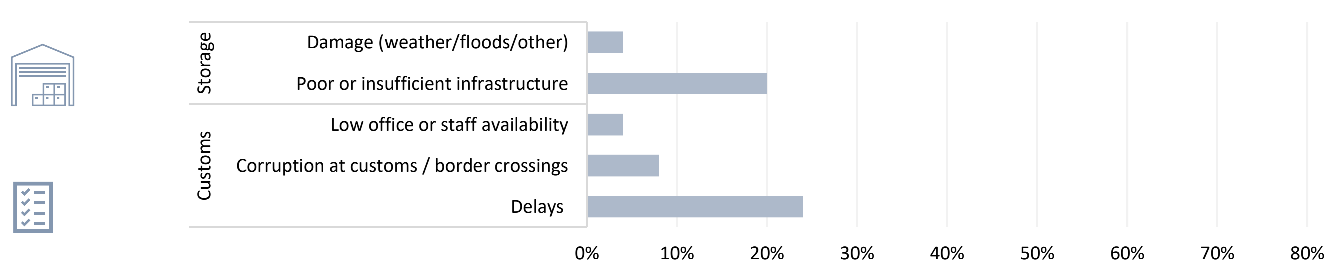
Source: Original survey of cargo generators - multiple choice question

Firms and sectoral chambers note the limited accessibility of the rail infrastructure in relation to the production areas. In Corrientes, rail is present in the Paso de los Libres area, but the branch lines are deactivated. In Chaco, rail does not pass through areas near Resistencia due to lack of railroad branches and few available platforms. Gobernador Virasoro is the center of the forestry industry but has no rail access to Ituzaingó (where there is room to consolidate cargo). Although a rail system is available to transport cotton, it is not being used because there is no available space or capacity (quota) to load cotton on the trains. This is because other commodities (grain) already occupy the transport slots. The discussions highlighted that the rail speeds are very low, and the frequency of service is poor, which discourages the use of rail by producers of rice, among others. The need to improve railway maintenance is highlighted by grain firms in Chaco and rice producers in Corrientes.

There is also insufficient waterway dredging and beaconing, affecting their navigability and operability. For example, lack of dredging of the Riacho Barranqueras river presents an issue for Chaco's grain firms. There is a lack of adequate port infrastructure to operate barges, affecting logistics efficiency, such as in Itá Ibaté and Goya. Moreover, provincial ports with national waterways suffer from the fact that no improvement works are done for the waterways. Regulatory restrictions and delays for the use of barges under another country's flag (e.g., Paraguay) complicate logistics, and there is a lack of containers, affecting the cotton chain.

The issues associated with customs delays at border crossings affect firms in particular in Corrientes (cotton, oranges) and Formosa (cattle). In Iberá (Corrientes), customs are a problem for consolidating cargo; the closest is in Goya/Paso de los Libres, 150 km away. Similarly, Mercedes has no customs, and loads have to be consolidated 200-300 km away.

Figure 22: At least 1/5 of NEA firms are burdened by customs delays and/or insufficient storage infrastructure



Source: Original survey with cargo generators - multiple choice question

The growth of mineral production in the coming decades is expected to generate additional strains on the regional logistics system. The World Bank (2023a) estimated that the expansion of mining in the region alone would generate up to a tenfold increase in transported production between 2022 and 2030. This would imply a corresponding increase in the number of trucks on national, provincial and local roads. Based on the freight flow projections (2045) presented earlier, a significant increase in freight flows is predicted on some segments, such as those linking NOA to Rosario and Buenos Aires; however, also for several roads linking Buenos Aires to NEA and further to Brazil and Paraguay, such as those crossing Misiones and Corrientes Provinces. Most roads crossing Formosa and Chaco are predicted to maintain low traffic levels. Already by 2031, lithium output and the inputs used in the production are expected to grow to between 1.8 million tons and 2.2 million tons. A significant increase is expected in the volumes transported on the region's roads, with NR51, NR52, NR17, NR34, and NR43 being most heavily used. Some of these, such as NR17 and NR43, are roads that are currently minor and not paved.

Also the survey of cargo generators conducted as part of the current study confirms that certain trunk roads are becoming saturated, due to the increase in activity in the region, especially the mining industry. Examples include NR34 from Pichanal to NR9; NR9 to Metán; and NR129.

Based on the survey of cargo generators and complementary discussions with the sectoral chambers, a Logistics Vulnerability Index for each chain-province pair was developed to illustrate the strength of logistics processes. The index, composed of sub-indicators such as logistics cost, time, and multimodality, analyzes the internal logistics of final production and inputs, from the origin of the cargo to its destination within the country if it is an internal transfer, or to the point of transfer, such as a port or border crossing, in the case of exports. The results suggest that the most vulnerable are the orange chain in Jujuy, the lemon chain in Tucumán, and the forestry chain in Corrientes, followed by the bean and copper chains in Salta. For example, in the case of the copper production in Salta, the interviewed firm noted that the transport cost per ton is very significant relative to the sales value of the product, and there are currently very limited transport options for the anticipated route; moreover, the infrastructure is in poor condition, with missing connections. And, while copper transport is not sensitive to travel time, its reliability is important. Value chains in the lower range of vulnerability include lithium in Jujuy and rice and cotton in Corrientes.

3.7. There is potential to shift some of the cargo to rail or fluvial transport, assuming improvements in the operating performance

Truck to rail

The main advantage of rail is the ability to move large volumes of cargo with fewer personnel and lower fuel consumption, compared to the road mode, provided that a series of conditions are met to exploit this potential. The North of Argentina has a sufficiently dispersed railroad network, thus presenting an opportunity for a modal shift, even if currently Argentina has some of the lowest rail shares of freight transport in LAC (4 percent). Most of Argentinian railways, especially those operated by concessionaires, have achieved improvements in productivity despite the lower levels of activity.

However, rail operates on a segregated infrastructure that requires maintenance and progressive renewal, which generates high fixed costs. To take advantage of the economies of scale that derive from the very nature of this mode, it is essential to mobilize large volumes of cargo and optimize the use of rolling stock through efficient rotation. In practice, poor maintenance and lack of resources have led to an overall condition of the rail infrastructure in the Norte Grande that is considered fair to poor, and investments that have been made have concentrated in the TAC (Belgrano) lines. Abandoned branch lines and low operating speeds are constant challenges that limit the effectiveness of rail transport in the region, complemented by lack of multi-modal connections that allow collecting cargo from production areas by truck and then transferring to rail for the longer-distance trip legs. Finally, the definition of the railway management model is still pending.

Several previous studies have quantified the potential cargo that could shift from road to rail transport, under specific assumptions. The former National Directorate of Cargo Planning and Logistics (DNPTCyL, 2019) estimated that, considering the zones crossed by at least one railway line and assuming no restrictions in infrastructure and rolling stock supply, some 12 percent of Argentina's cargo could be shifted to rail, mostly mining goods and grains. The analysis considered 200 km as the minimum distance threshold for mode shift, above which the potential would depend on the distance by road that would otherwise have to be traveled. Within the Norte Grande, the analysis identified the largest potential volumes to be shifted to rail to originate in parts of Chaco and Santiago del Estero (exceeding 1 million tons per zone), followed by several zones in Salta and Tucumán (between 450,000 and 1 million tons per zone) (Figure 23). No mode shift potential was identified for Jujuy, Formosa, La Rioja, and large parts of Catamarca, Chaco, Corrientes, and Misiones. On the other hand, Salta, Tucumán, and southern Catamarca were estimated to represent the largest potential for mode shift for the cargo in terms of the destinations, with volumes of between 240,000 and 1 million tons per zone (Figure 24).

Figure 23: *Potential to be moved by rail is higher for cargo originating in central and western Norte Grande*

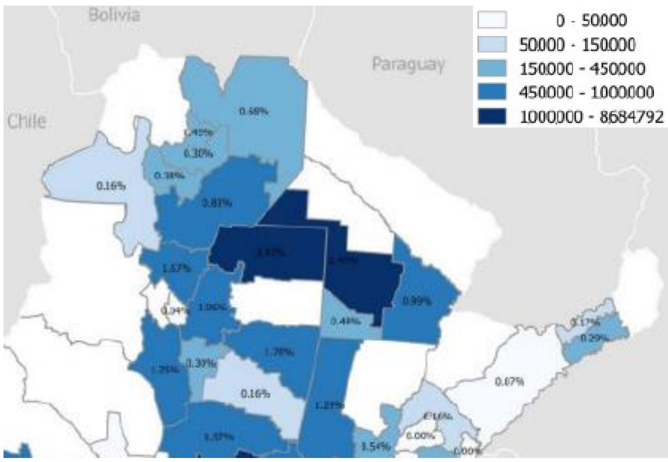
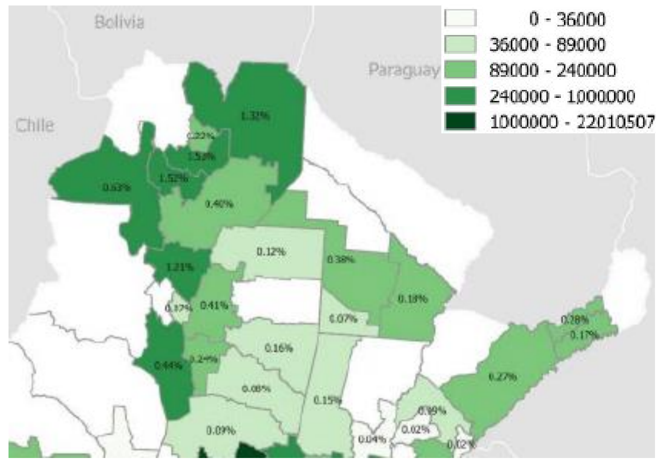


Figure 24: *Cargo with destinations in NOA have the highest potential to be shifted to rail*

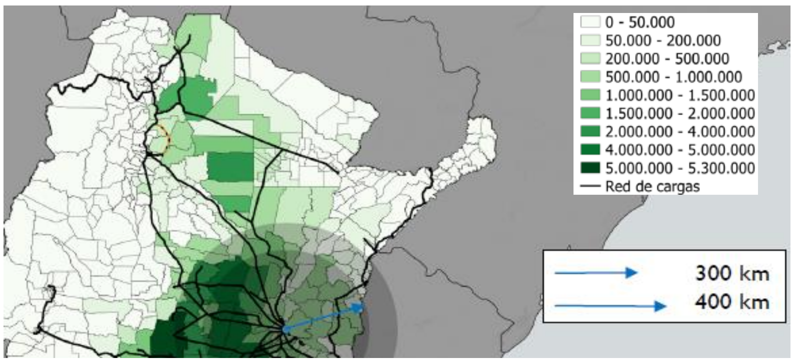


Source: DNPTCyL (2019)

Recent estimates are available on the amount of cargo that would have to be moved by the Belgrano and Urquiza lines under different scenarios and assumed tariffs per ton-km to cover operating and maintenance costs and recuperate investment (see Sant, 2024). In the case of the Belgrano line, the analysis assumes the average distance traveled to increase from the current 745 km to 1,000 km, the incorporation of the C8 branch and connection to Bolivia, a 30-percent reduction in wait times, and 15 percent of the return trips carrying cargo, as well as two different scenarios of the specific infrastructure and rolling stock improvements (resulting in longer wagon formations and improvements in speed from the current 15 km/h to 38-45 km/h). The analysis also assumes the average tariff to increase from the current US$ 2.5 cents to US$3 cents or US$4 cents. Depending on the type of intervention and considering a US$4 cents/ton-km tariff, between 13 million and 19.6 million tons would need to be transported to cover the costs of operation, maintenance, and return on investment, compared to the current 2.84 million tons. At US$3 cents/ton-km, the required volumes would be between 22.6 million and 33.2 million. In the case of the Belgrano "Sugar corridor" specifically, the needed volumes range between 9.2 million and 15.2 million, depending on the tariff, as compared to less than 1 million tons moved in 2022. In the case of the Urquiza line, the same analysis estimates that at least 2.4 million tons would be needed to cover the costs of operation and maintenance and to recover investment (nearly 5 times the volume transported in 2022).

Considering lithium inputs and outputs, copper, and other mining projects, the total volume of mining cargoes transported to and from the mining provinces of NOA (Salta, Jujuy, and Catamarca) will increase nearly ten-fold between 2022 and 2030, with a potentially equivalent increase in the number of trucks traveling on the national and specific provincial and local roads in the absence of some mode shift to rail. Currently 1,700 km of the tracks of the Belgrano line are being renovated and another 228 km improved, with international financing (CFI, 2023). Considering these investments, World Bank (2023a) estimated that by 2045 some 6.72 million tons (15.2 percent) with origin and/or destination in Salta, Catamarca, and Jujuy could be shifted from truck to rail, of which two-thirds would be mining products – copper, lithium, and inputs. New copper production and its input demand is projected at 1.12 million tons by 2045, of which 51 percent could be shifted to rail (including specifically the Belgrano line C14 branch), corresponding to those from the ports of Antofagasta to the Taca-Taca mine and vice versa. New lithium production is projected at 285,000 tons by 2045, of which 134,000 tons (47 percent) could be shifted to rail, while, of the 1.7 million tons of inputs needed for lithium extraction, 36 percent could be moved by rail. At present, the C14 branch moves a little less than 13,000 tons, projected to increase to 18,000 tons by 2045 in the absence of shift from road to rail. The prospect of the mining projects under consideration would allow adding more than 1.327 million tons to this branch, leading to a total volume of about 1.346 million tons. General Güemes, a distribution center and intended dry port in the Province of Salta, connected by the Belgrano line, already shows potential to concentrate economic activity linked to mining sector and is predicted to handle 760,000 tons of containerized cargo with origin or destination in the Norte Grande (World Bank, 2023a).

Figure 25: *Much of the grains produced in NOA could be moved by rail*



Source: Sant (2024)

Considering the operational rail network and a threshold of at least 400 km for rail to be competitive against road transport, a recent study estimated that **at least 13.3 million tons of grains produced in NOA alone could be moved by rail** (Figure 25). However, this theoretical potential is limited by the scarce stockpiling of grains outside the central area of the country and access issues to the port of Rosario, among other issues (Sant, 2024).

Several other products besides grains in NOA are characterized by spatial concentration of production and travel distances that would make rail a competitive alternative but currently use rail to a limited extent. For example, only around 10 percent of the sugar produced in the country (157,000 tons) – much of it concentrated in NOA – was moved by rail, and none of the nearly 500,000 tons of alcohol. Similarly, of the 2.1 million tons of lemon produced in 2022, mostly in Tucumán, only 41,000 tons (fresh fruit and derivatives) were moved by NCA (Mitre line). Limitations for more of this cargo to be transported by rail are presented by the infrastructure condition, especially at origin, travel time, and available rolling stock (Sant, 2024).

In addition to NOA, some cargo volumes – albeit more minor – could be moved by rail in Chaco and Corrientes. In the case of the Urquiza line specifically (Corrientes), further shift to rail is limited by the presence of the Paraná-Paraguay Waterway (Hidrovía Paraguay - Paraná), which provides a highly competitive alternative for freight transport, and which represents competition to rail. The current study estimates the rail cargo potential of the Urquiza line using a methodology described in World Bank (2023a) that uses the MOD2014 cargo origin-destination matrix as input. The analysis suggests that the Urquiza line, at least at present, has limited growth potential, with the cargo volumes moved likely only reaching 0.7 million tons by 2031. The line's cargo is expected to be dominated by agro-industrial goods (84 percent), with construction materials making up 14 percent, and other products comprising the remaining 3 percent. Despite its unique focus on agro-industrial goods, the Urquiza line is thus likely to remain financially unsustainable, unable to generate positive cash flows over a 15-to-30-year horizon even with investments to restore the tracks.

<u>Truck to boat</u>

The Norte Grande's fluvial system, formed by the Paraná and Paraguay rivers, is a valuable transportation route for its goods, with the provinces of Chacho and Corrientes having the most potential. The section with its northern end at the confluence of both rivers, extending to the southern limit of the province of Corrientes, approximately 400 kilometers downstream, is dredged periodically and has a 10-foot draft, in addition to the necessary nautical signaling for the circulation of larger vessels.

The volumes of cargo transported with origin (or destination) in the region along the Paraná and Rio de la Plata axis are considerable; however, the fluvial transport potential is currently underutilized. Fluvial transport in the Norte Grande is characterized by a low density of cargoes concentrated in cabotage traffic of grains and fuels (CFI, 2022, 2023). In the ports upstream of Santa Fe – the sections of the river of interest for the Norte Grande – the volumes of cargo transported (1.3 million tons) are significantly lower than in other sections.

Becoming a real option compared to other modal alternatives requires adequate, safe, and predictable navigable routes, efficient port infrastructure and equipment, and available and competitive transport services. Interventions in the region's port system need to be articulated within an integrated perspective of the transport system (including the rail network). The number of port projects underway requires actions to avoid underutilization of the facilities, based on demand studies and the design of modern management models.

World Bank (2022c) estimated that 2.8 million tons per year originating in the Norte Grande (products from central-western Chaco, eastern Salta, and western Santiago del Estero) could be transported by waterways, avoiding direct road transport to the ports in Rosario/Santa Fe, reducing logistics costs by 5 percent. The two main categories of products that could be transferred to river transport include (1) agricultural bulk flows from the Norte Grande to the ports of Rosario and Santa Fe and (2) regional products and general goods transported between the north of the country and the ports of Rosario, Santa Fe, and the Buenos Aires Metropolitan Area. For the first case, the specific production areas are in central and eastern Chaco, eastern Salta, and northern Santiago del Estero. The study estimates that it would be possible to transfer up to 53 percent of the agricultural bulk cargo originating in these areas to the fluvial mode, using the Port of Barranqueras (Chaco) as a transfer point. This would mean that 2.3 million tons per year could be transported through the Paraná River. In the second case, the study estimates that up to 500,000 tons per year of regional products and general goods could be moved through the Port of Barranqueras.

The survey of cargo generators in the region conducted as part of the current study suggests that the main production inputs for the priority value chains come from outside the Norte Grande region in the case of 64 percent of the firms, and the main product is mostly destined to Santa Fe and Buenos (grains to Rosario and the rest of the products to Buenos Aires). This implies long routes and travel times but may also be more conducive for shifting from road to rail and, where relevant, waterways. However, the firm responses also clearly highlight multimodal connectivity issues and insufficient/missing rail and waterway infrastructure as obstacles for shifting a greater portion of cargo to these modes. Despite the presence of infrastructure in several production regions of the Norte Grande and individual attempts to use rail and barge, trucking continues to be more competitive, although it is difficult to find trucks at certain times of the year. For example, interviews with production chambers in Corrientes suggest that trucks continue to be more competitive for long freight. Examples of possible multimodal transport routes mentioned by the interviewed sectoral chambers include (1) short freight, followed by train from Curuzú (Corrientes) and (2) barge from Itá Ibaté to Molino Fran.

Table 5: *Challenges and opportunities for rail and waterway use vary by province and value chain*

NOA provinces	
	Olive producers in **Catamarca** highlighted the deficient or non-existent rail infrastructure**,** with service subject to extensive delays and long transport times. In **Jujuy**, orange producers point to the low reliability of the service, high costs, long delays, lack of infrastructure for intermodal connections, infrastructure with high levels of deterioration, and low cargo security. In the case of sugar, although rail transport is used for 25% of cargoes, its effectiveness is severely limited by the poor condition of infrastructure, which forces slow speeds and multiple stops, extending travel times up to 15 days compared to 1 day by truck. In **Salta,** although rail could be an option for bean transport, time issues and the need for short freight to load make the total cost of rail transport not much different from direct trucking. Rail transport also has limitations for wine transport, including poor infrastructure, lack of intermodal connection facilities, and low reliability. In **Santiago del Estero,** although rail infrastructure exists, it cannot be used for cotton transport due to lack of maintenance. The structure of this chain is not optimized, which in some cases requires longer routes due to inadequate road infrastructure or the centralization of activities in Buenos Aires. In **Tucumán**, the use of rail – while present – is limited due to the poor condition of the rail infrastructure, which forces low speeds and frequent stops, extending travel times by up to 15 days compared to 1 day using road transport.
NEA provinces	
	In **Chaco**, cattle producers note the rail infrastructure does not meet the level of service required by the cargo. In the case of rice, the rail infrastructure has limited accessibility in relation to production areas, lack of maintenance and level of service

	reduce its viability. For the grain firms, multimodal connections would help improve the connection between production areas, mills and export points. In **Corrientes**, rail infrastructure shows significant deficiencies and limited supply. In relation to the transport of yerba mate, the Urquiza branches do not reach the points of origin of the loads because they are deactivated. There are few platforms available. Frequency and available capacity are low. The rail transport time is 10-15 days, due to the low speeds as a result of the obsolete tracks and high risk of derailment. In the case of rice transport, the deterioration of the rail network, its limited accessibility, low frequency of service, and slow pace of operation makes it inadequate for current logistics needs. In the case of forestry products, the Urquiza line has limited infrastructure and does not adequately connect the points of origin of cargoes, and there is a lack of infrastructure for intermodal connections. In **Formosa**, railway infrastructure is deficient or nonexistent, limiting alternative transport options for cattle. In **Misiones**, rail transport, through the Urquiza line, has serious limitations due to the poor condition of the infrastructure, limited coverage in the province, low frequency and few available platforms. Rail transport times, which vary between 10 and 15 days, are due to the reduced speed because of the poor condition of the tracks, increasing the risk of derailment.
	In **Chaco**, grain producers highlighted the lack of dredging and maintenance of the waterway access channels, and overall absence of multimodal transport options. The port infrastructure - operational - and the restrictions on the supply of barge transport services are not competitive most of the year due to high costs, and cargoes opt to a greater extent for road transport. Cattle producers note the port infrastructure does not meet the level of service required by the cargo and point to lack of dredging and maintenance of the Barranqueras stream. In **Corrientes**, river transport through the Paraná River is essential for productive activity, offering an alternative to truck-based transport. But the lack of dredging, maintenance of the waterway and inadequate, incomplete or abandoned port infrastructure make their use difficult, such as for the transport of forestry goods. Barge ports are needed in key locations such as Itá Ibaté and Goya. River transport infrastructure is also insufficient in **Formosa**. In **Misiones**, producers highlight the lack of infrastructure for intermodal connections and port infrastructure restrictions.

Source: Original survey of cargo generators and sectoral chambers

3.8. Identifying road and rail investments that could bring the largest socioeconomic benefits

The road and rail infrastructure gaps noted by the interviewed firms and sectoral chambers in priority value chains are consistent with the priorities highlighted by the Provincial governments in their work with the Federal Investment Council (CFI, 2023, 2022) and broadly aligned with the road infrastructure condition assessment conduced in the current study. The CFI study resulted in over 300 public policy recommendations, including in terms of infrastructure investments, transport and logistics services, regulations and institutions, and cross-cutting logistics aspects. These include, among others, the need for a bridge connecting Reconquista (Santa Fe) and Goya (Corrientes), new or improved border crossing points with Brazil, Paraguay and Chile, and improvement of at least 6,500 km of roads (4,500 km National and 2,000 km Provincial). On the stretches without available condition data, an estimated additional 1,000 km require improvement. In the rail sector, freight transfer centers and rolling stock were identified as a priority.

The infrastructure investment projects included in this long-list and the insights from the interviews with the firms and sectoral chambers served as a basis for identifying priority investments in roads and rail that could be expected to most directly support the region's economic development and the needs of the priority value chains. To select the most relevant projects within those pre-prioritized by the authorities of the Norte Grande Region, a multicriteria analysis (MCA) was conducted, including four dimensions of analysis and 14 attributes. The four dimensions include: (1) the likely local or regional impact based on the demand for infrastructure services in the project's area of influence, (2) likely contribution of the works to inter-regional connectivity, (3) Institutional complexity of implementation and budgeting, and (4) relevance for climate change mitigation or adaptation (see Annex 3).

The highest scoring[17] project was selected within each of the provinces and, subsequently, the 10 highest scoring projects anywhere in the region. From the original 124 projects that could be geolocated, 15 road and 5 rail projects were selected. Among the prioritized road projects are two dual carriageway projects on NR9, construction of a passing

[17] The four dimensions were weighted, respectively, as 0.4, 0.35, 0.15, and 0.1. The results were also broadly consistent with a Principal Component Analysis conducted for the same purpose.

lane on NR 34, and several pavement condition rehabilitation projects (Figure 29). The prioritized rail projects include the rehabilitation and upgrade of Belgrano lines C13, C15, and C, the Mitre line in Tucumán and Santiago del Estero, and the Urquiza line in Corrientes and Misiones (Figure 30). Most of these selected projects also correspond to the specific priorities voiced by the interviewed firms and sectoral chambers.

The prioritized projects vary in terms of their economic versus other relevance, given the multi-criteria approach for selecting them. For example, the selection of the Urquiza line among the 20 most relevant projects is driven not by its cargo potential (which, as explained earlier, is relatively limited at least in the short term) but by the other criteria. The line goes through poor areas and regions with priority export value chains and therefore excels in terms of its potential socio-economic impact and poverty reduction despite unlikely being financially viable.

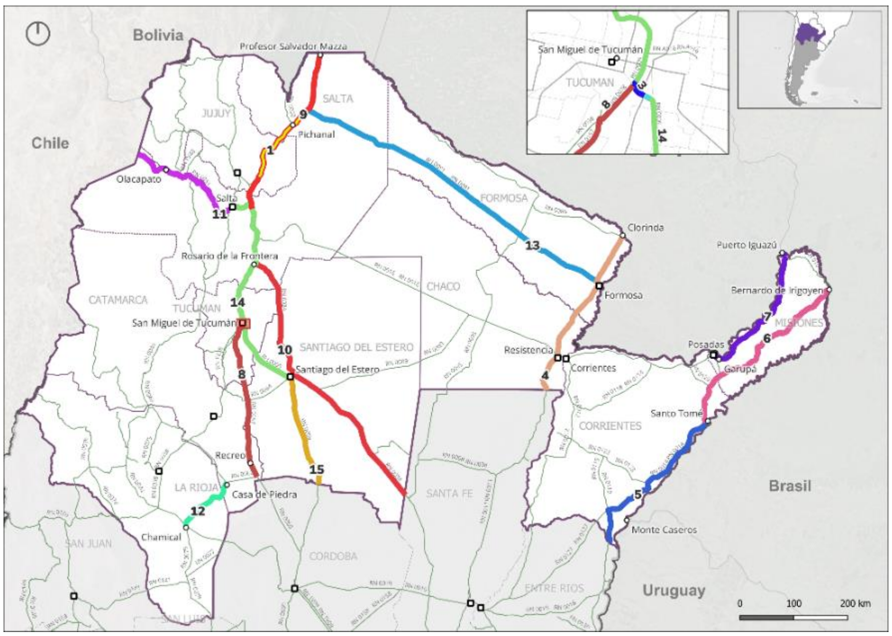


Figure 26: The multicriteria analysis shortlisted 15 road projects

Source: Own analysis based on firm surveys, conversations with sectoral chambers, and CFI (2022/2023)

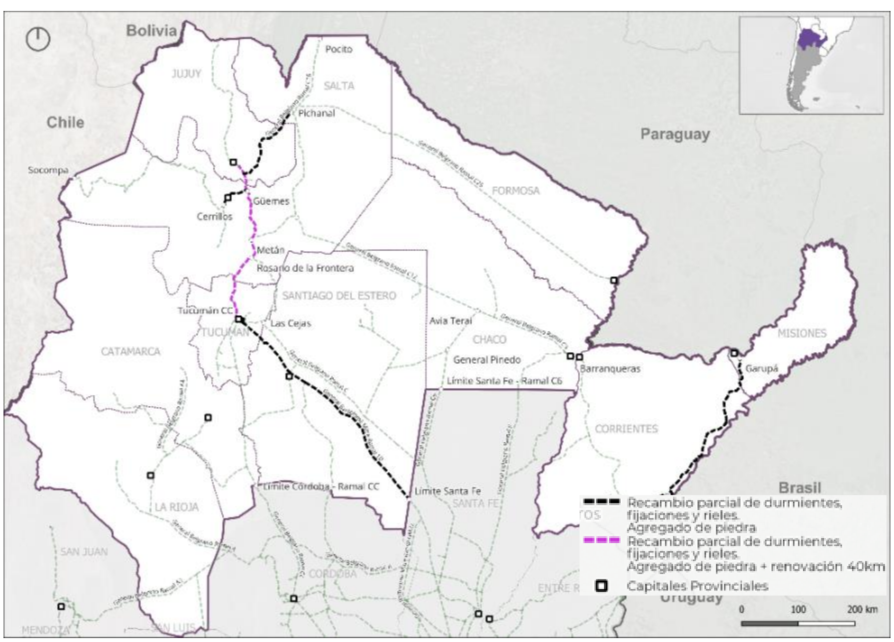


Figure 27: 5 potential rail projects were shortlisted

Source: Own analysis based on firm surveys, conversations with sectoral chambers, and CFI (2022/2023)

Table 6: *The prioritized road and rail works mostly focus on infrastructure rehabilitation*

	Road Works segment	Type	km	AADT (trucks)	Location of segment
1	NR34 - S. Pedro de Jujuy - Embarcación	Passing lanes	154	973	Jujuy, Salta
2	NR 9-ACC.A BANDA DEL RIO SALI - INT.PR306	Dual carriageway	2	2,462	Tucumán
3	NR 9-INT.R.P.306 - B/N NR38	Dual carriageway	2	2,767	Tucumán
4	NR11 - Lte. Santa Fe - Formosa City	Rehabilitation	364	1,194	Chaco, Formosa
5	NR14 - Lte. Entre Ríos -Santo Tomé	Rehabilitation	342	2,089	Corrientes
6	NR14 - Santo Tomé - Bdo. De Irigoyen	Rehabilitation	442	850	Corrientes, Misiones
7	NR12 - Posadas - Puerto Iguazú	Rehabilitation	298	1,266	Misiones
8	NR157 - Emp. NR60 - SM. Tucumán	Rehabilitation	310	1,083	Catamarca, Santiago del Estero, Tucumán
9	NR34 - Cabeza de Buey - Pocitos	Rehabilitation	360	1,255	Salta, Jujuy
10	NR34 - Lte. Santa Fe - Rosario de la Frontera	Rehabilitation	576	1,804	Santiago del Estero, Tucumán, Salta
11	NR51 - Gral. Alvarado - Lte. Chile	Rehab., paving (136 km)	289	467	Salta
12	NR79 - Chamical - Emp. NR60	Rehabilitation	125	226	La Rioja
13	NR81 - Emp. RN95 - Emp. NR34	Rehabilitation	498	180	Salta, Formosa
14	NR9 - City of Stgo. del Estero - City of Salta	Rehabilitation	461	1,822	Santiago del Estero, Salta, Tucumán
15	NR9 - Lte. Córdoba - Stgo. del Estero City	Rehabilitation	239	2,446	Santiago del Estero
	Rail Works segment			**tons per km**	
16	Belgrano Line - Branch C13-Güemes - Cerillos	Improvement *	63	78,775	Salta
17	Belgrano Line - Branch C15-Perico - Pichanal	Improvement *	167	31,592	Jujuy, Salta
18	Belgrano Line - Branch C-Tucumán - Palpalá	Improvement *+ renovate 40km	337	244,242	Tucumán, Salta, Jujuy
19	Mitre Line - G1-Tucumán - Santa Fe limit	Improvement *	474	1,654,709	Tucumán, Santiago del Estero
20	Urquiza – Garupa - Entre Ríos boundary	Improvement *	487	213,406	Corrientes and Misiones

* Partial replacement of sleepers, fasteners and rails, stone aggregate
Source: Own elaboration based on CNRT (2021), COSFER - Ministerio de Transporte de la Nación (2019) and interviews with sector specialists.

4. The shortlisted transport projects would generate significant direct and wider economic benefits

4.1. Some of the shortlisted projects would significantly reduce transport costs

To quantify the direct user benefits, the current study first estimates the impact of the specific shortlisted road and rail infrastructure projects on the transport costs from the point of view of transport service providers (carriers). Two scenarios were defined, *without* and *with* the project. The corresponding costs were calculated by applying the Railway Cost Model (COSFER) and the Road Cost Model (MCC), developed by the National Ministry of Transportation in 2017 and 2019,[18] respectively. The purpose of both models is to estimate transport operating costs based on typical operating parameters, producing results in terms of ARS and US$ per ton, km, and ton-km, which allows their comparison.

[18] Although the models were published in 2017 and 2019, they include an updating methodology that allowed to obtain more current results. Details of the methodology used to estimate the transport cost impacts are provided in Annex 3.

In all cases, current operating standards were established, and consideration was given to how the infrastructure works in question would improve some of the operating parameters of the mode of transport in the scenario *with* project. For example, for the scenario *without* project, considering the current state of the infrastructure in the section of work considered, the average speed for the route was evaluated, the annual kilometers that this average speed would allow, fuel consumption, rolling stock, etc. Then, the model was run again considering how an improvement in the condition of the infrastructure could improve the speed of the route, weight per axle, annual km traveled, etc. The difference between the two calculations corresponds to the cost savings. The analysis is conducted from the point of view of the transportation service providers; the projected savings may or may not be reflected in the freight market rates. Moreover, the savings correspond to what the National Directorate of Public Investment (DNIP) calls "Benefits from cost savings of vehicles that make up the normal traffic" (see DNIP, 2020). Normal traffic is that which currently exists, and the calculation in both the without and the *with* project scenarios assumes the same level of traffic. This allows to understand how transport costs would be reduced for existing traffic, without considering the benefits of induced or generated traffic that could eventually be generated by the project. Absolute cost savings are expressed in 2024 dollars.

The costs associated with road freight transport services depend mainly on the distance between the origin and destination of the cargo, the rolling stock used, the speed of circulation, the annual kilometers traveled and the condition of the infrastructure. These parameters determine the consumption of fuel and other inputs, insurance, labor, maintenance and amortization of the capital invested in the truck, all of which constitute the operating costs incurred by the companies offering these services**.** The primary and secondary road infrastructure network is provided and financed by the State, and only in some stretches is a toll charged for its use, which only covers a small part of the costs associated with the wear and tear of the infrastructure generated by each vehicle. Thus, unlike in the case of railroads, road transport service providers do not internalize the costs associated with infrastructure maintenance in their structure.

Unlike road freight, in the case of rail, the condition of the infrastructure at one point of the network limits the operating conditions of all traffic that needs to pass through that point, even if it represents a marginal percentage of the total distance traveled. For example, if a small section of the network admits up to 17 tons per axle and the rest 20 tons, the load capacity is limited to 17, if the train must travel through both sectors. Thus, if a section of the network is intervened, but not the rest, the improvements in operating conditions (speed, capacity and length of the trains) will only be observed in those traffics that have origin and destination within that section. On the contrary, if the traffic corresponds to passing freight or has origin or destination outside that section, it will only benefit from an improvement in speed in the kilometers it uses in that section.

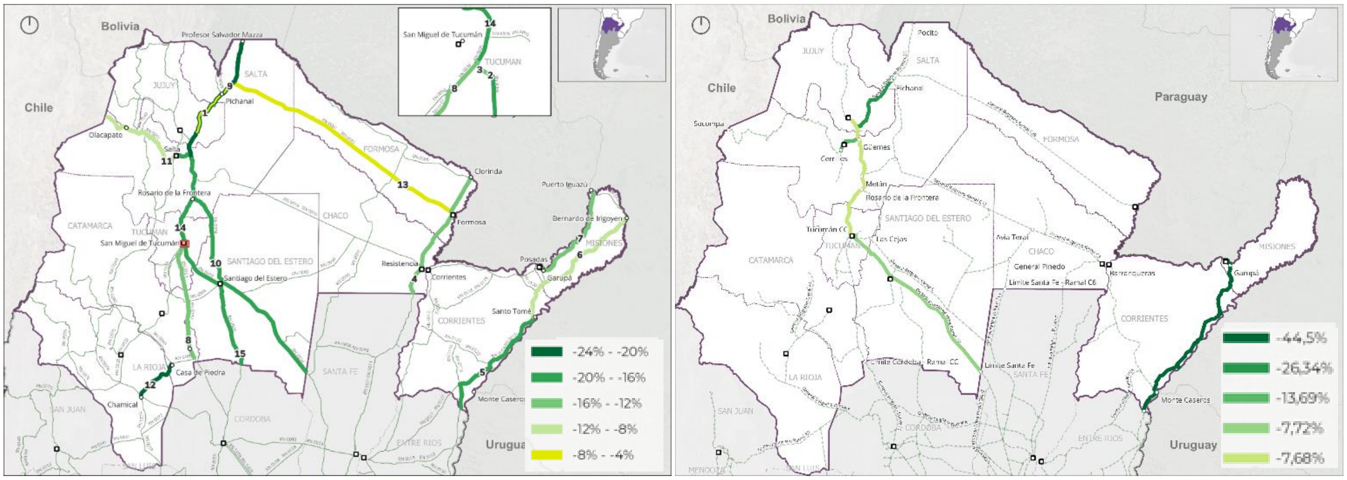
Therefore, in addition to estimating the impact of investment in individual rail lines, cost savings were also calculated for more comprehensive/ spatially coordinated projects by considering the origin-destination pairs of cargo and the network configuration of this mode of transport. Thus, the impact of concurrently implementing the three projects of the Belgrano line was evaluated, since they are interconnected, together 567 km. The two other "comprehensive" projects considered include the improvement of the Mitre GM1 branch line from Tucumán all the way to Rosario (851 km) and of the Urquiza line trunk line from Garupá all the way to Zárate (1,063 km).

In the case of road projects, operating cost savings in the intervened sections range between 4.5 and 24 percent. The greatest savings are seen in the case of works on NR79-NR60, NR34 (Cabeza de Buey – Pocitos), and NR9 (Ciudad de Santiago del Estero – City of Salta), all of them corresponding to pavement repair in sections of National Roads in poor condition (Figure 28 a.). Works to construct dual carriageways and passing lanes also have a relevant impact; although they are shorter sections, they represent a significant improvement in the service levels of the infrastructure and are located on key routes in the Norte Grande, such as allowing to access provincial capitals like San Miguel de Tucumán.

In absolute terms, considering the traffic that currently passes through the segments, the highest estimated total operating cost savings are on NR14 in Corrientes, and on NR9 and NR34 that both connect Santiago del Estero, Tucumán, and Salta (Figure 29). On all three of these segments the estimated total operating cost savings exceed US$35 million per year. In the case of some segments, such as NR51 in Salta connecting to the border with Chile, the total expected absolute cost savings for transport services operators may increase significantly in the coming years as compared to those estimated using current traffic levels, given the expected growth in trucks traveling to and from the lithium mining areas.

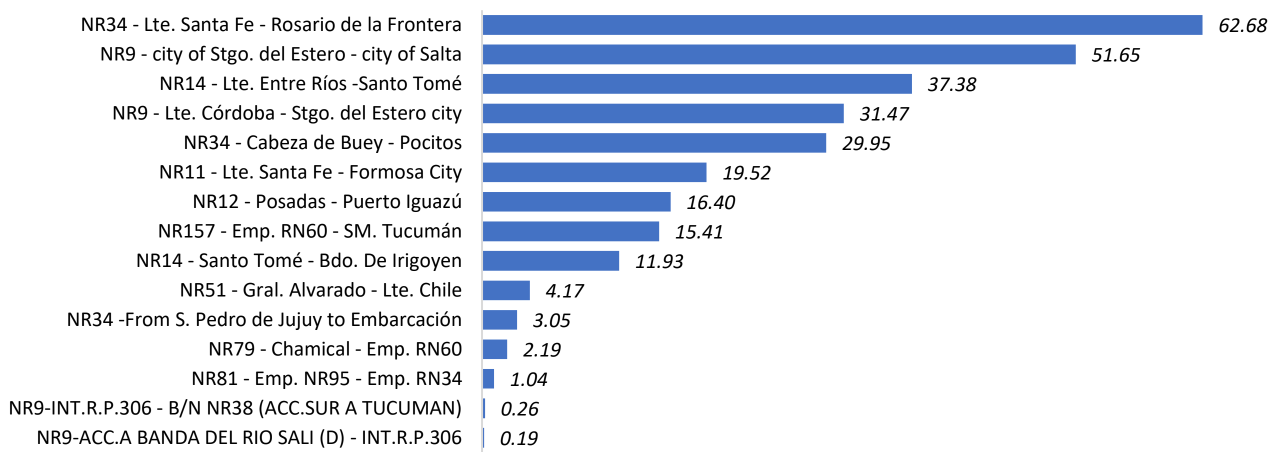
Figure 28: *The estimated operating cost savings per ton-km range between 4 and 44 percent, depending on the segment*

a. Road works *b. Rail works*



Source: Own elaboration based on DNV, MCC-Ministerio de Transporte de la Nación, CNRT (2021), COSFER - Ministerio de Transporte de la Nación (2019) and interviews with sector specialists

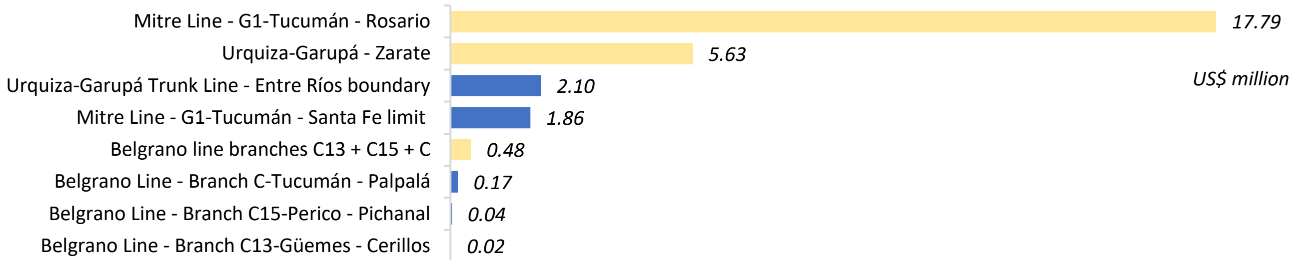
Figure 29: *The total operating cost savings in the segment would exceed US$50 million per year in the case of some road projects*



Source: Own elaboration based on DNV, MCC-Ministerio de Transporte de la Nación, and interviews with sector specialists

Regarding the selected rail works, the variation in operating costs is between 7.7 and 44.5 percent, the latter corresponding to the improvement project of the section between Garupá and the border of Entre Ríos of the Urquiza line (Figure 28 b.). The total absolute reduction in operating costs depends not only on the magnitude of the improvement in operating parameters but also on the relative weight of the length of the section within the network and on the proportion (and intensity) of the load that uses this section. The Garupá - Lte. Entre Ríos section – estimated to generate over US$2 million in savings per year – represents 46 percent of the length of the operating branches of the Urquiza line and 98 percent of the ton-km. Intuitively, its improvement is associated with a significant cost reduction considering the ton-km with origin and/or destination in the section and with respect to the entire network. Likewise, significant cost savings are expected when considering more comprehensive projects such as the improvement of the Mitre line all the way to Rosario (generating savings of nearly US$18 million per year). As noted before, due to the interconnected nature of the network, the joint implementation of the three Belgrano line projects would generate total operating cost savings that exceed the sum of the three individual segment (Figure 30).

Figure 30: *Total annual operating cost savings would be larger in the case of more comprehensive rail projects*



Source: Own elaboration based on CNRT (2021), COSFER - Ministerio de Transporte de la Nación (2019)

4.2. The shortlisted projects would generate thousands of direct, indirect, and induced jobs

Job multipliers in the infrastructure sector have typically been found to be high in Latin America. Recently, Arakaki et al. (2021) assessed the short-term job generation potential of infrastructure investments in Argentina. The analysis was based on a 2017 Input-Output model (Chisari *et al*., 2020) with a breakdown of the construction sector into multiple infrastructure subsectors. The disaggregation was feasible after compiling a dataset with cost structures for about 70 infrastructure projects. The analysis revealed significant heterogeneity across subsectors of infrastructure investment, with job generation potential ranging between 15,000 and 49,000 annualized direct, indirect, and induced jobs in the short-term per US$1 billion invested.

Focusing on the road and rail works prioritized through the multicriteria analysis and firm surveys – considered those that could most directly support economic activity in the Norte Grande – the current study estimates job generation potential, including direct, indirect, and induced.[19] The first of these is directly linked to the construction work, for example, the hiring of bricklayers, welders, road machinery drivers, etc. The second is the result of the increase in the demand for goods and services in other sectors of the economy that are inputs for the works, such as the cement industry, the iron and steel industry, and the production of crushed stone, among others. The last is generated by the increase in wage income associated with the increase in employment in the construction industry (direct) and its supplier sectors (indirect), which translates into higher consumption of goods and services by households and, consequently, an increase in the hiring of personnel to produce them. The analysis also estimates some characteristics of the jobs expected to be generated in terms of gender, age, and qualification. The magnitude of the impact of the construction work on employment will depend on the type of construction, the sectors supplying inputs and services, the dependence on domestic inputs compared to imported ones, and the consumption characteristics of households.

The current study applied the employment model developed by World Bank (2021), based on the Input-Output Matrix (IPM) methodology.[20] The IPM shows the interrelationship between activities, allowing to estimate the impact of the increase in aggregate demand of one sector on the rest of the sectors of the economy and to compute the change in employment because of the increase in production.[21] As discussed earlier, the prioritized road works include the construction of dual carriageways, passing lanes (third or fourth lanes), and pavement resurfacing. The proposed rail works are mostly improvement works, except for a 40 km section on the Belgrano line C branch, between Metán and Rosario de La Frontera, in Salta. Unlike renewal, improvement works consist of the partial replacement of components of the existing infrastructure, so the scope and tasks carried out differ considerably. Given the state of the infrastructure in the considered branches, significant improvement is assumed.

[19] The estimates do not consider the impacts from increased productivity from transport investments.

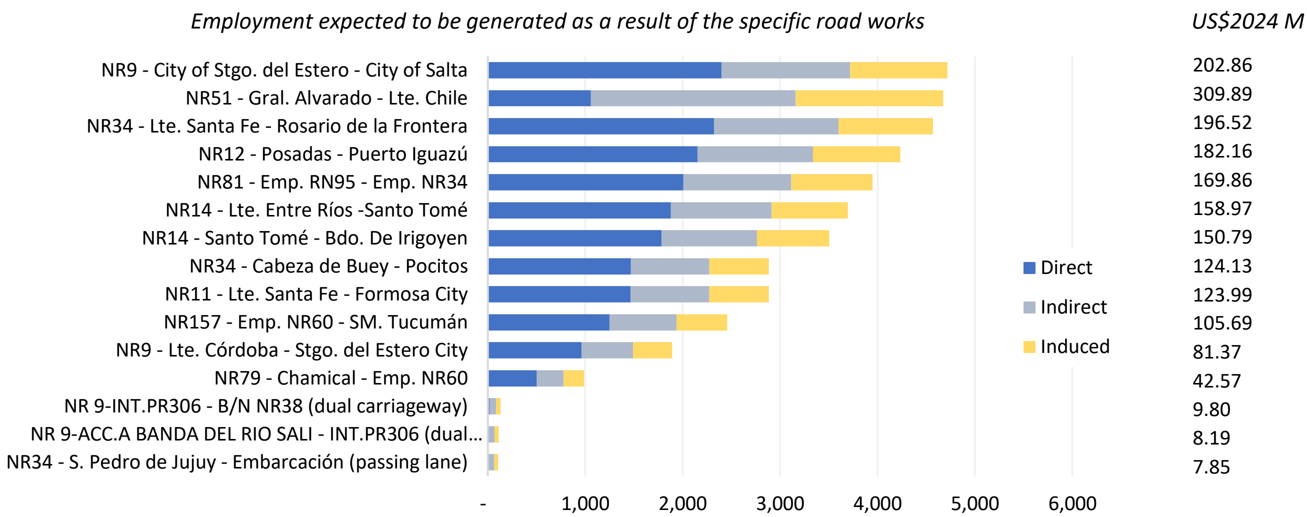
[20] "The IPM is an orderly record of the transactions between the productive sectors aimed at satisfying goods for final demand, as well as intermediate goods that are bought and sold among themselves. In this way, it is possible to illustrate the interrelationship between the various productive sectors and the direct and indirect impacts that an increase in final demand has on them.

[21] Detailed description of the methodology and assumptions are provided in Annex 5.

The implementation of the 20 selected works would altogether cost around US$2.102 billion (in 2024 dollars), of which 77 percent correspond to road works and 23 percent to railway works. Based on the total estimated investment value, it is expected that the execution of the works will generate some 50,100 jobs,[22] of which 42.3 percent are direct, 33.5 percent indirect, and 24.1 percent induced by the increase in household consumption. If the scope of some of the railroad projects considered is expanded (i.e., the aforementioned "comprehensive" projects), the total amount of investment needed would be about US$2.385 billion, generating some 55,600 jobs.

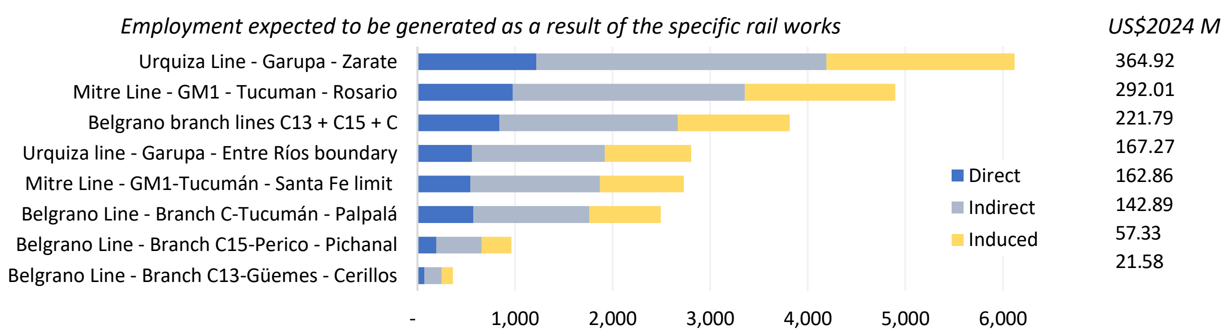
The road works that generate the most employment tend to be the most expensive ones (Figure 31). These include pavement reconstruction on NR9 between Córdoba and Santiago del Estero with 4,716 jobs; RN51 with 4,676 jobs; and RN34 between Santa Fe and Rosario de la Frontera with 4,674 jobs. In all cases, these are works that are also more employment intensive than railway works. In absolute terms, however, the "comprehensive" rail projects – on the Mitre and Urquiza lines – would generate the most employment, mostly indirect and induced.

***Figure 31:** The costliest road investments would generate upwards of 4,000 jobs each*



Source: Own elaboration based on World Bank (2021) model, BCRA, CAMARCO, COSFER (2017), DNV, INDEC, and TAC

***Figure 32:** Indirect and induced jobs represent most jobs generated by the shortlisted rail projects*



Source: Own elaboration based on World Bank (2021) model, BCRA, CAMARCO, COSFER (2017), DNV, INDEC, and TAC

The investment in the proposed road works will generate a range of jobs, by skill type. In the road works projects, operational and technical jobs are expected to account for most employment: 67 percent of all employment generated in the proposed dual carriageway and passing lane construction and 66-67 percent in the pavement rehabilitation works. Unskilled jobs represent between 25 percent (dual carriageways and passing lanes) and 26-29 percent in the

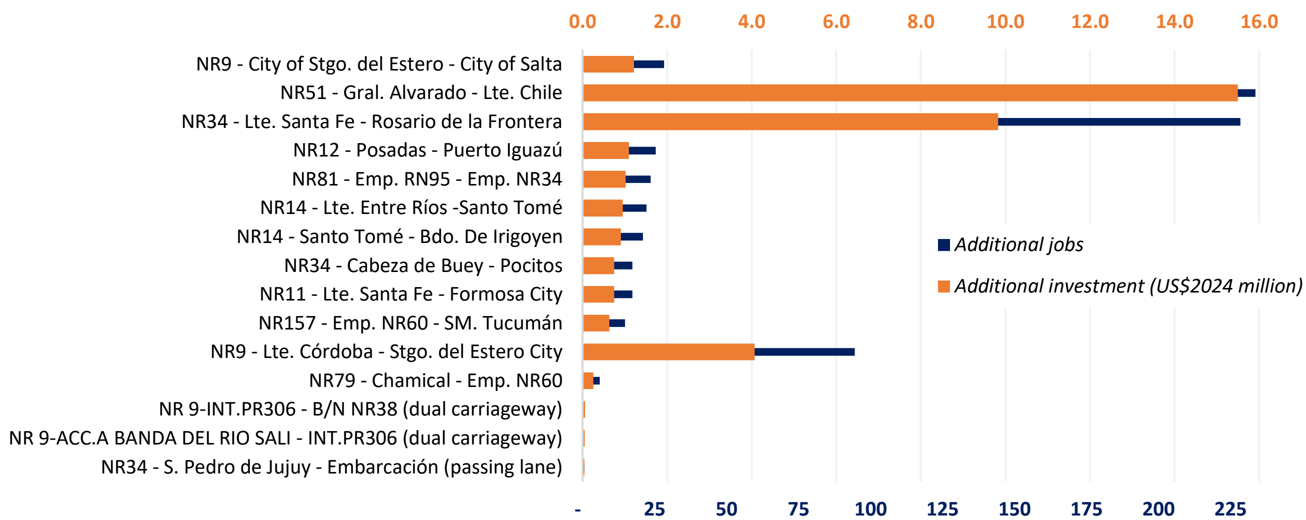
[22] The model calculates an equivalent annual value, as if enough work fronts were undertaken to complete the work in 1 year. In reality, depending on the magnitude of the work and the segmentation of sections in the tenders, the works may last more than 1 year (or less). If one assumes that this could be a 5-year plan, for example, and that input needs behave linearly, the employment generated per year would be 10,020 jobs.

pavement rehabilitation, while professional skilled jobs are expected to account for between 5-7 percent (pavement rehabilitation) and 8 percent (dual carriageways and passing lanes) of jobs.

In the case of rail works, the shares between the operational/technical, unskilled, and professional jobs are similar, at about 62-64 percent, 30-31 percent, and 6-7 percent, respectively. Women are expected to be employed in 26 percent of all the jobs generated as a result of the dual carriageway and passing lane construction projects, 15-23 percent of the jobs generated in pavement rehabilitation works (the upper part of the range corresponding to the works on NR51 where a portion of the segment would need to be paved), and 23 percent of the jobs generated by the rail works projects.

The participation of local employment in the overall estimated employment will depend on the qualification of the job required. Given that the considered works do not involve significant complexity and have already been carried out in the Norte Grande, it is likely that a large part of the direct employment will come from the local area, the province or neighboring provinces. Regarding indirect employment, it will depend on the availability of inputs in the region. Presumably, the consumption of stone, sand, fuel, rail sleepers, hotel and restaurant services, and vehicle rental will be acquired locally, while the rest will depend on the availability of local industries. On the other hand, most cement and concrete will probably come from other regions of Argentina where the cement plants are located, mainly Buenos Aires and Córdoba, although there is also production in Salta.

***Figure 33**: Some road projects may require significant additional investment to make the infrastructure climate resilient*



Source: Own elaboration based on World Bank (2021) and data from BCRA, CAMARCO, DNV, INDEC, World Bank (2019), and World Bank/GFDRR (2021)

Additional analysis of the expected employment impacts of the works was conducted assuming somewhat higher costs that would be associated with making the road segments more resilient to extreme climate events, in particular flooding. Taking as a reference World Bank (2019) and World Bank/GFDRR (2021), the segments exposed to low flood risk[23] were assumed to have 0.6-percent higher costs than in the reference analysis, while those exposed to high risk were assumed to cost 5 percent more compared to the base estimates. These estimates are indicative and would need to be refined through detailed engineering studies. They suggest that the largest additional investment needed to make the infrastructure climate resilient – and the highest associated additional employment generated – would be for the NR51 segment connecting Salta to the Chilean border (over US$15.5 million additional investment cost and about 235 additional jobs) and the NR34 segment connecting Santiago del Estero, Tucumán, and Salta (US$10 million and 228 jobs) (Figure 33).

[23] Based on the firm survey responses and the rainfall/ TWI analysis conducted as part of this study, most of the selected works are exposed to some flood risk and rainfall related interruptions to connectivity.

4.3. Beyond direct user benefits, the shortlisted works would boost provincial GDPs and gross value added

Infrastructure investments help improve welfare through several mechanisms. First, roads and other physical infrastructure provide services that directly contribute to improving the quality of life, thus increasing household welfare. Second, infrastructure services help increase household income – and, therefore, welfare – via improved market access to household products and job creation. Third, infrastructure investment boosts economic growth, which spills over to household welfare. Connective infrastructure, such as roads, is likely to have the greatest impact on economic growth, by increasing firm access to markets and worker access to job and income opportunities (Andres, Biler, and Herrera Dappe, 2015).

There is strong evidence that increased access to basic infrastructure services in rural areas is key for promoting poverty reduction, growth, and various wider economic benefits. Investments in road infrastructure reduce the cost of transport and logistics and improve market access (Aggarwal, 2018), and well-developed infrastructure also improves the competitiveness of the private sector (Wolassa, 2012), including in the agriculture sector (e.g., Teruel and Kuroda, 2005). Improved transport infrastructure can be expected to generate not only reductions in transport costs but also the price of imports for consumers while increasing the price local exporters receive for their sales. In turn, the increased purchasing power of workers and the arrival of new workers can be expected to increase the demand for non-tradable goods and services, making more competitive regions denser while also putting pressure on land prices. Moreover, investing in corridors in a given Province can create spillover benefits for other Provinces. Predictions from the New Economic Geography literature suggest that improvements in connectivity are likely to be associated with more spatial concentration, not dispersion, of economic activity, as firms increase scale and benefit from agglomeration economies by locating near other firms engaged in similar and related activities. Some districts might lose whereas others might gain from better connectivity, driven by factors such as the share of local production that is tradable.

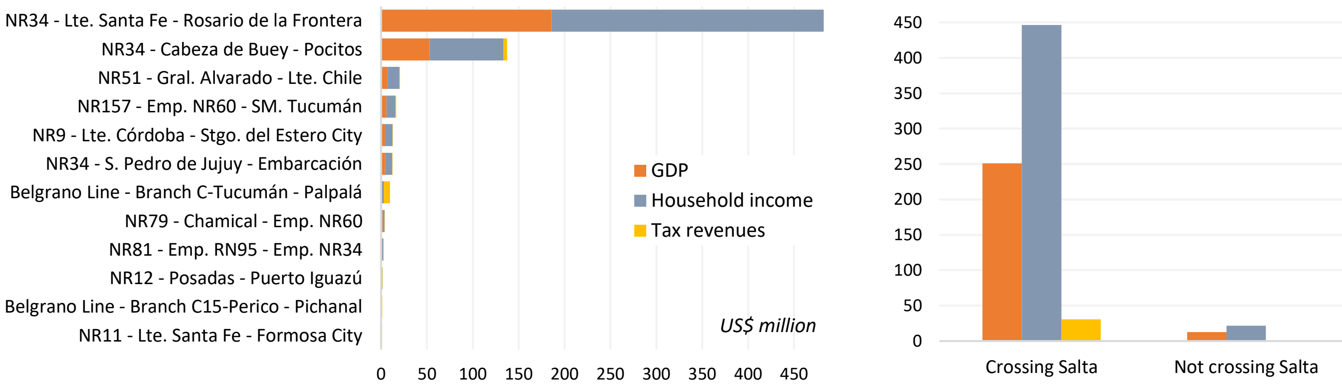
A recent study used a spatial equilibrium model to simulate the potential aggregate and regional effects of investment in transport infrastructure in NOA, specifically focusing on the cities being affected by the investment (see World Bank, 2020a). The specific scenario included the expansion of local sections of NR34, NR66 and NR1V66 to a four-lane highway with stronger all-weather surfacing, divides, and improved maintenance. While the predicted national-scale benefits associated with the investment are modest (0.16 percent national welfare gain), the individual major cities linked by the improved road (San Salvador de Jujuy and San Pedro de Jujuy) are expected to see a significant (2 percent) increase in employment, with spillover benefits also for the smaller economically linked small towns like General San Martin and San Pedro. The study also finds that the aggregate benefits would be larger if multiple types of investment were to take place – in both transport infrastructure and public services – in cities like San Pedro, San Salvador, City of Salta, and San Martin.

Considering the road and rail investments analyzed in the previous sections – assessed as the most directly relevant for supporting the Norte Grande's key value chains and economic activity **– the current study developed province-specific spatial Computable General Equilibrium (CGE) models to estimate the expected provincial and national GDP, sectoral value added, household income, and tax revenue effects.** Given the availability of pre-existing models, the analysis focused on the provinces of Salta, Jujuy, Catamarca, Chaco, and Corrientes.

Salta

The projects with by far the most significant expected effect in terms of provincial GDP and household incomes are two segments of NR34 (Figure 34). In addition, the improvement of the Belgrano line C branch is expected to generate some of the larger tax revenue impacts across all projects. Some of the projects with high estimated macroeconomic benefits for Salta – namely, NR157 and NR9 – do not actually cross the province but are important for its trade flows. Altogether, the improvement of the segments that are at least partially within Salta's own territory are estimated to increase the provincial GDP by US$251 million, its household income by US$446 million, and its tax revenues by US$31 million (all measured in 2024 dollars). The two segments of NR34 account for about 94-95 percent of the total benefits.

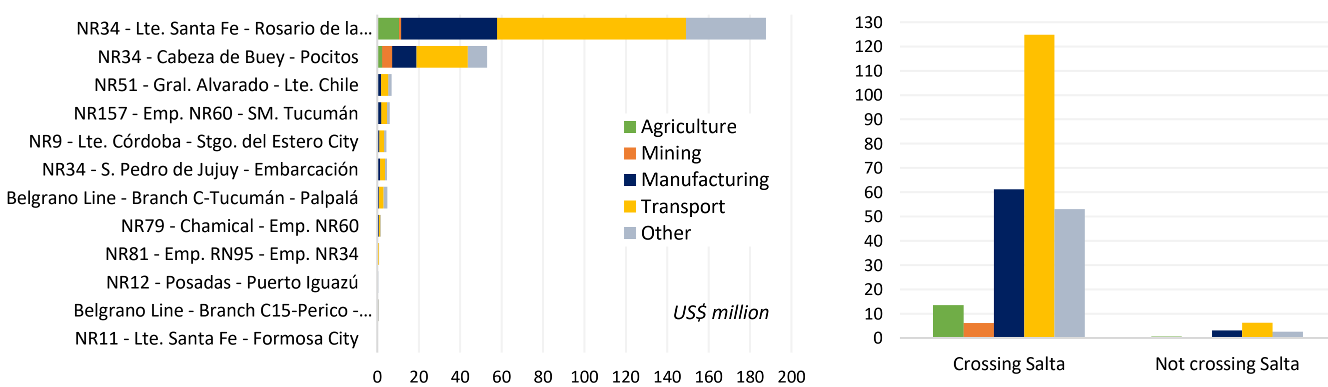
***Figure 34:** Salta's economy would most directly benefit from the improvement of NR34*



Source: Own estimates based on the estimated transport cost savings and province-specific general equilibrium model

The analyzed projects are estimated to generate significant gross value added (GVA) for the transport and manufacturing sectors, followed by "other" sectors, agriculture, livestock, forestry, and fishing (hereon: "agriculture"), and mining. The agriculture, transport, and manufacturing sectors would most benefit from the rehabilitation of the NR34 segment between Santa Fe border and Rosario de la Frontera (connecting Salta, Tucumán, and Santiago del Estero), while the largest GVA for the mining sector is expected from the rehabilitation of the NR34 segment between Cabeza de Buey and Pocitos (connecting Salta and Jujuy) (Figure 38). However, it should be noted that the model's equations do not account for the significant increase in mining activity expected in the province over the next decade, such as that associated with the Taca Taca copper mine and several lithium projects; therefore, the GVA estimates for the sector can be considered as very conservative.

***Figure 35:** The shortlisted transport improvements would generate significant GVA for Salta's manufacturing and "other" sectors*



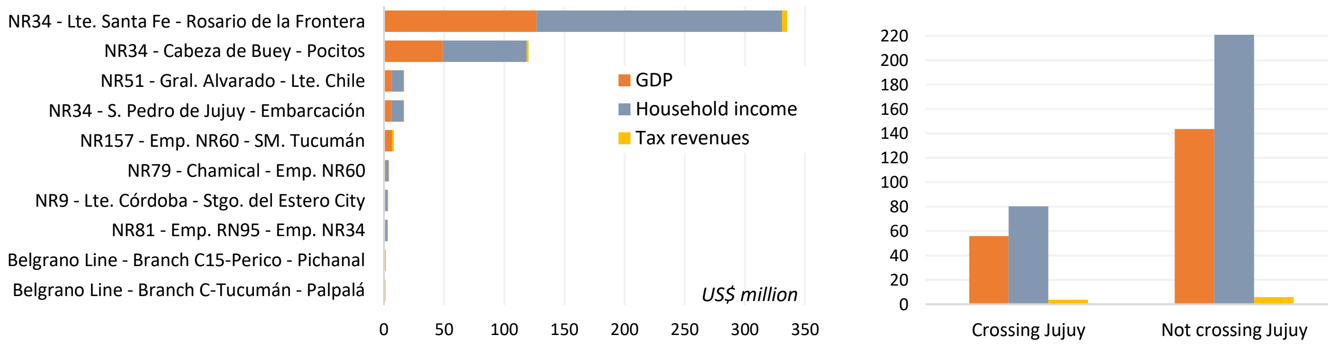
Source: Own estimates based on the estimated transport cost savings and province-specific general equilibrium model

__Jujuy__

As in the case of Salta, the same projects are also estimated to have the largest economic benefits for the GDP, household incomes, and tax revenues of Jujuy; however, in this case, two of the segments (NR34 and NR51) do not actually cross the province's own territory. In addition, relatively large benefits are also expected from the improvement of the NR34 segment between San Pedro de Jujuy and Embarcación (connecting Jujuy to Salta) (Figure 39). Altogether, the improvement of the segments that are at least partially within Jujuy's own territory are estimated to increase the provincial GDP by US$56 million, its household income by US$80 million, and its tax revenues by close to US$4 million.

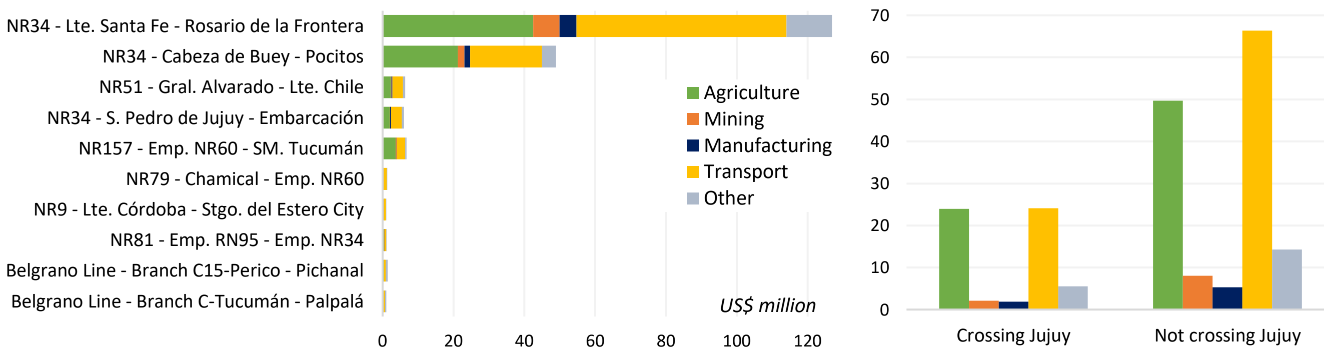
In contrast to Salta, in the case of Jujuy, the agriculture sector (but not manufacturing) is estimated to be a comparatively important beneficiary of the proposed investments. The sector's GVA would account for about 42 percent of the total GVA estimated to be generated by projects that cross Jujuy's own territory and about 35 percent of the total of the other projects. The rehabilitation of NR34 between the border of Santa Fe and Rosario de la Frontera is expected to generate by far the largest gross value added for Jujuy across all projects, approximately US$127 million (Figure 37). As in Salta, the model likely underestimates the GVA impacts that would materialize for the mining sector.

Figure 36: *Jujuy's economy would benefit from road and rail improvements in the neighboring provinces*



Source: Own estimates based on the estimated transport cost savings and province-specific general equilibrium model

Figure 37: *The agriculture sector in Jujuy would gain significant GVA*

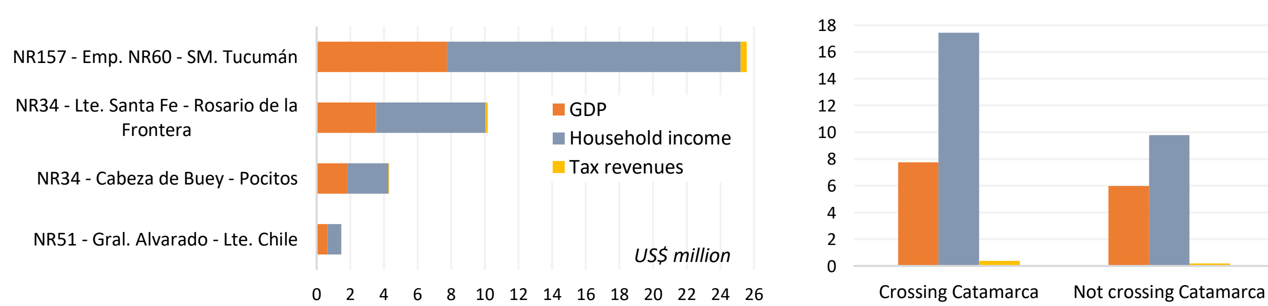


Source: Own estimates based on the estimated transport cost savings and province-specific general equilibrium model

Catamarca

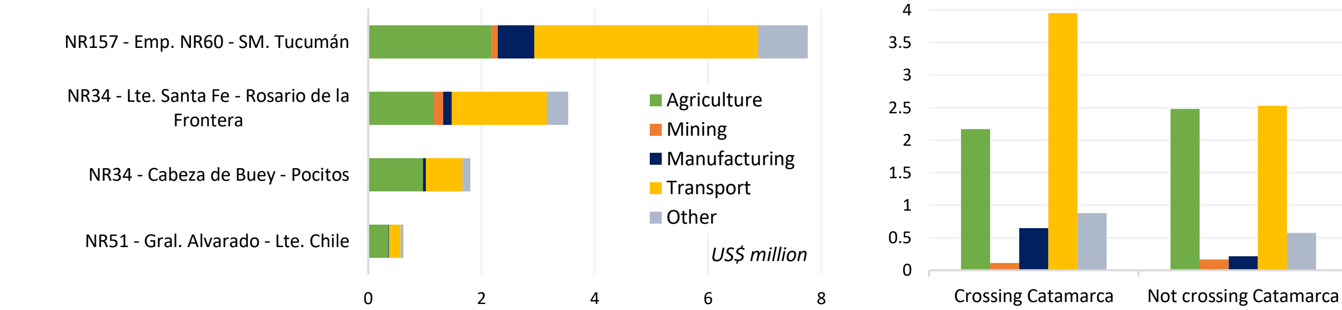
For Catamarca, the largest provincial GDP, household income, and tax revenue benefits are expected from the only project crossing the province's own territory, namely the NR157 segment connecting the province to Tucumán and Santiago del Estero (Figure 38). The improvement of NR157 is estimated to increase Catamarca's provincial GDP by nearly US$8 million, its household income by about US$17.5 million, and its tax revenues by US$0.4 million. Smaller but still tangible benefits are also expected to be associated with the rehabilitation of the two NR34 segments and the NR51 segment that all would also generate large benefits for Salta and Jujuy. Similarly to Jujuy, the agriculture sector in Catamarca is expected to be a key beneficiary of the proposed road rehabilitation works in terms of the sectoral gross value added (Figure 42). However, as in Salta and Jujuy, the benefits for the mining sector are likely underestimated.

Figure 38: *Catamarca's economy would most benefit from improved connectivity to Tucumán and Santiago del Estero*



Source: Own estimates based on the estimated transport cost savings and province-specific general equilibrium model

Figure 39: Catamarca's agriculture sector would be a key beneficiary in terms of its GVA

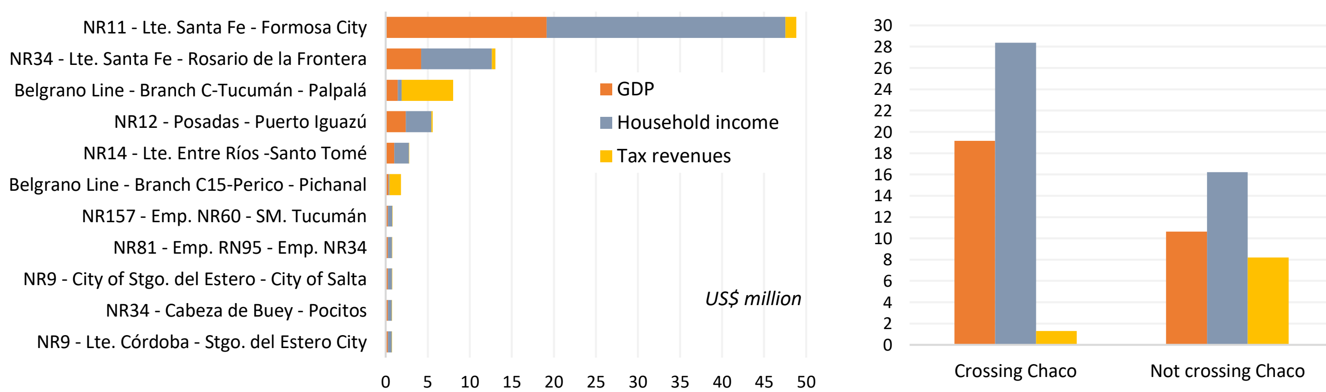


Source: Own estimates based on the estimated transport cost savings and province-specific general equilibrium model

Chaco

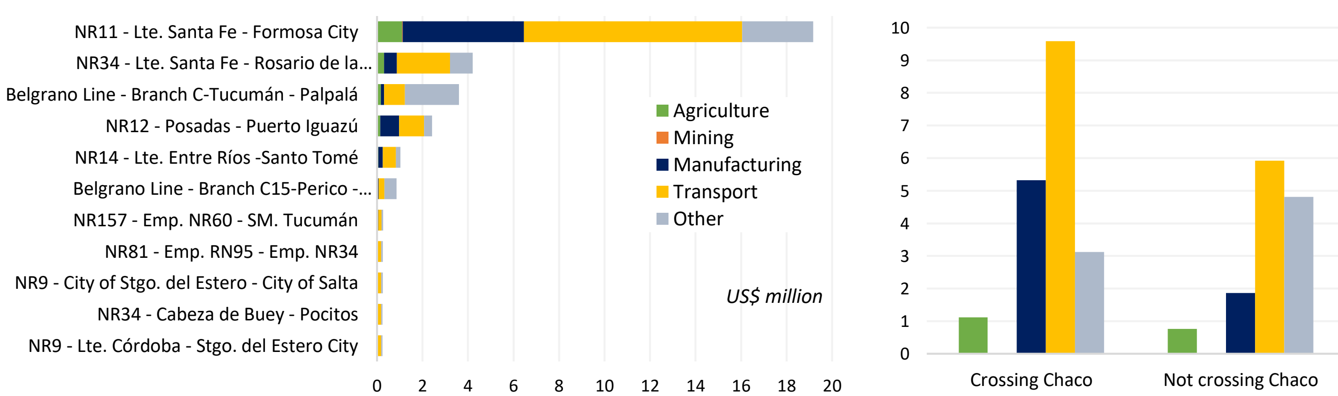
The rehabilitation of NR11 between Santa Fe border and Formosa City is the only project that was analyzed that physically crosses Chaco's own territory, and it is estimated to generate by far the largest province-level GDP and household revenue benefits (Figure 40). The model also suggests that the improvement and renovation of the Belgrano rail line C branch, connecting Tucumán, Salta, and Jujuy but not entering Chaco itself, would deliver the largest tax revenue benefits. The second most important project in terms of Chaco's provincial GDP and household income is the NR34 segment between the Santa Fe border and Rosario de la Frontera, which is in the top three most impactful projects also in the case of Salta, Jujuy, and Catamarca. Similarly to Salta, in Catamarca the manufacturing sector is estimated to be a key beneficiary of the analyzed road and rail works (Figure 41).

Figure 40: The rehabilitation of NR11 would generate the most significant benefits for Chaco's economy



Source: Own estimates based on the estimated transport cost savings and province-specific general equilibrium model

Figure 41: Chaco's manufacturing sector would be a key beneficiary as measured by sectoral GVA

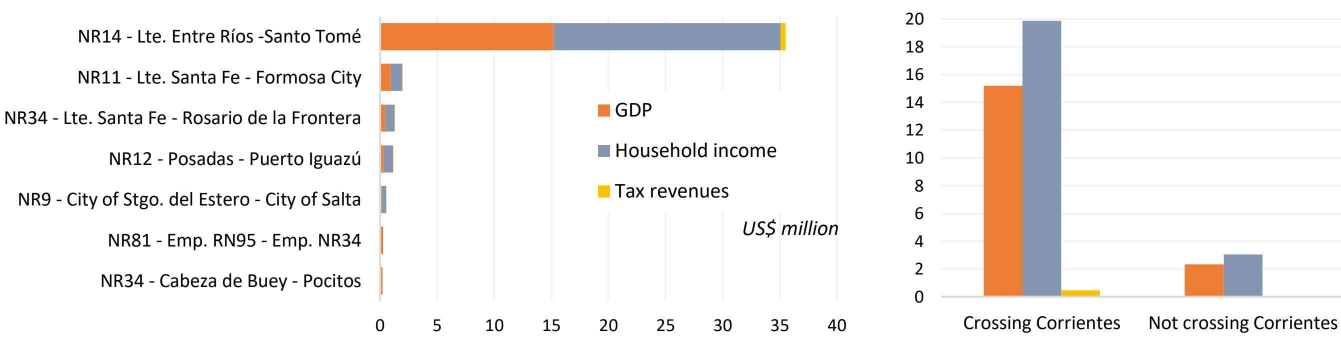


Source: Own estimates based on the estimated transport cost savings and province-specific general equilibrium model

Corrientes

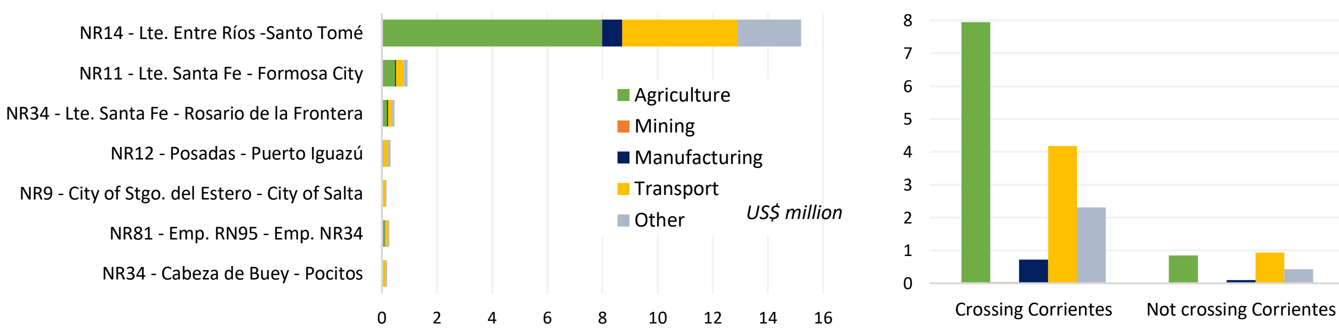
The only analyzed project directly crossing Corrientes is the NR14 segment between the border of Entre Ríos and Santo Tomé in Corrientes, and its rehabilitation is estimated to generate by far the largest economic benefits for the province across all of the pre-prioritized road and rail works: about US$15 million in GDP growth, US$20 million in household income, and US$0.5 million in tax revenues. The same project could also generate gross value added of about US$15 million, of which the agriculture sector would represent about 52 percent, followed by the transport sector (27 percent) (Figure 43). Several proposed road improvements that do not actually cross the territory of Corrientes would also benefit the province's economy, including two segments of NR34 that are also assessed to be the most impactful for the other analyzed provinces.

Figure 42: *The rehabilitation of NR14, connecting to Entre Rios, would generate significant economic benefits for Corrientes*



Source: Own estimates based on the estimated transport cost savings and province-specific general equilibrium model

Figure 43: *The agriculture sector would reap over half of the GVA*



Source: Own estimates based on the estimated transport cost savings and province-specific general equilibrium model

5. Improvements in electricity and digital connectivity are needed to amplify the benefits of better transport connectivity

The benefits of transport infrastructure investments increase when infrastructure services investments are coordinated (bundled), as shown by evidence from Peru (Escobal and Torero, 2004), East Africa, and the Lake Chad region, where the impacts of *bundled* infrastructure investments (in roads *plus* internet connectivity, electrification, or border crossing improvements) on sectoral employment and structural transformation were found to be more significant compared with road-only investments (Moneke, 2020; Herrera Dappe and Lebrand, 2021; Lebrand, 2022). Similarly, in Brazil, a recent study finds strong complementarities associated with the joint provision of highways and electricity, which increases gross value added per capita at the time the infrastructure investment is made (see Selod, Steinbuks, Trotter, and Blankespoor, 2024). While the current study does not model the wider economic impacts of bundled infrastructure investments, the sections that follow summarize the digital connectivity and electricity access improvements that would most directly complement the transport and logistics interventions in supporting priority value chains and economic activity in the Norte Grande.

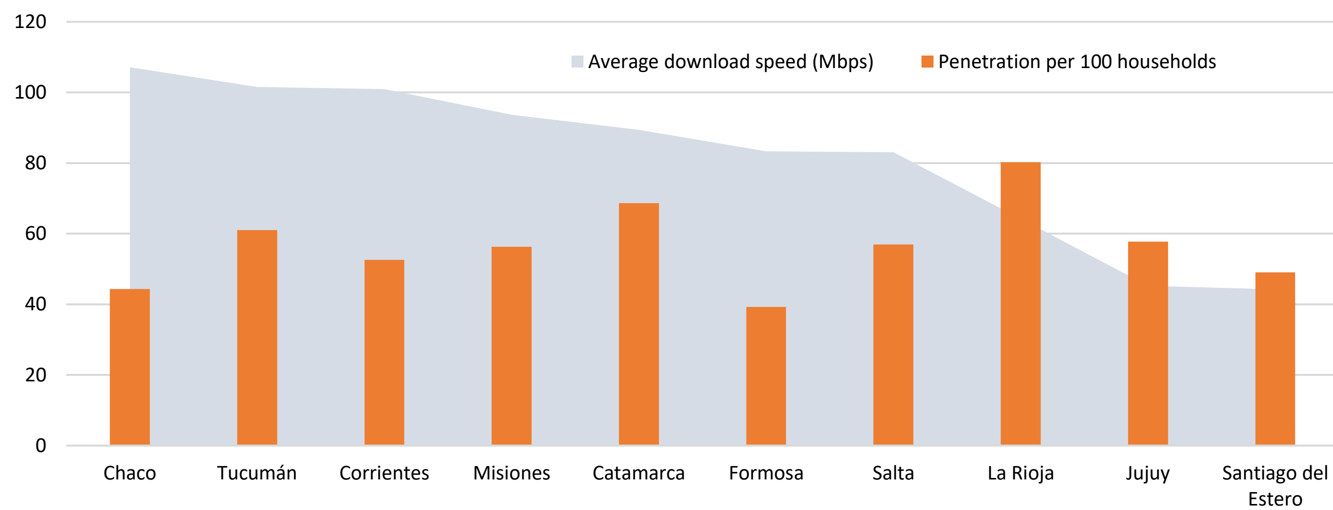
Internet access and the digital transformation process are central to the efficiency of logistics systems. Digital connectivity is important for coordination and exchange of information between cargo generators, both for logistics tasks and for production and trade issues. Mobile connectivity allows constant connection and communication with the carrier and the cargo, leading to efficiency improvements and value-added services (tracking and security, among others). Moreover, it facilitates services and tools to improve logistics services (security, traceability and quality control, among others). In both cases, connectivity can improve service efficiency and generate added value for cargo generators and final consumers.

Similarly, the availability of energy at a reasonable cost, with a satisfactory quality of service and without consumption restrictions, is key for economic activity. The cotton industry, with its ginning, spinning, and weaving processes, is a significant consumer of electricity, especially in Chaco, Santiago del Estero, Catamarca, and La Rioja. Similarly, the citrus fruit sectors are intensive users of electricity for refrigeration and processing. The extensive grains sectors – soy, corn, beans, and sorghum – require electricity for grain movement and quality maintenance. Therefore, investments and policies that improve electricity access and quality, especially if coordinated across provincial boundaries, can amplify the benefits of improved transport connectivity.

5.1. Digital connectivity gaps impede productive activities and the quality of transport services

Fixed connectivity in Argentina has improved year after year, with increasing connection speeds and greater service penetration. By the end of 2023, it had reached almost 140 Mbps average download speed and 78.56 connections per 100 households and 25.23 per 100 inhabitants.[24] Currently, the Argentinean Federal Fiber Optic Network (REFEFO) extends 32,804 km. A second stage is planned to be completed soon, adding over 4,400 km of fiber optic and thus connecting an additional 490,000 people (reaching a total of 22 million).

Figure 44: *Average download speeds are lowest in Santiago del Estero and Jujuy; fixed broadband penetration – in Formosa and Chaco*



Source: Own elaboration based on ENACOM open data (2023)

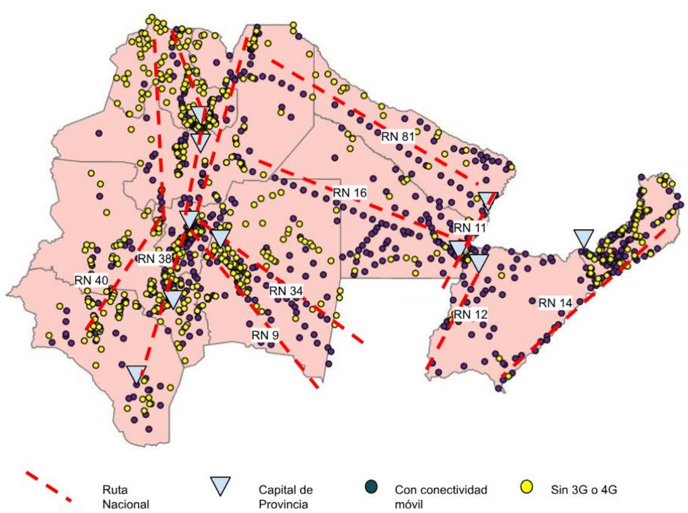
[24] In terms of **fixed broadband penetration**, Argentina is second in the region, only behind Uruguay, which has a rate of over 90% of households, and ahead of countries such as Mexico (70%), Costa Rica (64%), Brazil (63%), Chile (63%), Bolivia (55%) and others. Furthermore, the penetration of fixed broadband service is higher than other public services such as gas (58%) and sewage (62%). In terms of **quality of service**, Argentina ranks 62nd out of 159 countries in the Speedtest Global Index that compares fixed broadband download speed, behind Chile (4), Brazil (24), Uruguay (26), Peru (29), Colombia (35), Costa Rica (51), Ecuador (55), Paraguay (56), and ahead of Mexico (75), Venezuela (95), El Salvador (96), Bolivia (121) and others. See: https://www.speedtest.net/global-index (retrieved 7/31/2024).

There are stark regional disparities in digital access within Argentina, with predominantly rural regions, such as the Norte Grande, particularly disadvantaged.[25] Out of the 1,453 localities without broadband connectivity, 308 are in NOA and 92 in NEA, with Catamarca having the largest number of unconnected localities across the ten provinces of the Norte Grande, followed by Jujuy and Santiago del Estero. There is a significant variance between regions in terms of connection speed, both between provinces and within provinces. This is particularly relevant in the greater North of Argentina, where all provinces have an average connection below the national average, and only three provinces have an average download speed above 100 Mbps (Chaco, Corrientes, Tucumán). Some provinces, such as Santiago del Estero and Jujuy are systematically among the provinces with the lowest speed in the country (Figure 44). Also in terms of fixed broadband penetration per 100 households, there is still a significant deficit, with La Rioja being the only province that is above national average. Since 2014, penetration has increased significantly in all the Norte Grande provinces although to a lesser extent in Chaco, Formosa, and Santiago del Estero, where it remains below 50 connections per 100 households.

While mobile broadband service coverage in Argentina is higher than the LAC average, with only 4 percent of the population lacking mobile connectivity in their place of residence compared to 7 percent in LAC (GSMA, 2023), 3G/4G technology is available in less than half of the towns in the Norte Grande. According to ENACOM, less than 30 percent of localities in the provinces of Jujuy, La Rioja and Catamarca have 3G/4G coverage. Between 40 and 50 percent of the towns in Santiago del Estero, San Juan and Salta have 3G/4G, while in the provinces of Formosa, Tucumán, Chaco and Corrientes the share reaches between 60 and 80 percent.

The location of mobile sites is essential for providing mobile connectivity service. Sites are the geographical locations with 4G equipment, also known as antennas or equivalent facilities. According to ENACOM and Ministry of Defense, the Norte Grande provinces have 4,670 mobile sites, equivalent to 17 percent of the total for the whole country (22,814), when the population share is 22 percent and the share of the surface area – 23 percent.[26]

***Figure 45:** Areas far from national roads lack 3G/4G connectivity*



Source: own elaboration based on ENACOM open data (2023)

***Figure 46:** REFEFO aligns with major national roads*

Source: Argentina.gob.ar

Localities with 3G/4G are mostly located in the areas surrounding the provincial capitals or the main national routes. Localities along NR9, 11, 12, 14, 16, 16, 81, 38, 40 and 81 have 3G or 4G mobile connectivity. Certain road corridors have coverage because at the time of bidding for the 4G spectrum in 2014 it was specified that they should have 100% mobile coverage. Specific routes covered by the coverage obligations include Santiago del Estero - San M. de Tucumán (NR9), Salta - Salvador de Jujuy (NR9, NR34, and NR66), Rosario - Santiago del Estero (NR34), Córdoba - Tucumán (NR9,

[25] About 1,400 localities (30%) in Argentina are uncovered; 99 percent of them rural (World Bank, 2022b).

[26] Higher population, however, does not always need to equal a higher number of towers. In rural regions, multiple towers may be needed to reach isolated areas and connect a low number of users. The same number of towers would be able to cover many more users in urban areas.

NR60 and NR157), and San M. de Tucumán - Salta (NR9). However, mobile connectivity may occur only when crossing the main cities and towns on the routes, and not along the entire route.

The Office of the Chief of Cabinet of Ministers has signed Province-level agreements related to Plan Conectar and the The Federal Fiber Optic Network (REFEFO) expansion. In the Norte Grande, such agreements have been signed only with the provinces of Catamarca (2021), Salta (2020), and Corrientes (2021). In Catamarca, the agreement includes an investment by the national government to build and illuminate 187 km of optical fiber, which will serve to extend the connectivity of 43,000 people. One of the routes to be deployed will include 100 km of optical fiber between El Salado and Fiambalá, also including the towns of Copacabana, Banda de Lucero, Tinogasta, El Puesto and Anillaco. The deployment of the remaining 87 km will be part of the route between Belén and Andalgalá and La Puntilla must be added.

In Salta, the agreement signed by the Chief of Cabinet, the state-owned telecommunications company, and Salta aims at reducing the digital gap, giving priority to the development of the REFEFO to provide connectivity at affordable prices, mainly in remote areas. The initiative will provide connection to 20 localities in the interior of the province, increasing the number of people with internet service (currently more than 25 percent do not have a provider) and improving the quality of the connections. On the other hand, new kilometers will be renewed and extended through Transener's high voltage networks, which through the contribution of ENACOM and ARSAT will have 103 km of new fiber and 140 km will be reconditioned in the towns of General Güemes, Campo Santo, El Bordo, Cobos, Salta, Lumbreras, Metan, Metan Viejo, Rosario de La Frontera, Copo Quile, El Potrero and Antilla. Finally, in Corrientes, a framework for institutional collaboration and cooperation to promote access and shared use of telecommunications infrastructure was established.

The survey undertaken as part of the current study aimed to better understand the digital availability and connectivity needs of freight generators in the Norte Grande, both in their production centers (fixed broadband) and in the routes between their different production centers and production destinations, such as large urban centers, ports or others (mobile broadband).

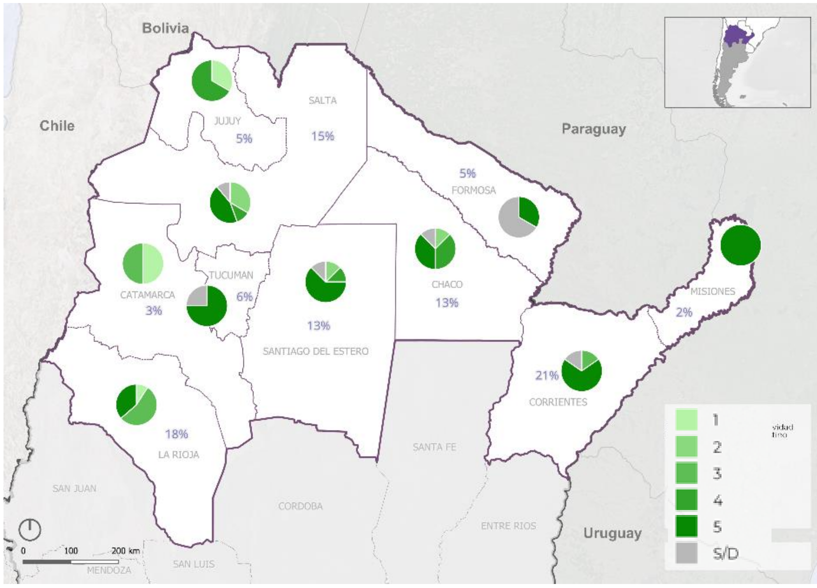
The survey results reflect the aforementioned deficiencies in terms of fixed connectivity in northern Argentina. Fifteen percent of the surveyed firms (concentrated in Catamarca, Chaco, Corrientes, and Formosa) do not have access to fixed broadband connectivity and rely on mobile or satellite connectivity. Of those who do have fixed connectivity, 42 percent have speeds of 0-30 Mbps, and 19 percent between 30-100Mpbs. In other words, 61 percent of firms have poor-quality fixed broadband services.[27] Tucumán, Corrientes, and La Rioja are the only provinces where at least some firms report having high-speed connections (above 300Mbps).

The survey responses also highlight issues with mobile connectivity. More than half of the firms have some kind of connectivity on transport routes. However, only 22 percent said they have stable mobile broadband; 26 percent have sporadic/intermittent mobile data, 17 percent only have phone connectivity, and the remaining 35 percent have no or very little connectivity during the trip.[28]

[27] Speeds up to 10 Mbps are sufficient for sending emails and using online search engines. Between 10 and 30 Mbps can be sufficient to watch a high-definition broadcast and use a smart device. Between 30 and 100 Mbps is enough to watch a 4K stream on up to four devices and download large files (up to 2GB) quickly. Between 100 and 300 Mbps you can watch 4K streams on up to five devices and download large files very quickly. At over 300 Mbps 4K streams can be viewed on nearly 10 devices and at over 1000 Mbps high volumes of data can be downloaded at very high speed.

[28] Of the 62 respondents, 8 did not answer this question. The analysis was performed on the number of respondents who did answer this question.

Figure 47: *Most firms find it important to have mobile connectivity en route*



Source: Own elaboration based on original survey

Against this backdrop of poor mobile connectivity, most of the surveyed firms consider connectivity *en route* to be important. Nearly 70 percent (37 firms) assigned "high" importance to access to mobile connectivity during the trip, including to be able to communicate with the transport service providers (see Figure 50 for a province-specific breakdown). In contrast, 15 percent of firms do not value commuting connectivity, and 17 percent are indifferent. In some cases, the surveyed firms associated this indifference with the fact that they outsource the logistics service and tracking.

5.2. The region continues to face gaps in electricity access quality despite significant generation potential

The electricity matrix of the Norte Grande (a total of 7.5GW) is dominated by thermal generation (representing about 48 percent of installed capacity and present throughout the region), followed by hydro (38 percent), concentrated almost entirely in Misiones. Several thermoelectric plants operate in the region, such as those in San Miguel de Tucumán; key hydroelectric plants include Yacyretá in Corrientes and Salto Grande. There is also growing interest in the development of distributed renewable energy projects, especially solar and wind power; for example, Jujuy has promoted significant projects such as the Cauchari solar park, including to support the lithium mining sector needs. The wide availability of renewable resources represents a great opportunity to deepen the contribution of the Norte Grande to advance Argentina's energy transition while improving electricity access for the local population and firms. In 2021, electricity generation through renewable sources in all of Argentina was 17,437 GWh (12 percent of the total generation for the year); of this renewable total, 17 percent was generated in the Norte Grande. Renewable energy generation in the region is predominantly solar (about 47 percent of the total 2,879 GWh generated per year), followed by biomass-based production (23 percent) and wind power (16 percent).

The NEA region accounts for 7.1 percent (3,099 MW) of national capacity and primarily relies on the Yacyretá hydroelectric plant, supplemented by smaller thermal plants and renewable sources, but suffers from a centralized grid that is prone to outages. Nearly all of NEA's power capacity is concentrated in the Corrientes province (2,745 MW attributed to Yacyretá). This centralization in a single hydroelectric plant creates a structural deficiency in the NEA grid. Thermal generation is limited and low-powered, installed near major urban centers. Experts attribute this to weak natural gas supply in the region, making NEA less competitive for large, combined cycle generators.[27] All of NEA's renewable generation comes from biomass projects (106 MW), mostly derived from the forestry industry and to a lesser extent the tanning industry. It includes black liquor in Misiones' cellulose plants, quebracho in Chaco's tannin factories, and forest industry by-products in Misiones and Corrientes, with the latter being more prominent. The grid's structural weakness, lacking reactive power, means that small distribution network faults (mainly due to high demand from cooling equipment) can trigger massive outages, even on high-voltage lines.

NOA has a more balanced energy grid with diverse power sources but faces challenges in converting networks for export and limitations in power generation due to reduced gas supplies from Bolivia. NOA accounts for 10.1 percent (4,418 MW) of the total Argentinian generation capacity. There are large thermal power plants in all provinces, especially Tucumán and Salta. Renewable energy sources include sugar mill cogeneration (in Salta, Tucumán, and Jujuy), hydroelectric plants, the Arauco Wind Farm (La Rioja), and recently installed solar plants in specific corridors of Salta, Jujuy, and between Catamarca and La Rioja.[28] The main challenge has been converting networks designed for local demand into surplus export networks. As opposed to the NEA, the development of the electric grid in NOA is more balanced in terms of power distribution by sources and provinces, with the Salta and Tucumán power plants standing out as large conventional thermal generation poles. The main restriction for a better quality of supply, according to the experts consulted, lies in the decrease of gas deliveries from Bolivia, which has generated limitations to the generation of the Independencia and Güemes power plants, among others, evidencing cuts in the electric energy service due to lack of power, particularly during the summer.

Local thermal generation plants in the Norte Grande provinces indicate network supply deficiencies and bottlenecks, necessitating forced dispatches to meet local demand. Despite being connected to the Transmission System and having links to the country's main corridors and high-voltage supply (NEA-NOA / NOA-CENTRO-GBA / NEA-YACYRETÁ-GBA), the presence of thermal generation indicates the deficient supply of the networks, the bottlenecks that form between the transmission and/or transformation capacity, and the local demands. This is evident as the installation of local thermal generation is carried out to provide forced dispatches within the local distribution area due to a demand that cannot be met by other more cost-effective technical means.

The electricity transmission system in the Norte Grande is operating at the limit of its capacity. Since 2015, the high-voltage grid has not been expanded, which has generated difficulties in meeting the growing energy demand in the region. Since 2015, not a kilometer of high-voltage line has been added even as the installed power increased by 9,425 MW (28 percent) between 2015 and 2021 (Noticias Jefatura de Gabinete 2017-2023). Electricity demand is growing steeply, especially in the provinces with rapidly growing metalliferous mining activities such as the extraction of copper from the Taca Taca mine in western Salta, where it is expected to quadruple between 2022 and 2030 (Secretaría de Minería, 2023).

Transmission restrictions more severely affect NOA. The transmission restrictions from the NOA region have been long-standing. Transmission capacity from this region has been close to 0 MW since late 2018, with a temporary exception period between September 2022 and September 2023, during which new capacity was enabled; however, generation supply quickly saturated the new capacity. As a result, projects in the NEA region are starting to be offered despite the region having a lower solar generation potential.

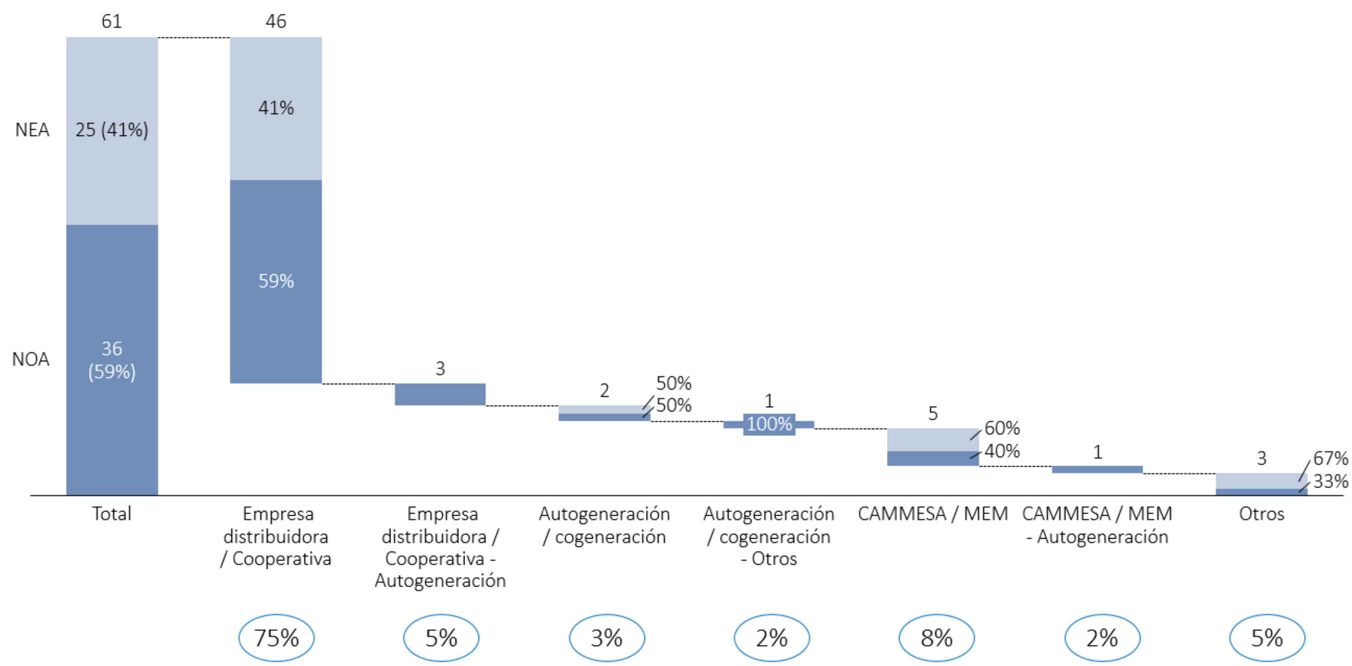
Over 1,300 MW of renewable projects were identified for entering the wholesale energy market (MEM), most of them in NOA. 990 MW of the renewable projects are in NOA (765 MW solar, 200 MW wind, and 24 MW biomass), and the remaining capacity corresponds to solar projects in NEA. Additionally, the recent RenMDI tender allocated over 60 percent of the national capacity to NOA and NEA (totaling 335 MW), emphasizing the importance of generation that must be dispatched in specific provinces because of network restrictions. Within the region, most of the allocated capacity was in Chaco, Misiones, and Formosa, requiring forced generation in these provinces.

Distributed generation, promoted by Law No. 27.424 for self-consumption, is not uniformly adopted in the Norte Grande. Law No. 27.424 promotes self-consumption with renewable energy for small users regulated by distribution companies and associated with local feeders with typical capacities of up to 300 kW, but possibly reaching 2,000 kW. Only six of the ten provinces in the Norte Grande have ratified their adherence to the national regulations through their legislative powers. Among the remaining four, two (Salta and Jujuy) have their own provincial regulations, while Formosa and Santiago del Estero do not. This situation prevents distributed generation projects from being developed in the latter two provinces.

Most sectors in the Norte Grande are connected to the grid, but there is a lack of published service quality indices. Most of the sectors under analysis (except for mining operations) are mostly connected to grids to meet their electricity consumption, and largely linked exclusively to distribution companies, meaning that they do not directly source from national jurisdiction facilities. Regarding the quality of service, published indices or indicators reflecting the provider performance are lacking; however, some conclusions can be drawn based on the survey conducted as part of the current study.

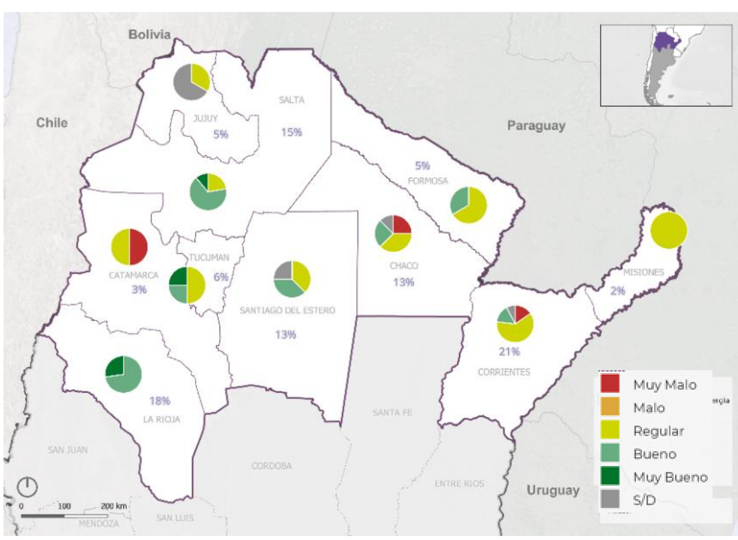
Most (80 percent) of the surveyed firms in the Norte Grande's priority value chains access electricity through local Cooperatives and Distributors, regardless of the size of the establishment. CAMMESA and self-generation are the sources of supply in the remaining 20 percent of cases (Figure X). This distribution configuration is similar in NOA and NEA. Respondents who state that they consume energy distributed by CAMMESA are a minority (10 percent) concentrated in 5 provinces: Catamarca, Chaco, Formosa, Jujuy and La Rioja. Finally, by value chain, the only ones that, due to their size, service requirements and availability, do *not* use local cooperatives or distributors are rice, sugar, grain storage and olive trees, although in these chains the presence of local cooperatives or distributors continues to be the main source electricity access.

Figure 48: *Most firms access electricity through local cooperatives and distributors*



Source: Own elaboration based on original survey of producers and grain collectors

Figure 49: *The perception of electricity service quality is somewhat better in NOA than NEA*



Source: Own elaboration based on original survey of producers and grain collectors

When asked if electricity access was a limiting factor to cover the current production, 72 percent answered that it does so satisfactorily, slightly higher in NOA than in NEA (78 vs. 64 percent). By province, the perception is the worst among the firms in Corrientes (63 percent), Chaco (54 percent) and Santiago del Estero (63 percent). However, when asked about the quality of service, only 8 percent of firms consider it to be very good. The perception of the quality is better in NOA, especially in La Rioja and Tucumán (Figure 51). In NOA, 64 percent of the firms consider the quality of service to be either very good or good, compared to only 20 percent in NEA. Overall, 8 percent of the surveyed firms consider the quality to be very bad (16 percent in NEA specifically).

High costs of the service are the main challenge for adequate electricity access for the surveyed Norte Grande firms, both in NOA and NEA. 42 percent of the firms selected this option as the main challenge, followed by service quality (36 percent, with 40 percent in NEA and 33 percent in NOA) and supply restriction (18 percent). As a result, nearly half (46 percent) of the surveyed firms have implemented or are evaluating the implementation of an additional source of energy to the existing one, with slightly more firms doing so in in NEA than NOA. At the provincial level, the provinces with the greatest willingness to add an additional source of energy supply are Catamarca, Jujuy, and La Rioja, three provinces with high solar PV generation potential. Formosa, Salta, Santiago del Estero, and Tucumán show the least willingness to incorporate new sources of supply.

By value chain, the cotton and sugar chains are the only ones where no firms plan to invest in additional sources of electricity supply, and the share of firms willing to do so is also low in the forestry, livestock, and grain aggregation chains. On the other hand, the olive and sugar chains are very likely to invest, likely because they are in provinces such as Catamarca and Corrientes where the perception of service provision is mostly negative. In addition, the olive chain has the particularity of being in La Rioja and Catamarca, two of the most arid provinces in the country. The scarcity of water for irrigation implies extracting groundwater from wells that are more than 100 meters deep using combustion pumps. This raises the cost of using energy for irrigation. For this reason, producers in the region are evaluating the potential for distributed solar energy generation and supplying the source for water extraction.

The most commonly source of additional generation being considered by firms is self-generation with solar energy. 71 percent of the respondents selected the solar option followed far behind by the purchase of fossil fuel generators (11 percent), biomass (7 percent), and other options. Firms in several value chains only consider solar energy: forestry, livestock, beans and wine; only two chains do *not* consider solar (lemon and orange chains in Jujuy and Tucumán). On the other hand, although several chains generate a significant volume of organic waste, this source is only considered in the olive and yerba mate chains. Finally, when analyzing the propensity to source energy from the wholesale energy market, which has limitations due to the capillarity of its infrastructure, 90 percent of those surveyed stated that they would not transfer their supply to the wholesale market. Only in the provinces of Chaco and La Rioja do some firms (forestry, grains, olive, and wine producers) express willingness to do so.

6. Priority interventions to support the Norte Grande's economic corridors need to be coordinated across space and sectors

The need to invest in road infrastructure, including to improve its capacity, condition, climate resilience, and road safety, emerges as a clear priority from the spatial analysis and surveys conducted as part of the current study. The interviews and focus groups highlight, in the case of NEA, infrastructure gaps on NR14, NR12, and NR11; the need for a bridge in Resistencia-Goya; the need for an authorization to use trucks on Yacyretá; and the poor condition of rural roads. In NOA, the saturation on sections of NR34 and NR9, the need to pave portions of NR51, and the need for maintenance of PR5 were highlighted. The above priorities are closely aligned with those identified in World Bank (2023a), focusing on the need to improve road quality of the main roads serving NOA (National Roads 34, 9, 51, and 52; and Provincial Roads 70, 17, 27, and 129). Improved road conditions and connectivity can lower transport costs directly and by helping promote competition and increased supply of trucking services, including of more professional trucking firms.[29]

Considering both the mining-related expected increase in loads and the climate change impacts, there is need to update the road maintenance approaches. Rural roads in the Norte Grande are managed through different models, including by Provincial authorities and by road consortiums, but there is no "one successful model" to follow, and individual Provinces (Salta, Tucumán, Misiones) have expressed the need for help in re-designing the rural road management model. Climate risk information should be systematically considered in the spatial prioritization and

[29] Allen *et al*. (2024) found that, on routes in Colombia that are farther from economic activity and not well connected, fewer and smaller truckers provide services at higher prices, because fewer providers imply less competition/ higher individual market shares on routes.

design of road investments, to ensure that the most critical routes continue functioning. More climate resilient roads can also help lower the transport prices charged by transport service providers.[30]

The high cost of the road transport service is also due to the age of the fleet and a low supply at harvest time. The limited availability of trucks and trucking services, especially in periods of high demand, is an issue affecting all priority value chains. The limited availability of services for transporters (fueling and rest areas) is also noted in both regions. Although freight transport in Argentina operates in a deregulated market, and there is free setting of freight rates between the load giver and the carrier,[31] there are opportunities for the national government to take action to help improve the supply of trucking services. Among others, key actions could include reducing the current limits to Chilean truckers being able to serve demand in Argentina and working with trucker unions. The similarly pervasive issue of obsolete truck fleets can be addressed through the introduction of truck renewal schemes that can be combined with trucker professionalization programs. The implementation of rest areas for trucking service providers in strategic locations should be integrated into the design of future road rehabilitation and improvement projects.

The surveyed cargo generators and collectors face issues related to customs and border crossings, particularly affecting the export-oriented value chains. Customs delays and border crossings appear particularly common for the value chains with a relatively higher level of processing (non-bulk general cargo). Concrete steps to improve the border crossing times and customs processing can include the simplification of procedures, increased capacity at key agencies such as SENASA, and improvements in the coordination across agencies involved, including through digitization of procedures.

In both NOA and NEA, the rail and fluvial infrastructure deterioration, the limited availability of modal interconnection centers, delays, low reliability and poor service quality were highlighted by the surveyed producers. There is a need to invest in the maintenance of the region's rail infrastructure and improve its accessibility to the key production areas. The level of service – availability, capacity, speed, and certainty – also needs to be addressed. Based on multicriteria analysis, the current study identifies the key segments that require rehabilitation and/or improvement and that would be expected to have a significant positive socio-economic impact, including several segments of the Belgrano line, Mitre, and Urquiza lines. In the case of the latter, however, its prioritization in the short term would depend on whether financial feasibility is a key consideration, given the comparatively low cargo potential. Given the travel distances, the presence of a navigable waterway in the area, and the concentration of production near the ports (in Entre Ríos), achieving a significant freight shift to this railway line may be challenging. Considering the country's considerable budget constraints, investment in the Urquiza line may therefore not be advisable from the regional or national perspective, despite having potentially significant local (province-level) socio-economic benefits, given the availability of other potential projects with much greater potential for improving logistics efficiency in a financially sustainable way. In addition, focusing specifically on the needs of the lithium value chain, World Bank (2023a) identified as a priority the rehabilitation and modernization of the C14 branch of the Belgrano rail line to have all its stations in operation and achieve an annual loading capacity of at least 400,000 tons/year.

River transport service constraints highlighted by firms include infrastructure gaps, delays, and high costs. The lack of dredging and regulations were identified as a bottleneck for the supply of transport services, the high cost of transport to access ports, a low level of quality (or lack of) port infrastructure. Improvement in the accessibility and quality of rail and fluvial transport in the Norte Grande can help lower the costs of these modes and increase their mode share but also put a downward pressure on road transport prices.[32]

Although numerous logistics platform initiatives exist, a comprehensive strategy is needed tailored to the expected users (demand studies) and for adapting the regulatory framework to clearly define land use in the area; and generate incentives to attract companies (CFI, 2022, 2023). To develop the economic corridors, there is a need to promote agreements and commercial strategies between operators of the logistics system so that cargoes located in

[30] A recent global study found that shipments during the rainy season pay a premium of about 6 percent, on average, but the effect exceeds 20 or even 30 percent in individual countries characterized by poor road infrastructure quality (see Herrera Dappe, Lebrand, and Stokenberga, 2024).
[31] Although there are reference rates for grain transport, even so, the freight rates charged can be up to 30/35% lower than the reference rates or can exceed them when there is an oversupply of cargo and a shortage of available trucks (Barbero *et al.* 2020).
[32] Recent research from India suggests that trucking prices are higher on routes with weaker competition from rail (see Molnar and Shilpi, 2024).

the area of influence of the ports of Chile and Brazil can have access to competitive prices, and improve the performance of the vertical axis connecting the Norte Grande with the central region of the country, including by strengthening the integration of the road, rail and river-sea networks.

Several specific priority transport and logistics interventions emerge as potentially most impactful to support economic activity in in province and the region overall, based on the insights gained from the firm and sectoral chamber surveys, analysis of previous studies, and the different lenses of prioritization presented in earlier chapters of the study (Table 7).

However, in addition to transport and logistics, investments are needed to bridge the current gaps in the Norte Grande's broadband and mobile connectivity – in order to improve firm productivity and also the quality and predictability of the trucking services and border crossing times. Investments are needed to:

- Ensure 4G access beyond the vicinity of the national roads, including to ensure better quality transport services and traceability of cargo traveling from the Norte Grande to markets; and
- Improve broadband access and downloading speed in provinces that are currently lagging behind: in the first case, Formosa, Chaco, and Santiago del Estero and, in the second – Santiago del Estero, La Rioja, and Jujuy.

Productive sectors differ, with some able to generate energy from biomass as part of their value chain while others not. The former is mainly the case of the forestry and sugar industries, whose production complexes allow to complement the main activity in the value chain with electric generation projects, usually framed in cogeneration projects. The main strength of these sectors is that, as they increase their demand, they can increase their supply, either through the processing of more raw materials or through a search for greater efficiencies. For the rest of the sectors, specific solutions can be proposed, depending on the specific legislative framework, technical feasibility, and economic incentives.

There are several broad recommendations for improving the Norte Grande's energy sector – including in relation to its role in supporting productive activities. Recommendations specific to the subregions include the need to balance the incorporation of renewable energy projects with the limited transport capacity to ensure dispatch priority (NOA) and to complete gas supply infrastructure projects to address the power generation deficit and utilize renewable energy growth and optimized dispatch with Yacyretá to stabilize supply in the region (NEA). Across the Norte Grande, there is a need to ensure transformation capacity and correct sizing of high voltage networks to guarantee service quality and to leverage the productive sectors' potential to generate energy through biomass as part of their value chain, particularly in the forestry and sugar industries which can not only supply their own electricity needs but also sell excess to the grid. In the case of the paper mills in Chaco, Corrientes, and Misiones, there is also potential to use black liquor for cogeneration. In the olive, wine, and rice value chains, irrigation is a critical component, with electric power being essential. The use of solar energy and biomass (like olive pits) for electricity generation is being explored, with some projects already underway, such as the Mission project for generating power from olive pits and pruning residues. In the rice value chain, there is potential for using rice husk and straw for power generation, despite technical and commercial challenges. The Citrusvil - Alcovil complex in Tucumán is notable for converting citrus effluent into biogas for energy generation, recognized as a Clean Development Mechanism by the United Nations.

Many of the priority investments – in transport, digital connectivity, and electricity access – should be spatially coordinated across provincial boundaries to ensure that their benefits are maximized. That way, they can most effectively support priority value chains and economic corridors that cross province boundaries, boosting local incomes and job generation and promoting increased scale and specialization.

Although many of the identified priority interventions can be addressed at the provincial level, several will need to be handled by national level entities. These include the policies needed to improve the conditions for competition in the transport services markets (further liberalizing trucking service provision and implementing railway open access), the rehabilitation and maintenance of strategically important national roads, and the improvement of the electricity transmission and mobile broadband infrastructure. Moreover, some of the proposed investments are significant in size, exceeding several hundred million dollars. Provincial governments will need to work in coordination with their municipalities to understand local challenges while also engaging with the national government to ensure sufficiency financing for projects of certain size and complexity and to develop a regulatory framework that can provide stability and confidence to local and foreign investors (World Bank, 2020b).

In some respects, the government may need to step in given the limited incentives for the private sector to do so. For example, extending mobile coverage to roads that currently lack 4G coverage presents an economic challenge for mobile operators**,** due to the low population density, high maintenance costs, and high investment costs due to the distance of infrastructure and services.

Table 7: Complementary hard and soft transport and logistics interventions will be needed in every province

	Transport infrastructure	Logistics and soft interventions
Salta	**Roads:** Construct passing lanes on NR34 (S. Pedro de Jujuy – Embarcación) and rehabilitate NR34 (Cabeza de Buey – Pocitos; Lte. Santa Fe-Rosario de la Frontera); rehabilitate and pave NR51 (Gral. Alvarado - Lte. Chile); rehabilitate NR9 (City of Stgo. del Estero - City of Salta); rehabilitate NR81 (Emp. RN95 - Emp. NR34) **Rail:** Improve Belgrano C13 (Güemes – Cerillos) and Belgrano C15 (Perico – Pichanal); improve and renovate Belgrano C (Tucumán – Palpalá) **Additional priorities (sugar, lithium, forestry):** upgrade NR34 to a highway (Pichanal - NR9); upgrade NR9 to a highway until Metán; improve Belgrano line C14 (Güemes-Puna); reconstruct bridges in Tartagal and Carapari	▪ Improve hygiene services and service stations in Pichanal to improve conditions for haulers ▪ Construct a hub to consolidate and do redispatch – forestry ▪ Develop multimodal logistics nodes in Güemes, Pichanal, Lajitas/Metán/Rosario de la Frontera, and Acapato – grains, legumes, cotton, livestock ▪ Improve Customs and border crossings
Jujuy	**Roads**: Construct passing lanes on NR34 (S.P. de Jujuy–Embarcación), rehabilitate NR34 (Cabeza de Buey-Pocitos) **Rail**: Improve Belgrano C15 (Perico – Pichanal); Belgrano C improvement and renovation (Tucumán – Palpalá) **Additional priorities (lithium):** Asphalt NR40; pave and maintain RN51 and NR9; widen RP129 to improve safety; improve Belgrano line branch C14 from Güemes to Puna	▪ Expand capacity of bonded warehouses in AMBA – lithium ▪ Improve Customs and border crossings; digitalization ▪ Improve SENASA operating capacity
Cata-marca	<u>**Roads**</u> **:** Rehabilitate NR157 (Emp. NR60 - SM. Tucumán)	▪ Improve Customs and border crossings ▪ Develop logistics centers in La Paz, Tinogasta, Fiambala
Tucumán	**Roads :** Rehabilitate NR34 (Lte. Santa Fe-Rosario de la Frontera); rehabilitate NR157 (Emp. NR60 - SM. Tucumán); construct dual carriageway on NR9 (ACC.A BANDA DEL RIO SALI - INT.PR306 and INT. PR306 - B/N NR38); rehabilitate NR9 (City of Stgo. del Estero - City of Salta) **Rail:** Improve and renovate Belgrano line C (Tucumán – Palpalá); improve Mitre G1 line (Tucumán - Santa Fe limit) **Additional priorities (sugar):** increase capacity of NR34; improve rail condition to increase speeds	Reduce customs disruptions due to service outages; expedite customs clearance times
La Rioja	**Roads:** rehabilitate NR79 (Chamical - Emp. NR60)	Improve Customs and border crossings
Santiago del Estero	**Roads:** rehabilitate NR34 (Lte. Santa Fe-Rosario de la Frontera); rehabilitate NR157 (Emp. NR60 - SM. Tucumán); rehabilitate NR9 (City of Stgo. del Estero - City of Salta and Lte. Córdoba – city of Stgo. del Estero) **Rail:** improve Mitre G1 (Tucumán - Santa Fe limit) **Additional priorities (grains):** Improve road safety on rural roads	▪ Expand truck repair services ▪ Develop a multimodal logistics center in Beltran (on NR34)
Formosa	**Roads:** rehabilitate NR11 (Lte. Santa Fe - Formosa City); rehabilitate NR81 (Emp. RN95 - Emp. NR34) **Additional priorities (cattle):** improve NR11 between Clorinda and Resistencia; improve condition of rural roads	Improve Customs and border crossings
Chaco	**Roads**: NR11: rehabilitate (Lte. Santa Fe - Formosa City) **Additional sector-specific priorities (cattle, grains, cotton, rice):** improve NR11 (Clorinda-Resistencia); dredge Riacho Barranqueras river; improve port of Barranqueras; improve roads to spinning mills in Resistencia/Corrientes; improve condition of rural roads; develop train+barge transport in the Itá Ibaté and Curuzú area; build additional bridges and multimodal connections between production areas, mills, and export points - grains	Build/expand Las Palmas-La Leonesa port Logistics complex
Corrientes	**Roads:** rehabilitate NR14 (Lte. Entre Ríos -Santo Tomé; Santo Tomé - Bdo. De Irigoyen) **Additional sector-specific priorities (forestry, Yerba, rice, cotton):** rehabilitate NR12 from Corrientes capital city to NR118; improve level of service on NR14 between Paso de los Libres (Corrientes) and San José (Misiones); improve condition of rural roads (e.g., in Mercedes); construct a bridge between Goya and Reconquista – forestry, cotton	▪ Construct service stations and truck beaches on NR14 ▪ Construct a customs/ SENASA hub in the Mercedes area ▪ Improve Customs and border crossings – cotton, oranges ▪ Pass bitrain regulation for the Corrientes-Misiones area
Misiones	**Roads:** rehabilitate NR14 (Santo Tomé - Bdo. De Irigoyen); rehabilitate NR12 (Posadas - Puerto Iguazú) **Additional sector-specific priorities (forestry, Yerba):** upgrade NR14 to a highway from Paso de los Libres to San José (250 km) and improve road safety; pave provincial roads; improve condition of rural roads	Pass bitrain regulation for the Corrientes-Misiones area

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Annex 1: Economic activity and logistics patterns of value chains, by province

Table 1.1: *Percentage share of value chains in the total provincial load*

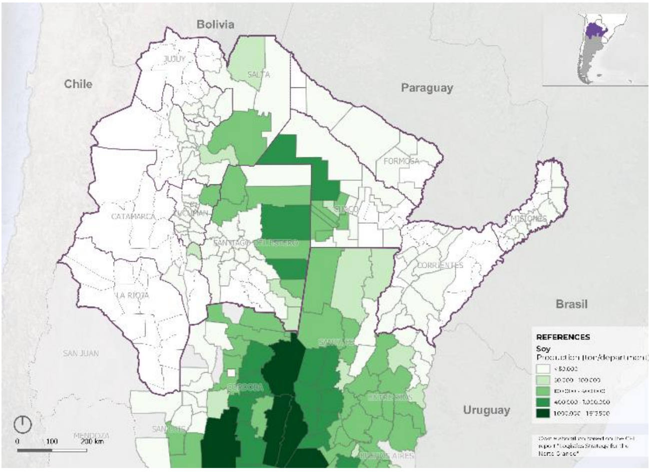
	NOA						**NEA**			
Chain	**Catamarca**	**Jujuy**	**La Rioja**	**Salta**	**Santiago del Estero**	**Tucumán**	**Chaco**	**Corrientes**	**Formosa**	**Misiones**
Cattle	3.0%	3.0%	20.0%	3.0%	3.0%	5.0%	8.0%	7.0%	23.0%	1.0%
Grains	4.0%	2.0%	1.0%	23.1%	77.3%	16.0%	29.6%	0%	3.1%	0%
Rice	0%	0%	0%	0%	0%	0%	0.8%	10.0%	6.6%	0%
*Beans **	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data
Cotton	0.2%	0%	0%	0%	0.3%	0%	3.6%	0%	2.4%	0%
Sugar	0%	20.0%	0%	1.9%	0%	27.7%	0%	0%	0%	0.1%
Lemon	0.1%	2.1%	0%	2.7%	0%	24.9%	0%	1.0%	0.2%	0.1%
Orange	0%	7.0%	0%	0.8%	0%	0.8%	0%	5.0%	0%	0%
Wine	0.2%	0%	23.1%	0.2%	0%	0%	0%	0%	0%	0%
*Olive **	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data
Yerba	0%	0%	0%	0%	0%	0%	0%	1.0%	0%	3.0%
Forestry[33]	0%	4.0%	4.0%	1.0%	2.0%	1.0%	31.0%	50.0%	20.0%	80.0%
Lithium	1.0%	1.0%	0%	0%	0%	0%	0%	0%	0%	0%
Copper	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total	**9%**	**39%**	**48%**	**33%**	**83%**	**75%**	**73%**	**74%**	**55%**	**84%**

* The 2018 Origin and Destination Matrices do not present disaggregated data on tons transported of beans and olives.

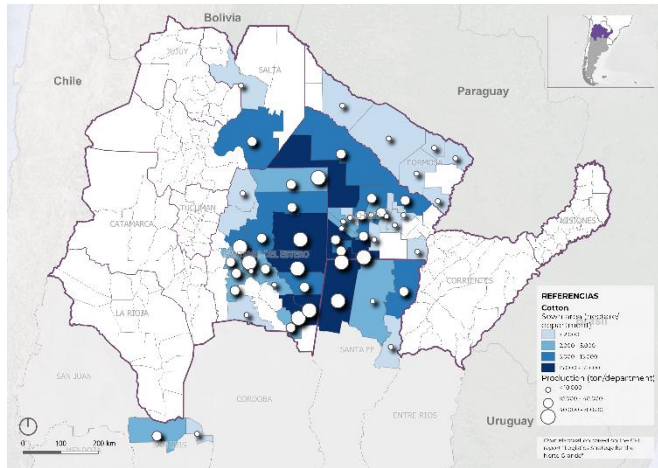
[33] The provinces of Chaco, Formosa, Jujuy, Salta and Santiago del Estero have forestry activities based on native forests, which will not be considered in this study.

Figure 1.1: *Production intensity of priority products in the Norte Grande*

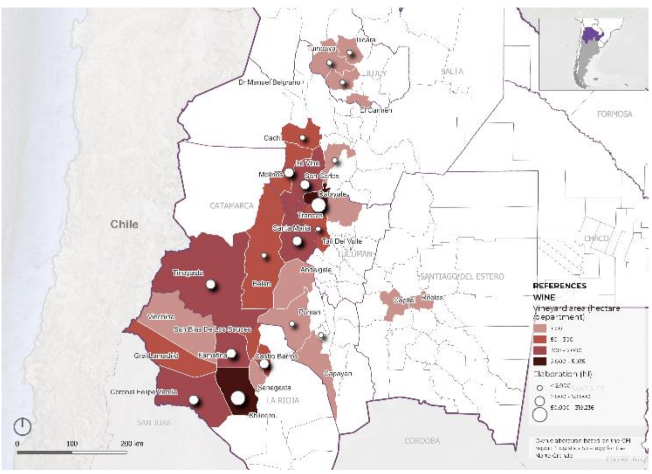
a. Soy



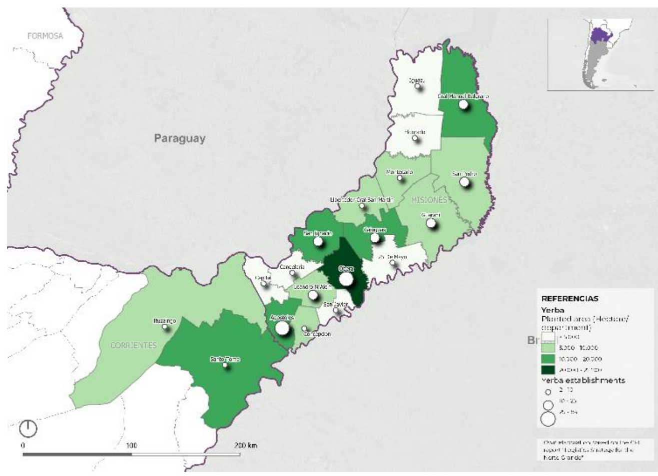
b. Cotton



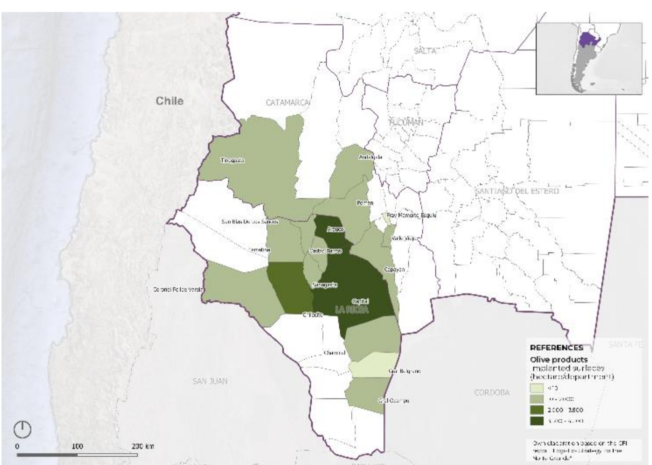
c. Wine



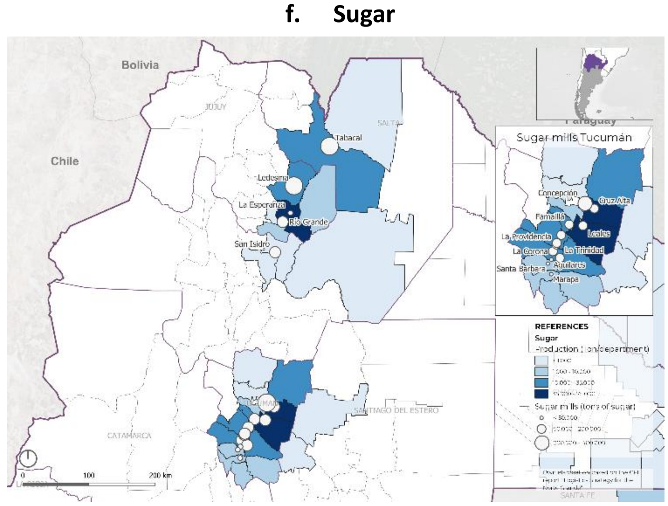
d. Yerba mate



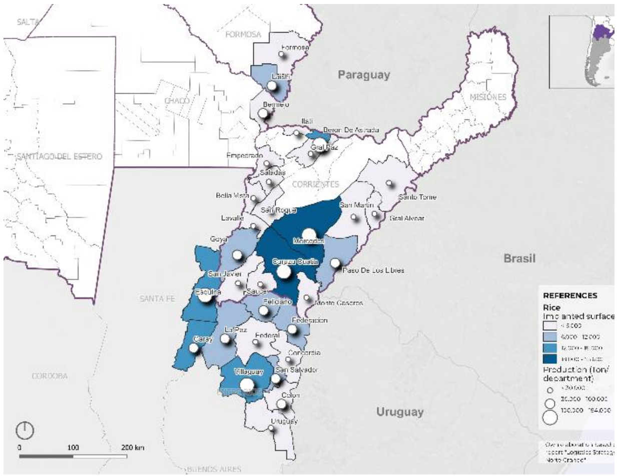
e. Olive



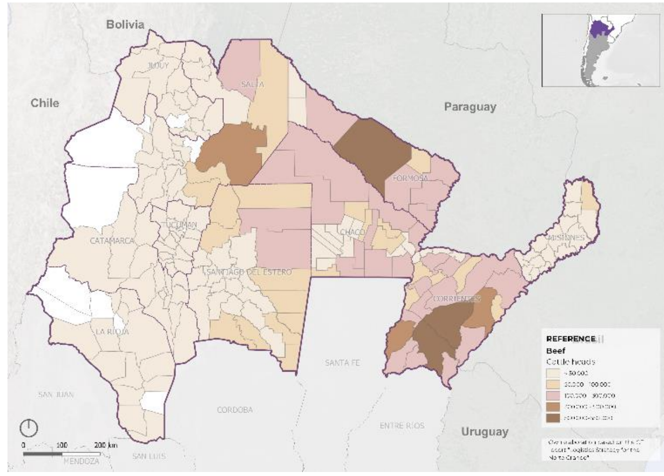
f. Sugar



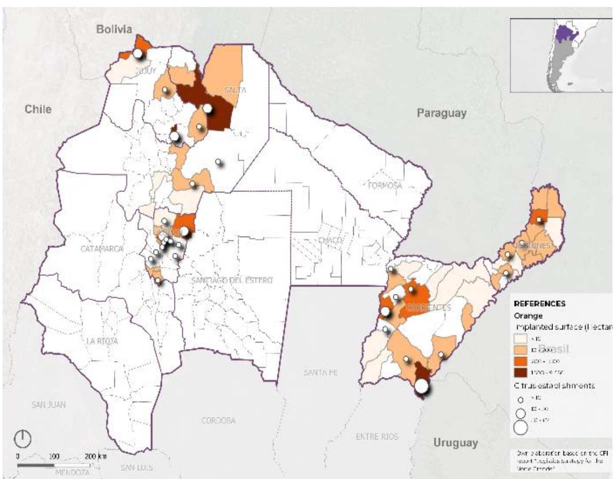
g. Rice



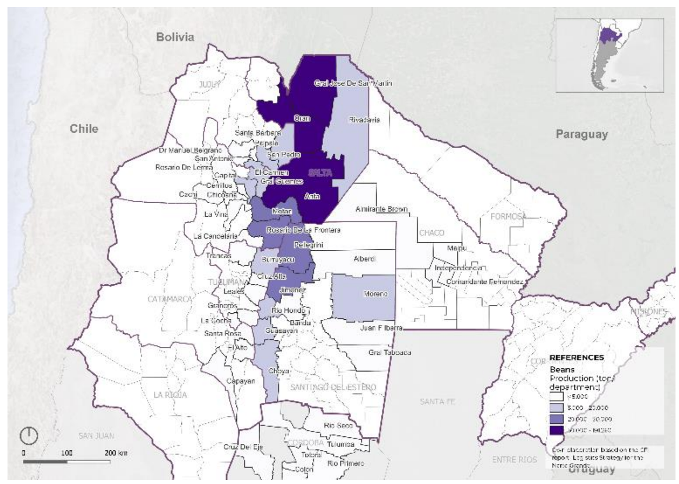
h. Cattle



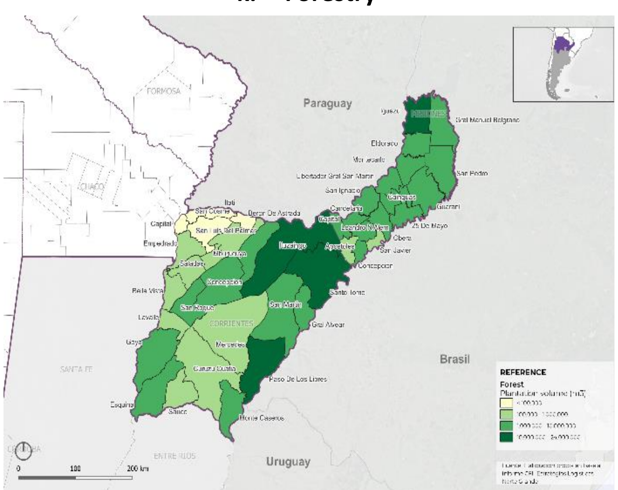
i. Oranges



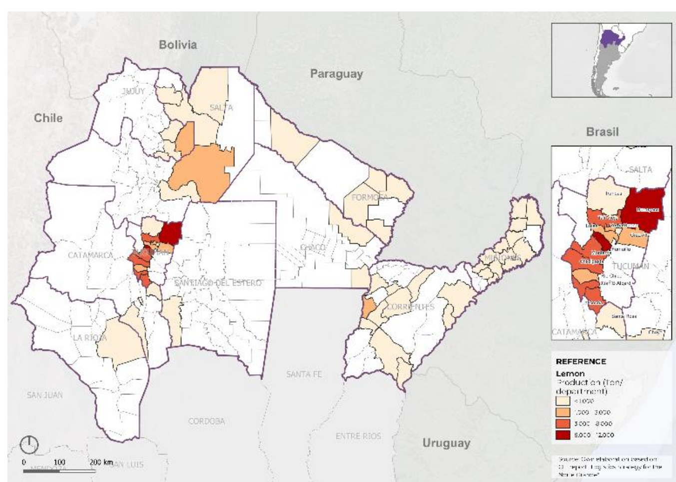
j. Beans



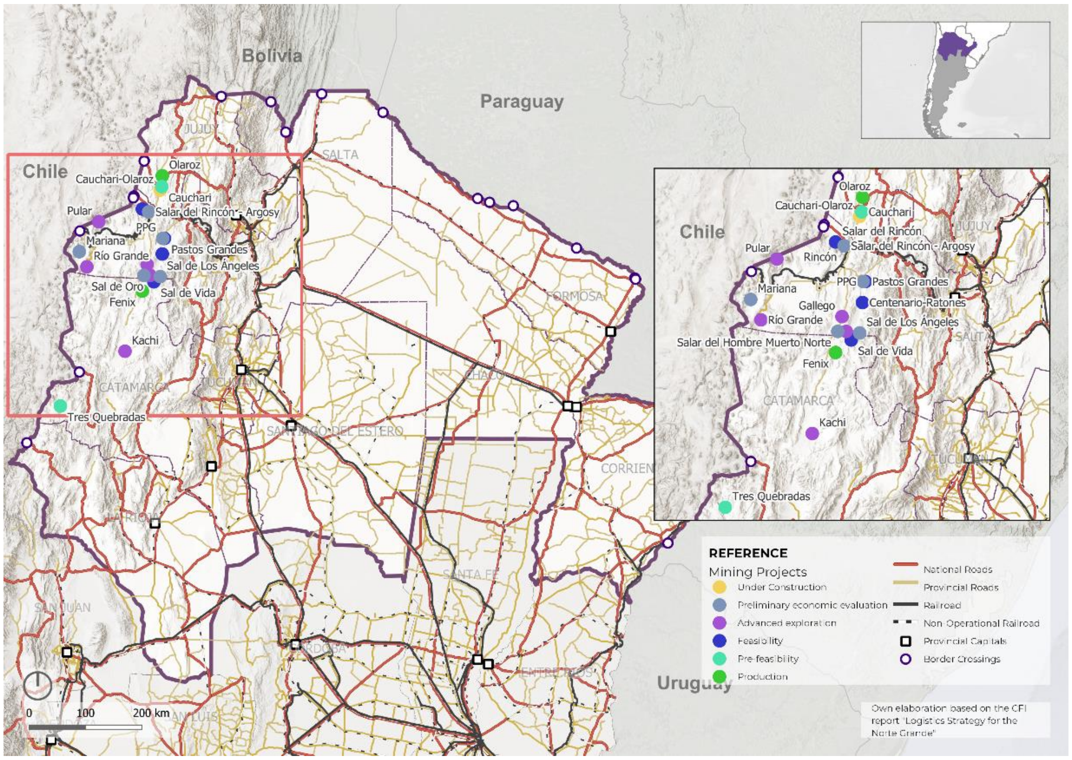
k. Forestry



l. Lemon

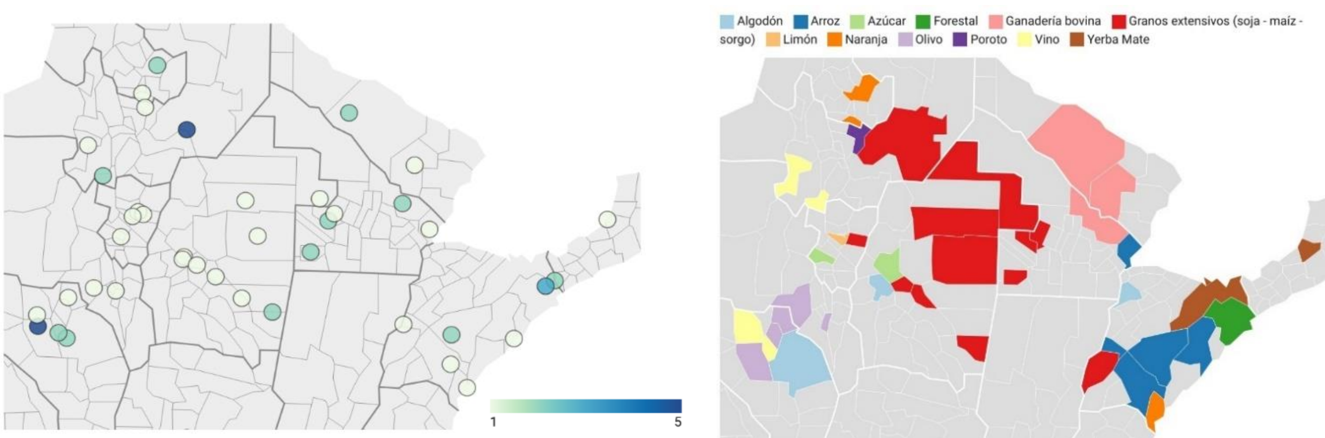


m. Lithium



Source: Own elaboration using data from CFI (2023) and complementary sources

Figure 1.2: *Survey responses were received from firms – including producers and grain collectors – distributed across Norte Grande provinces*



Source: Own elaboration based on original survey

__Catamarca__

Olives

The main inputs in primary production are fuels and agrochemicals (fertilizers, herbicides and pesticides). Industries demand containers for fractionation in different sizes (half liter and one liter are the most frequent) and materials (glass, plastic and sheet metal). On the other hand, bulk sales demand 200-liter tanks, mostly made of plastic.

Agricultural production takes place in establishments that, in general, have adopted high technological standards. The main production areas include Pomán and Valle Viejo. Harvesting is mechanical and is transferred to processing plants that press the fruit to extract the oil. Transport is carried out in trailer trucks that cover a distance of 30-40 km, on average. The load is up to 40 bins (each with a capacity for 500 kg of olives to be processed), reaching 20 tons. There are companies that fraction (pack) their own production for final sale and others that sell to large traders.

The main destination of production is the foreign market (80%), mainly through the port of Buenos Aires and, to a lesser extent, the ports of Chile. Exports include fractioned products (mostly in 1-liter containers) and in bulk in 20-foot flexitank containers or 200-liter drums. Destinations are Spain, United States, and Brazil. Shipments to Brazil go by truck and use the Puerto Iguazú border crossing. For the domestic market it is packed in different size containers both at origin and outside the region. The companies that pack send to their own distribution centers or marketers mainly in the AMBA. If the packing is outside the region, it is shipped in tanker trucks (28 ton) to a node in the province of Santa Fe. In all cases they use road transport as the exclusive alternative.

Chaco

Extensive grains, including producers and collectors

The main inputs are fuel, fertilizers and agrochemicals, from suppliers in Argentina (Santa Fe, Rosario) and abroad (e.g., United Kingdom). These inputs are transported weekly by truck. The problems of inputs transported by road include high costs, insufficient frequency and inefficiency in the amount of cargo due to the lack of length of the trailers.

90% of the soybean grain produced in Chaco is destined for domestic processing. The main industries involved in this processing include oil (crude and refined), biodiesel, and the production of animal feed (meal and pellets). Both the grain and its industrial derivatives are mainly oriented to the external market. Production is destined for the ports of greater Rosario. Storage capacity in the region is limited, which can affect logistical efficiency. Low storage capacity requires more frequent transport under suboptimal conditions, increasing costs and associated risks.

Cattle breeding

The main input is feed, which is transported by truck from nearby areas (in the case of feedlots), and seeds, in the case of grazing.

The logistics of the beef chain is organized in several key stages. In the first stage, cattle are transported from the ranches to the slaughterhouses, mainly using trucks adapted to ensure the welfare of the cattle during the journey. Average distances vary between 50 and 200 kilometers, depending on the specific location of the ranches and slaughterhouses. Once the cattle arrive at the slaughterhouses, the slaughter and processing phases are carried out. In Chaco, slaughterhouses are classified into different categories according to their capacity and production destination. Class A slaughterhouses are authorized for export and maintain high hygienic-sanitary standards, while Class B and C slaughterhouses focus on the domestic market, with inspection by SENASA and provincial authorities, respectively. The second stage of logistics focuses on the transport of processed meat from the meat packing plants to the domestic consumption markets. The meat is transported in refrigerated trucks, ensuring that it is kept in optimal conditions until it reaches butcher shops and supermarkets. Traffic is routed along national and provincial routes, facilitating access to the main consumption centers in the country. The third stage covers the transport of meat destined for export. Meat is transported from the meat packing plants to the ports of departure, mainly located in Buenos Aires. This stage is carried out in refrigerated trucks. Meat destined for export is packaged to meet international standards.

Rice

The main input is paddy rice, with suppliers located locally in the province and in the country. Among the most important localities in Corrientes are Puerto Eva Perón and General Lucio V. Mansilla. This input is transported weekly by road by truck.

The movement of paddy rice, both harvested and dried, is mainly organized by the mills, which are highly integrated in the value chain. These mills directly or indirectly control the primary production and the dryers, thus ensuring an efficient and coordinated management of the entire process. In general, paddy rice is transported in short sections to the dryers. It is then moved to the mills, although in some cases both facilities are in the same area. Loading is done in bulk trucks, optimizing transportation at this initial stage. From the mills, if the rice is destined for the domestic market, the cargo is split and palletized for transport by truck. This method facilitates the handling and distribution of the product to the various points of sale. For the external market, the rice is transported by truck to the ports of departure or directly to its final destination. Loading and packaging options vary, ranging from bulk to containers, as well as 50 or 25 kg bags or 1.2-ton big bags. This diversity in packaging options allows the company to adapt to the specific needs of each market and ensures that the rice arrives in the best possible condition.

The rice value chain in Chaco shows a high degree of integration (between 70% and 80% of primary production belongs to the same industry). The industry has 80% of the drying capacity, which is optimal for maintaining rice quality during storage and transport. Because domestic rice consumption in Argentina is relatively low, more than half of Chaco's production is exported after industrialization, either as brown or white rice.

Corrientes

Cotton

The main input for fiber producers is raw cotton. The supply chain has 80% of its suppliers located within the province, while the remaining 20% comes from other producing provinces. This input is transported daily by road. Cotton fibers are destined in similar proportions for the domestic and foreign markets. Of the total fiber produced in Corrientes in 2022, 30% was destined for the domestic market, while 70% was exported. This balance in regional distribution underscores the importance of maintaining an efficient logistics infrastructure to meet both demands.

The cotton chain includes several links, from planting and harvesting cotton to the different manufacturing stages, such as the production of fibers, yarns, fabrics and clothing. The industrialization of primary production in this region is high.

Orange

Fuel and agrochemicals (fertilizers, pesticides, and herbicides) are the main inputs in primary production. About 50% of inputs are purchased locally and the rest outside the region (within the country). The packaging for fresh production that is sold on the domestic market is made from locally produced wood. The boxes for export are sourced from national suppliers.

Orange production is carried out in farms that combine the use of technical equipment with intensive labor. Harvesting is predominantly manual. The Monte Caseros area, on the banks of the Uruguay River, is where the largest planted area is concentrated. The distance between primary production and packing plants tends to be relatively short (30 to 50 km). Although the predominant destination in the area is the domestic market - with nodes in the main urban agglomerations, mainly the AMBA (600 km), Greater Córdoba (800 km) and Greater Rosario (500 km) - the surveyed company indicated that its orientation is the external market. 100% of production is transported by truck. Orange exports from the area are mainly to neighboring countries, basically Paraguay. Although production is seasonal, the existence of cold storage facilities means that the region has the capacity to supply market demand practically all year round.

Yerba mate

The main input is the Yerba Mate Canchada (which undergoes a first coarse grinding), which is transported to the production points by truck.

The region has ideal agroclimatic conditions, allowing the harvesting of green leaves in two periods: the main winter harvest, from April to September, which accounts for 80% of production, and the summer harvest, from December to March, which accounts for the remaining 20%.

Yerba mate is transported to the domestic market and port terminals exclusively by road. The logistics of the chain is organized into three main movements. First, short transport from the field to the industry. The green leaf is transported to the dryer in trucks by short freight, with an average distance of 50 kilometers, mainly on rural roads. Once the yerba canchada is obtained, it is transported from the dryer to the mill, covering an average distance of 150 to 200 kilometers. Tractor trailers with a capacity of 20 to 28 tons are used.

Secondly, the long transport from the mill to the domestic market. Yerba mate is transported to supermarkets and distribution centers throughout the country. The 20% is destined to supply the region itself. The main route is CABA, covering an average distance of 1,050 kilometers.

Finally, the long transport from the mill to export. 90% of exports correspond to processed yerba mate. The product is transported from the mills to the ports by long freight. Exports are formalized at customs offices in the region (San Javier, Yrigoyen, Posadas, etc.) and leave mainly through Buenos Aires (70%). The cargo is consolidated in bulk in 40-foot containers, with a capacity of 25 to 30 tons.

Rice

The main input mentioned in the surveys is paddy rice. The supply chain has suppliers located in the province locally, in the country and abroad. Among the most important localities in Corrientes are Mercedes and San Roque. This input is transported weekly by road.

The rice produced in Corrientes is destined for both the domestic and foreign markets. Adecoagro, one of the main companies in the region, operates two mills in Paso de los Libres and Mercedes. Iberá Mercantil also has a mill in Mercedes. Together, these facilities exceed 200,000 tons of annual milling. In addition, there are six other active mills in the province, contributing to the total processing capacity.

Forestry

The main input is wood from natural or planted forests, which is transported to the production points.

The movement of forest products from forests and sawmills to local markets and export points mostly takes place on NR12 and NR14, which facilitate access to other provinces and export ports.

The logistics of the forestry chain in Corrientes is organized into several key links. The first link involves transporting timber from the forests to the sawmills, mainly using trucks due to the geographic proximity of the forest resources. Average distances for this transport range between 50 and 100 kilometers, with bulk trucks, commonly semi-trailers and two-trains, being the predominant means of transport in this initial phase.

The second link in the logistic chain involves transporting processed products from sawmills to domestic and foreign markets. At this stage, lumber and other derived products are transported mainly by truck. For products destined for the domestic market, cargo configuration and packaging are adjusted according to destination and subsequent distribution. Although the use of railroads is almost non-existent, it would be a suitable option for transport to export ports and large consumption centers, with average distances exceeding 1,000 kilometers.

Short-haul transportation of logs from the field to sawmills is an essential part of the primary stage, and most of these sawmills are located near the plantation centers. The industrial load is focused on the transportation of sawn timber to the domestic market, covering the entire country. Less than 10% of production is destined for the foreign market, with China and the United States being the main destinations.

Lumber is transported to the domestic market and port terminals almost entirely by road, accounting for 99% of the total, while only 1% is transported by rail, using the General Urquiza railroad. The logistics organization of the forestry chain is structured in different stages.

The initial stage consists of short freight, which meets the demand for transporting logs from the forest to the sawmill, with an average distance of 50 kilometers. Trucks or two-trains carrying an average of 30 tons are used to transport the logs, mainly over dirt roads.

The next stage, the long freight, consists of transporting the lumber from the sawmill to the domestic market, covering the entire country. This movement involves long distances, with the lumber loaded on trucks with a capacity of 25 to 28 tons, covering an average distance of 1,000 kilometers, the main route being from Iguazú to the AMBA.

The last stage is the long freight for export, this operation handles most of the exports consisting of sawn or rough sawn pine timber over 6 mm. These export traffics are transported by truck to port terminals, mainly Buenos Aires, which handles 75% of the cargo as outbound customs. Most of the companies formalize and consolidate the cargo at the port, using 40-foot containers. The main export route is from Iguazú to the Port of Buenos Aires, with final destination in the United States.

Formosa

Cattle breeding

The main input is feed, which is transported by truck from nearby areas (in the case of feedlots) and seeds, in the case of grazing.

The logistics chain begins with the transfer of the cattle from the ranches to the slaughterhouses. This transportation phase is mainly carried out in adapted trucks, ensuring the welfare of the cattle during the journey, which covers average distances of between 50 and 200 kilometers, depending on the location of the ranches and slaughterhouses. When the cattle arrive at the slaughterhouses, processing stages are carried out.

The next link in the logistics involves transporting the processed meat from the slaughterhouses to the domestic consumption markets. The meat is transported in refrigerated trucks to ensure that it is kept in optimal conditions until it reaches butcher shops and supermarkets. National and provincial roads support accessibility to the country's main consumption centers.

The last stage involves the transport of meat destined for export. From the slaughterhouses, the meat is transported to the ports of departure, mainly located in Buenos Aires, using refrigerated trucks. Meat destined for export is packaged according to the necessary protocols to comply with international standards and guarantee its quality during transport.

Jujuy

Sugar

The main inputs mentioned in the survey are gas for production, which is supplied by pipeline, and sugarcane, which is transported from areas near the mill by truck.

The logistical organization of the production chain in Jujuy is based on three types of transportation. First, short freight, which consists of transporting sugarcane from the fields to the mills. These fields are geographically close to the mills, with average distances between 20 km and 60 km, and are transported in bulk trucks, generally semi-trailers with overturned boxes.

Secondly, long freight, which involves the transportation of processed sugar from the mills to the domestic market. Logistics operations are mainly carried out by truck and packaging depends on the destination of the product. The main destinations are the Buenos Aires Metropolitan Area (AMBA) and, to a lesser extent, Córdoba, with average distances that can reach up to 1,100 km.

Finally, long freight for export, with a main modal allocation by truck, mainly for sales to Chile, although railroads are also used to Buenos Aires and Rosario.

Oranges

Fuel and agrochemicals (fertilizers, pesticides and herbicides) are the main inputs in primary production. About 50% of inputs are purchased locally and the rest outside the region (within the country). The containers of fresh production that are sold in the external market and the metal drums for juices and oils were identified as the main inputs for industrial processing. They are predominantly sourced from the rest of the country, i.e. extra-regional.

The departments of Ledesma and Oran concentrate the largest planted area and correspond to the location of the surveyed company. The distance between primary production and packing plants tends to be relatively short (30 to 50 km).

Freight to the port of Buenos Aires covers a distance of 1600 km and is contracted to third parties. The fruit is marketed in 20 and 40 foot refrigerated containers. Although the predominant destination in the area is the domestic market - with nodes in the main urban agglomerations, mainly AMBA (600 km), Gran Córdoba (800 km) and Gran Rosario (500 km) - the surveyed company indicated that its orientation is the external market. The main mode of transport is by truck. Jujuy orange exports are mainly destined for the EU and are concentrated in the months of June to September. The companies are integrated and have their own cold storage and packing facilities.

Lithium

The main input during the conventional lithium carbonate production process is Soda Ash or sodium carbonate (reagents represent 40.9% of production costs, according to the National Mining Secretariat.[34] The chemical product used comes mainly from the United States and enters the country through Chile. Shipments arrive regularly at the port of Antofagasta, as Chile is the world's second largest lithium producer.

The product obtained is lithium carbonate, which is exported (mainly to China and Japan) through the ports of Buenos Aires and Antofagasta (northern Chile).

The lithium carbonate is transported to the ports by road, in a 22-ton truck. It is mostly packed in 1,000 and 500 kg big bags (one per pallet). The trucking service is provided by third parties and, given the low storage capacity at the production plant, a regular supply is required. The mining companies do not carry out customs clearance at the plant. Production is consolidated in 20-foot dry containers (20 tons of cargo) in bonded warehouses at the port of exit. Ocean freight is agreed between the parent companies and the shipping companies.

[34] https://www.argentina.gob.ar/sites/default/files/soda_ash_serie_de_estudios_para_el_desarrollo_minero_carbonato_de_sodio_soda_ash_caracteristicas_usos_y_demanda_2.pdf).

La Rioja

Olive

The main inputs in primary production are fuels and agrochemicals (fertilizers, herbicides and pesticides). Industries demand containers for fractionation in different sizes (half liter and one liter are the most frequent) and materials (glass, plastic and sheet metal). On the other hand, bulk sales demand 200-liter tanks, mostly made of plastic. The origin of the inputs has local components, from neighboring provinces such as Catamarca, from Buenos Aires and from abroad.

The olives are harvested mechanically and transported to processing plants that press the fruit to extract the oil. Transport is by trailer trucks that cover a distance of 30-40 km on average. The load is up to 40 bins (each with a capacity for 500 kg of olives to be processed), reaching 20 tons. There are companies that fraction (pack) their own production for final sale and others that sell to large traders.

The main destination of production is the foreign market (80%), mainly through the port of Buenos Aires and, to a lesser extent, the ports of Chile. Exports include fractionated products (mostly in 1-liter containers) and in bulk in 20-foot flexitank containers or 200-liter drums. Destinations are Spain, Brazil, and the United States. Shipments to Brazil go by truck and use the Puerto Iguazú border crossing. For the domestic market, it is fractionated in different size containers both at origin and outside the region. The companies that fractionate send to their own distribution centers or marketers mainly in the AMBA. If the fractionation is outside the region, it is shipped in tanker trucks with a capacity of 28 tons to a node located in the province of Santa Fe.

In all cases, road transport is used as the exclusive alternative.

Wine

Primary production requires fuel and agrochemicals (fertilizers, herbicides, and pesticides). Fuel comes mainly from a regional refinery and agrochemicals are sourced from other regions of the country. Winemaking requires various inputs, including glass containers and the rest of the components that make up the bottle (cork, capsule, label) as well as cases. Most of the bottles come from Mendoza. There is a certain minority production in La Rioja, which is bottled in demijohns.

Famatina, Sanagasta and Chilecito are some of the key productive valleys. The production is packaged at origin and sent to the destination markets already fractioned, in boxes of 6 bottles that are palletized (about 100 boxes per pallet). In many cases, the wineries are located on the same farms where the vines are grown; in the case of a short freight, this rarely exceeds 40 km.

Most of the production is destined for the domestic market, concentrated in the AMBA, although the regional and local market is also important. About a quarter of the production is exported, mainly through Buenos Aires and, to a lesser extent, through Chilean ports via the Cristo Redentor Pass.

Transportation is exclusively by truck to both markets.

Salta

Beans

The main inputs are phytosanitary products and packaging material (polypropylene bags (big bags, 50kg and 25 kg). The phytosanitary products are of national origin and 70% of the bags are imported from India. In both cases the logistical impact is low, since they are shipped infrequently and the volume, compared to the volume of production, is insignificant.

The bean value chain in Salta begins with planting and harvesting in rural areas. Farmers employ advanced agricultural techniques to maximize crop yields. Once harvested, the beans are transported in bulk from the fields to the processing plants, over distances that vary according to the location of the fields and plants. Transportation is mainly in trucks adapted to protect the beans during transport, ensuring that they arrive in good condition at the processing destinations.

At the processing plants, the sorting industry sorts the beans according to various quality, color, and weight parameters. In Salta, there are 50 processing plants within the pulse complex. The beans are stored in silo bags or sent to storage facilities. Bags or "big bags" of up to 1,000 kilos or polypropylene bags of 50 kilos are also used for traditional harvesting.

The next step in bean logistics is the transportation of the processed beans from the processing plants to the domestic consumption markets. The beans are transported in suitable trucks to maintain their quality along the way. National and provincial roads facilitate transportation to the main consumption centers in the country, such as Buenos Aires, Rosario and Córdoba.

The last stage of the bean logistics chain in Salta involves transportation for export. From the processing plants, the beans are transported to the ports of departure, mainly located in Buenos Aires. The beans are transported by truck and, in some cases, rail transport is used for longer distances. Beans for export are packaged to meet international standards and guarantee their quality during transport. The main export markets include countries in Latin America, Europe, and Asia. Nearly two thirds of bean production is oriented to the foreign market, with more than 85% of exports going to the NOA-NEA provinces.

The logistic organization of the bean chain in Salta is based on two main movements. The first is the short freight from the field to the industrial plant, where the beans are transported in bulk in trucks. These short-distance freights, generally carried out by third parties or the company's own trucks, have a maximum load of 30 tons. The average distance between the field and the plants is 50 kilometers, although in some cases it may be longer.

The second movement is the long freight from industry to export. Almost 40% of exports correspond to white beans, followed by black beans (28%) and red beans (8.9%). Most of the processing industry starts exporting beans directly from their plants, consolidating the merchandise in situ. The beans are divided into 25- or 50-kilogram bags, depending on the destination and client. Salta accounts for more than 85% of the region's foreign sales. Exports to Brazil are made by land, while to the rest of the world they are shipped in 20-foot dry containers, with an average capacity of 24 tons, which are transported to the ports of Zárate and Buenos Aires, which operate 50% of the cargo as outbound customs. The main export routes are from Salta to Iguazú and Brazil, and from Salta to the port of Buenos Aires and Italy.

Wine

Primary production requires fuel and agrochemicals (fertilizers, herbicides and pesticides). Fuel comes mainly from a regional refinery and agrochemicals are sourced from other regions of the country. Winemaking requires various inputs, including glass containers and the rest of the components that make up the bottle (cork, capsule, label) and boxes.

Cafayate is the department with the largest planted area; provincial production accounts for about 2% of the national total. Two of the three companies surveyed are located in Cafayate; the remaining one in Molinos. The production is bottled at origin and sent to the destination markets already fractionated, in boxes of 6 bottles that are palletized (about 100 boxes per pallet).

Most of the production is destined for the domestic market, concentrated in the AMBA. About a quarter of production is exported, mainly through Buenos Aires and, to a lesser extent, through Chilean ports via the Cristo Redentor Pass.

Transportation is exclusively by truck for both markets.

Extensive Grains

The main inputs are soybeans, fertilizers and agrochemicals. The supply chain has suppliers located in the country. These inputs are transported daily by road.

The soybean logistics chain begins with the harvest of the grain and can be organized in different ways, depending on the storage and modes of transportation used. The merchandise is transported in bulk and has the corresponding documentation, known as a waybill. Short freight between the field and the storage area is generally carried out by local carriers using older trucks, covering distances greater than those of the core zone, exceeding 50 kilometers.

Long haulage, which covers significantly longer distances (more than 700 kilometers), is carried out in larger trucks, with a net capacity of 30 tons and of lesser age. In the best case, this transport can be carried out by rail, which optimizes logistics.

Santiago del Estero

Cotton

The supply chain relies on domestic suppliers whose main origin is the province of Santa Fe. These inputs are transported by road using motor freight.

Cotton logistics and transportation in the province of Santiago del Estero are organized in several key links to ensure efficiency in the supply chain.

Raw cotton is transported from the field to the ginning plants. These transfers are made in trucks with loads of 15 to 17 tons, covering distances of 50 to 70 kilometers when transported in bulk. Alternatively, boll cotton is transported in trailer trucks carrying 15 to 20 ton loads, covering distances of 200 to 300 kilometers. A typical route for bulk transportation is within the province, while boll cotton is usually transported from other provinces to Santiago del Estero.

In the next stage, the cotton fibers are transported from the ginneries to the spinning mills. The cotton is transported in bales of 200 to 250 kg each, with a total load of 20 to 25 tons per truck, over an average distance of approximately 800 kilometers. The yarn is then transported from the spinning mills to the weaving mills. The truck trip is carried out in palletized boxes, covering an average distance of 900 kilometers.

In the final stage, the fabrics are transported from the weaving mills to the manufacturing plants. The loads, which are palletized and have a total weight of 22 tons, travel approximately 900 kilometers.

For export, the cotton fibers are transported from the ginneries to the export ports. Dispatches are made in bales of 200 to 250 kg each, with a total load of 20 to 25 tons per truck, covering an average distance of 1,000 kilometers.

Although there are spinning plants distributed in several provinces, the weaving plants are predominantly located in NOA, which helps to reduce the distances required to transport fibers to these facilities. Once processed, the fibers transformed into fabrics are sent to apparel manufacturing, which is mainly concentrated in AMBA.

The entire cotton value chain, from the field to the final garment manufacturing process, uses trucking. This means of transportation is essential to ensure the continuous and efficient flow of products through the different stages of processing and marketing. Reliance on trucking underscores the importance of maintaining and improving road infrastructure to support the transit of goods and optimize the cotton supply chain in Argentina.

Extensive Grains

The main inputs mentioned in the surveys are soybeans, fertilizers, and agrochemicals. The supply chain has suppliers located in the country, Rosario and Santa Fe. These inputs are transported by road daily.

The main destination of origin-destination pairs correspond to the Rosario-Santa Fe area, where most of the industry is concentrated. The main origins include Colonia Dora, Santiago del Estero, Presidencia Roque Sáenz Peña, Tucumán, Quimilí and Metán.

There are two main movements in the logistical organization of the chain. The first is the direct truck trip from the field to the industry. This direct shipment during the harvest period is only possible for a minor part of the grain, since the terminals are limited by their reception and loading capacity. The producer can defer delivery by storing the grain in silo-bags, which implies an increase in logistics costs, but these can be compensated by a better selling price for the grain.

The second movement is the indirect trip, which includes a journey from field to storage and then to the industry. The short freight between the field and the collection is carried out in trucks operated by local carriers, which are mostly very atomized, traveling distances of more than 50 km. In some cases, as in the case of the AGD Beltrán storage facility, distances can exceed 200 km. The storage plants condition the grain by removing moisture and foreign material, which improves the quality of the product delivered to the processing plants.

Long haulage between the storage facility and the industry is mainly in 30-ton trucks of lesser age. When rail transport is used, loads are handled in large stockpiles with rail turnouts, using formations of between 40 and 60 wagons, each with a net capacity of 50 tons. In previous years, a small part of the production was transported by barge from the port of Barranqueras to the ports of Gran Rosario.

Sugar

The main inputs mentioned in the survey are gas for production, which is supplied by pipeline, and sugarcane, which is transported from areas near the mill by truck.

The province is connected by a network of national and provincial roads that facilitate the movement of sugar from the mills to local markets and export points. Paved roads allow overland transportation, while the railroad system, although with certain limitations, is relevant for transportation to export ports.

The province of Santiago del Estero faces several logistical challenges. Infrastructure in certain rural areas is deficient, which negatively affects transportation efficiency. The associated costs, particularly fuel and vehicle maintenance, represent a significant burden for producers. In addition, competition with other sugar-producing provinces, such as Tucumán and Jujuy, presents additional pressure, as these provinces may have logistical or production advantages that Santiago del Estero does not.

<u>Tucumán</u>

Sugar

The main inputs mentioned in the survey are gas for production which is supplied by gas pipelines and sugar cane is transported from areas near the mill by truck.

The logistics of the sugar chain in Tucumán is organized into three main links. The first link is the short freight from the field to the mill, where sugarcane is transported in bulk trucks, generally in semi-trailers, from fields that are usually between 20 and 60 kilometers from the mills.

The second link is the long freight from the mill to the domestic market. Processed sugar is transported mainly in trucks, with packaging adjusted according to the destination of the product. Thus, it is divided into 1.25 to 1 ton big bags, 50 and 25 kilogram bags, or already bagged on pallets, in 10 kilogram bags of 10 packages of 1 kilogram. Although the railroad has a smaller share of 6%, it is also used for transportation to the AMBA or Rosario, with average distances of around 1,100 kilometers. The third link is the long freight from the mill to export. For foreign markets, transportation is mainly by truck, particularly in the case of sales to Chile, the main destination. The railroad is also used to a lesser extent, Belgrano Cargas or Nuevo Central Argentino, depending on the origin, to the ports of Rosario and Buenos Aires, with the cargo generally in big bags.

Sugar produced in Tucumán is transported to consumption centers and industrial food establishments, mainly located in the AMBA, followed by Córdoba as an important destination. Tucumán's transportation infrastructure is key to sugar logistics. The province is well connected by a network of national and provincial routes, facilitating the movement of sugar from the mills to local markets and export points. The main routes used include National Route 38 and National Route 9, which allow efficient access to other provinces and export ports. Although the railway system has some limitations, it is still relevant for transporting sugar to the export ports in Buenos Aires.

Lemon

Fresh lemon production takes place on farms where fuel, fertilizers and pesticides are the main inputs in the supply chain. According to those surveyed, supplies are obtained from local suppliers (with origin in Tucumán). At the industrial stage, corrugated cardboard boxes are demanded, produced mostly by a national company with corrugated cardboard plants in the country.

The activity is led by large companies with a strong export presence. The European Union stands out among the destination markets. The activity is subject to a marked seasonality that depends on the harvest and export period.

The packing and industrial facilities tend to be integrated in the same area and close to the production sites, a distance that is covered with a short freight that tends to be less than 50 km. Production is packed in boxes that are palletized and then consolidated in transport units: 20-foot refrigerated containers for export and trucks, mostly with refrigerated holds for the domestic market.

The main destination nodes for export production are Buenos Aires, Campana and Rosario for transatlantic destinations (EU, Russia and others) and, to a lesser extent, Mendoza for shipments from Chile across the Pacific Ocean where the main destination is the US West Coast.

The mode of transport used by the respondents is exclusively by road to cover a distance of about 1,200 km to the ports (in the case of exports) and to the main wholesale marketing centers (in the case of domestic consumption), such as the Central Market of Buenos Aires; this corresponds to the predominant practice in the sector. Although there are rail shipments, they are currently relatively marginal.

<u>Misiones</u>

Yerba Mate

The main input is Yerba Mate Canchada (subjected to a first coarse grinding), which is transported to the production points by truck.

The Mercosur countries are the main consumers of yerba mate, with Syria and Chile being the most important destinations for Argentinean exports. Ninety percent of exports correspond to processed yerba mate, 8% to extracts and 2% to canchada yerba.

The yerba mate value chain is made up of two fundamental links: primary production and industrial processing. The green leaf is harvested and transported from the plantations to the dryers in trucks, traveling distances of 50 to 100 km on rural roads. At the dryers, the green leaf is processed through drying, canning and parking to obtain canned yerba mate, which is stored in 50 kg bags for several months. It is then transported to mills located in urban centers for milling and fractionation, covering distances of 150 to 200 km in trucks that can carry between 20 and 28 tons.

The average distance between the mill and the marketing centers is 1,030 km, with a load of 25 tons. The freight cost from the mill in Oberá to the port of Buenos Aires is US$43 per ton, which represents 1.5% of the FOB cost. The total logistics cost, which includes international freight, amounts to US$433 per ton, equivalent to 15% of the FOB value. The main domestic transportation route is from Oberá, Misiones, to Buenos Aires, covering a distance of 1,500 km and representing more than 35% of the total yerba mate cargo.

Logistics Vulnerability Indicator (LVI)

A Logistics Vulnerability Indicator (LVI) was developed to evaluate the logistics situation of the various production chains in greater detail. This indicator is an analytical tool that allows quantifying the strength and stability of logistics processes within a specific numerical scale. The indicator is constructed based on survey responses when possible, and otherwise covers those gaps with secondary information.

The LVI is expressed as a real number ranging from 1 to 5. On this scale, the value of 5 expresses the highest vulnerability, indicating that the logistics process is exposed to significant risks and is susceptible to disruptions. On the other hand, the value of 1 represents the lowest vulnerability, reflecting a logistics process protected against possible contingencies.

The implementation of the LVI provides insight that clarifies critical points in the logistics chain, allowing organizations to identify areas for improvement and strengthen their risk mitigation strategies. This approach can inform the potential resilience of supply chains in a dynamic and changing business environment.

The IVL is assessed for each chain-province pair. The indicator analyzes the internal logistics of final production and inputs, covering from the place of origin of the cargo to its destination within the country, if it is an internal transfer, or to the point of transfer, such as a port or border crossing, in the case of exports. It does not consider international logistics, whether by land or sea.

Sub-indicators

The IVL is composed of 9 sub-indicators. Each sub-indicator has a relative weighting assigned to it, the total sum of the weights being equal to 100%. The table below shows the sub-indicators, their weights and respective justifications, detailing the relevance of each dimension in the logistics of the chains analyzed.

Table 1.2: *Logistic Vulnerability Index Sub-indicators*

Sub-indicator	Weight	Justification
Logistics cost	20%	Cost is an important factor as it can influence the economic viability of the chain.
Time	10%	Time is important because it can deteriorate the product and generate the need for more working capital. Their weight is not as high as the cost
Multimodality	5%	A multimodal chain is less vulnerable
Logistical alternatives / flexibility	5%	Given that generally there are few alternatives among the origins and destinations of the chains studied, this sub-indicator was given a low weight.
Condition of infrastructure used	15%	The condition of the infrastructure has a significant impact, as traveling along corridors in poor condition increases logistics costs, jeopardizes the safety of cargo and people, and increases delivery times.
Efficiency of nodes (ports, border crossings)	15%	Nodes have a major impact on logistics time and costs
Transport supply	10%	With greater availability of transportation, better prices can be obtained; when a chain lacks supply, its vulnerability increases.
Environmental sustainability	10%	Depending on the effect of the chain on the environment, it can achieve greater sustainability in the long term.
Security	10%	This sub-indicator considers the possibility of theft in the logistics chain.

As shown in Table 1.3, province-value chain pairs are classified into four ranges of logistics vulnerability:

- High vulnerability (4 - 3.85): 4%.
- Medium-high vulnerability (3.65 - 3.4): 36%
- Medium-low vulnerability (3.25 - 2.95): 28%.
- Low vulnerability (Light green: 2.9 - 2.6): 32%

Almost 40% of the chains by province analyzed for the Norte Grande have a high or medium-high vulnerability index. The most vulnerable are the orange chain in Jujuy, the lemon chain in Tucumán and the forestry chain in Corrientes. These results imply that the chains in these provinces are more exposed to high logistics costs, long delivery times, lack of adequate infrastructure and a limited supply of transport services.

Some 32% of the chains analyzed are close to the low vulnerability range. These include lithium in Jujuy, rice and cotton in Corrientes.

The results of the LVI can be combined with the impact of the chains on provincial economies. This combination may result in an original tool for prioritizing actions to address the multiple logistical challenges facing the Norte Grande.

Table 1.3: *LVI by province-value chain pair*

Value chain	Province	Value chain - Province	IVL
Orange	Jujuy	Orange - Jujuy	3,85
Forestry	Corrientes	Forestry - Corrientes	3,65
Lemon	Tucumán	Lemon - Tucumán	3,65
Bean	Salta	Bean - Salta	3,6
Copper	Salta	Copper - Salta	3,55
Cattle	Chaco	Cattle - Chaco	3,5
Cattle	Formosa	Cattle - Formosa	3,5
Olive	La Rioja	Olive - La Rioja	3,45
Wine	Salta	Wine - Salta	3,45
Wine	La Rioja	Wine - La Rioja	3,4
Sugar	Tucumán	Sugar - Tucumán	3,25
Orange	Corrientes	Orange - Corrientes	3,25
Yerba	Misiones	Yerba - Misiones	3,2
Yerba	Corrientes	Yerba - Corrientes	3
Grains	Chaco	Grains - Chaco	2,95
Grains	Salta	Grains - Salta	2,95
Grains	Santiago del E.	Grains – Santiago del E.	2,95
Cotton	Santiago del E.	Cotton – Santiago del E.	2,9
Rice	Chaco	Rice - Chaco	2,75
Sugar	Jujuy	Sugar - Jujuy	2,75
Sugar	Santiago	Sugar - Santiago	2,75
Olive	Catamarca	Olive - Catamarca	2,75
Cotton	Corrientes	Cotton- Corrientes	2,7
Rice	Corrientes	Rice - Corrientes	2,65
Litio	Jujuy	Litio - Jujuy	2,6

Annex 2: Using satellite imagery and machine learning to estimate road condition

The road index (RI) is described by the following formula:

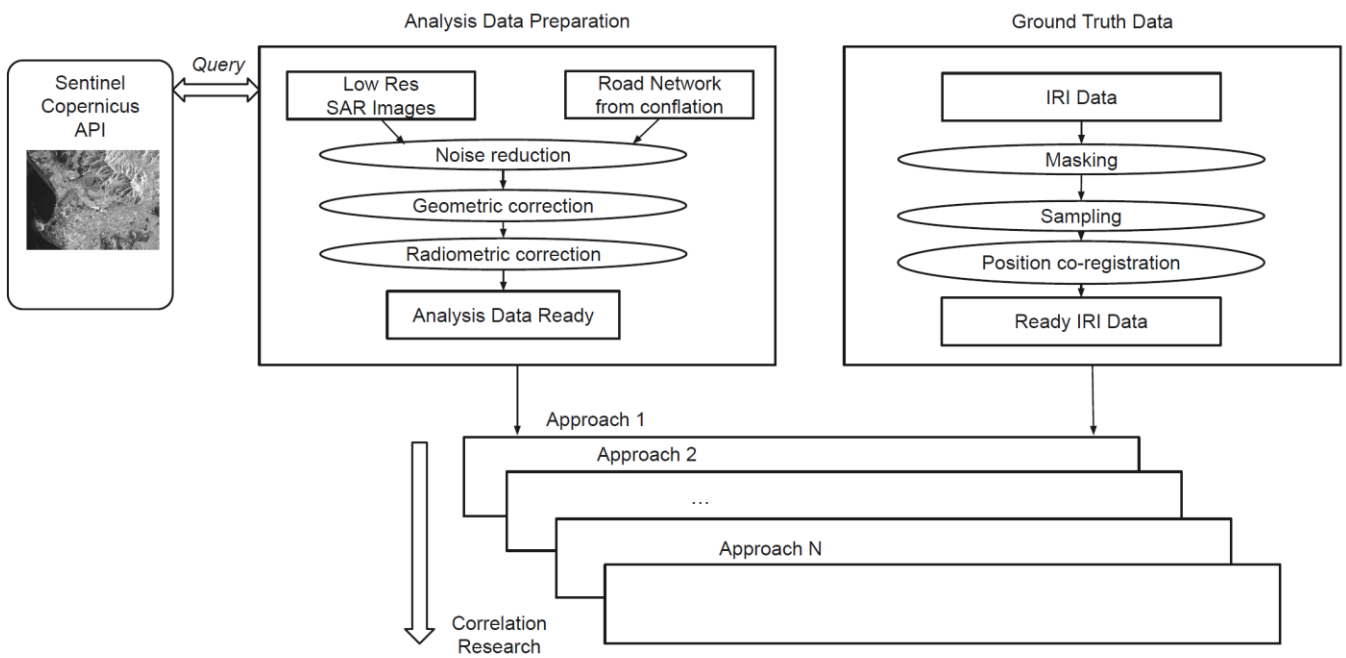
$$RI = \frac{3 * \min(SWIR, NIR, B)}{SWIR + NIR + B}$$

In the analysis, we used 3 sources of information:

(1) Vector data on the location of each type of road: fusion of SISVIAL data (official data that was considered as authoritative for the mapping of the National Road network) and open-source data (Bing, Meta, Open Street Maps).
(2) Sentinel-2 optical imagery (09-2023 to 01-2024), which provides SWIR imagery data but has a lower resolution in the blue and near-infrared bands. Blue and NIR are provided at 10-meter resolution whereas SWIR images have a 20-meter resolution so we upscale SWIR image to 10 meters for the road index computation.
(3) Sentinel-1 SAR radar images (01-2020 to 11-2023)

Features calculated from the satellite imagery were projected onto the road segments.

We used an automated learning algorithm (XGBoost), which was trained over 5,600 km of routes and verified over 1400 km of (AC&A data from December 2019) to evaluate the roughness index throughout Argentina. We then used thresholds on the roughness index to obtain 3 categories: good, fair and bad. categories: good (IRI =< 6), fair (>6 and =< 8), and poor (>8).



Annex 3: Multi-criteria analysis to develop a shortlist of priority projects

Based on infrastructure investment projects pre-prioritized by the Norte Grande provincial authorities and reflected in the *Logistics Strategy for the Norte Grande* financed by the Federal Investment Council (CFI) in 2022, the current study developed the methodology adopted for the selection of the most relevant projects for the reduction of land transportation costs. In the Strategy, 116 infrastructure, services, and regulation interventions are proposed. The current study selected initiatives specifically related to infrastructure works, particularly those corresponding to road and railroad projects. The corresponding reports were reviewed, and a detailed list of investment projects was prepared. Most of the projects had already been geo-referenced. However, national roads that need repaving (4,491 km in poor and 2,150 km in fair condition) were not indicated. The current study identified the road sections that require this type of intervention to then geo-reference them. For this purpose, the State Index and Present Serviceability Index reports of the National Roads Authority were used, corresponding to the year 2021-2022, which specify the state of the national routes in their different sections. The total number of projects analyzed amounted to 124.

For the selection of the most relevant projects within those pre-prioritized by the authorities of Norte Grande and as reflected in the Logistics Strategy for the Norte Grande, a multi-criteria matrix was prepared that combines the list of projects with a series of attributes that allow a ranking to be made.

Four dimensions of analysis were established, operationalized in 14 attributes:

1. The **Local or Regional Impact** dimension includes five indicators associated with the economic activity that takes place in the project's area of influence (AOI), indicative of the demand for infrastructure services:
   - *Current production volume* of the priority value chains in the AOI, based on data published by the public sector and business chambers[35]
   - *Volume of projected cargoes originating in or destined for the buffer departments*, distinguishing between total cargoes and those corresponding to the prioritized chains
   - *Gross product* of the AOI departments, based on information provided by the National Geographic Institute (IGN) of Argentina (based on Goodman et al. 2019).
   - *Population* of the AOI departments, based on the National Population Census (2022)
   - *Poverty* in the AOI departments, measured as people living in household with unsatisfied basic needs as per the National Population Census (2022)
2. Contribution of the works to **inter-regional connectivity:**
   - *Annual Average Daily Truck Traffic (AADT),* available for all national roads, but not for those under provincial jurisdiction, based on data from Dirección Nacional de Vialidad (DNV for 2021)
   - *Relevance of the corridor* – whether the projects are important for the more general regional logistics integration corridors *(*NOA-Puertos, Northern Transversal Corridor, Hidrovía Corridor, Mercosur Corridor).
   - *Likely direct contribution to the reduction of land transportation costs.* In some cases, these are direct impacts such as improved road surfaces and less wear and tear for the rolling stock; in others, the reduction of fixed costs due to increased speeds and, therefore, the number of km traveled per year.
   - *Export orientation,* where export chains are those exporting at least 50 percent of production volume.[36]
3. **Institutional complexity of implementation and budgeting**:
   - *Magnitude of the estimated investment:* The allocated budget was considered in those cases where information is available; for the rest of the recommended works, ranges were estimated based on references from specialized works.
   - *Institutional complexity:* whether the agencies involved in the execution of the works are governments of one or several provinces, whether they also involve the national government, etc.
   - *Allocated financing:* whether the works in question already have an allocated budget from national or subnational entities or financing by international or other organizations.
4. **Impact on climate change mitigation or adaptation:**
   - *Mitigation:* Railway projects have a higher score due to less emissions per ton transported. In the case of road projects, paving a road results in lower fuel consumption and vehicle wear and tear, as do works to solve congestion problems.
   - *Adaptation:* The routes with the highest risk of impact of climate change (e.g., flood risk causing significant economic losses) are identified based on World Bank/GFDRR (2021).

The table below summarizes the indicators adopted and the associated weighting in each case.

[35] Secretariat of Agriculture of the Nation (SAGyP), Argentine Sugar Center (CAA), FEDERCITRUS, National Institute of Viticulture (INV), International Olive Council (IOC), National Economic Census 2018 (CNE18), National Institute of Yerba Mate (INYM), National Inventory of Forest Plantations - National Directorate of Industrial Forestry Development.

[36] Data for this indicator is derived from the value chain analysis conducted by CIPPEC through surveys/ focus groups.

__Table 3.1:__ Dimensions, Attributes, and weightings considered in the Multicriteria Analysis

Dimensions	Attributes	Weights	
A. Local Economic Importance	A1. Current Production	0,080	**0,40**
	A2. Projected OD Tons	0,080	
	A3. GDP	0,080	
	A4. Population	0,080	
	A5. Poverty	0,080	
B. Interregional Connection	B1. Annual Average Daily Traffic (trucks)	0,088	**0,35**
	B2. Relevance to Corridor	0,088	
	B3. Direct contribution to the reduction of land transportation costs.	0,088	
	B4. Incidence of Export Chains	0,088	
C. Institutional and Budgetary Complexity	C1. Magnitude of Investment (indirect)	0,050	**0,15**
	C2. Institutional complexity	0,050	
	C3. Allocated Funding (yes/no)	0,050	
D. Climate Change relevance	D1. Support for the adaptation or mitigation of CC	0,050	**0,10**
	D2. Risk of CC impact	0,050	
TOTAL		**1,00**	

Each of the dimensions described above was evaluated as follows:

- **Quantitative variables**: quintiles were defined and a score of 0.2, 0.4, 0.6, 0.8 and 1 was assigned to each one.
- **Qualitative variables**, assigning a low, medium-low, medium, medium-high and high impact, equivalent to a score of 0.2, 0.4, 0.6, 0.8 and 1, respectively.
- **Binary variables**: values 0 and 1 were assigned.

The scores obtained in each case were then weighted according to the table presented above, establishing a single score for each project.

Alternatively, the Principal Components Method (PCA) was used to define the index weights. After comparing the results obtained from the application of both methodologies and with the purpose of having a wide territorial coverage, the first weighting table was chosen as it offers greater flexibility.

Next, the highest scoring project was selected within each of the 10 provinces of the Norte Grande region. Then, the 10 highest scoring projects were considered for the region, regardless of their geographic location. Thus, from the original base of 124 projects, 20 were selected.

Annex 4: Estimation of transport cost savings as a result of the pre-prioritized road and rail infrastructure works

Road projects

According to CFI (2022), the roads under national jurisdiction in the Norte Grande Region are characterized by: low traffic, asphalt, flat terrain, a 6.70-meter roadway, an acceptable or good level of service, wide shoulders (>2.5m), unpaved shoulders, and poor or fair condition. The same report points out that the last points are the most critical due to the negative impact they have on road safety, operating costs and public expenditure.[37] These elements are considered when modeling transportation flows in general, and in the Norte Grande in particular, and are decisive in assessing the impact that the implementation of road infrastructure works would have on their costs.

- **Cost estimation model.** As anticipated, in this case, we have chosen to apply the Road Cost Model (MCC) - Version 4, published in 2019 by the National Ministry of Transportation. This model allows, by entering a series of input data related to the origin and destination of the cargo, its typology, the type of rolling stock used, the average speed and/or annual kilometers traveled, the type of road and the average existing traffic on it, to calculate the operating costs and the cost assignable to the maintenance of the existing infrastructure, per vehicle, km and ton-kilometer, in the scenarios with and without project.
- **Estimation period:** the MCC was published in mid-2019, including an update methodology, which was replicated here to obtain cost values as of 2022. For this purpose, the following were considered:
    - BCRA Monthly Average Nominal Exchange Rate (TCNPM)[38]
    - Price of Gasoil type 2 in the Energy Secretariat[39]
    - Remunerations of workers registered in the sector Transporte Automotor de Cargas of the Observatorio de Empleo y Dinámica Empresarial (OEDE) of the Ministry of Labor of the Nation[40]
    - First Category Driver Salary - Joint Act of CCT 40/89[41]
- **Input Data.** For the definition of the input variables required by the MCC, the road sections to be intervened were characterized (type of road, type of soil, TMDA, state of the infrastructure), using the information collected and published by the National Roads Authority (DNV) on its website and the State Index and Present Serviceability Index reports, corresponding to the period 2021-2022, which specify the state of the national roads in their different sections[42] .
- **Operational Parameters.** A series of estimates had to be made to define the operating parameters associated with the type of work to be evaluated:
    - **Type of vehicle:** in all cases, a standard 45-ton truck was considered, assuming a payload of 14 tons, as it is the predominant one in the Region. The latter was approximated by using the Origin and Destination Matrices of Road Loads of the National Ministry of Transportation, corresponding to the year 2016, in which the typical configurations and the tonnage transported are detailed, considering that 100% of the return trips are made in ballast.
    - **Average speed:** the average speed of traffic on the section to be intervened was estimated. This calculation is based on a combination of the pavement condition and the current service levels reported by the DNV, with the maximum and average traffic speeds according to the pavement condition, obtained from interviews with specialists in the sector. In accordance with current regulations, the maximum speed for trucks on national roads is 80km/h. Given the condition of the pavement and the existing service levels, the following maximum and average speeds were considered:

Table 4.1: *Speed assumptions*

km / hora	Bueno	Regular	Malo
Vel. Máxima	80	70	40
Vel. Promedio	58	51	29

    - **Annual mileage traveled:** another of the reports periodically prepared by the DNV corresponds to the COSTOP, a calculation of the operating costs of providing road transport services in Argentina. Although for this work we chose to apply the MCC model for the calculation of operating costs, the COSTOP was used to adopt the

[37] CFI (2022) Logistics Strategy for the Norte Grande. Diagnosis and Intervention Proposals for the Road System.

[38] https://www.bcra.gob.ar/PublicacionesEstadisticas/Tipos_de_cambios.asp

[39] http://res1104.se.gob.ar/consultaprecios.mayo.php

[40] https://www.argentina.gob.ar/trabajo/estadisticas/oede-estadisticas-nacionales#1

[41] https://www.camioneros-ba.org.ar/index.php/gremiales/salarios/escalas-salariales

[42] For more details see https://www.argentina.gob.ar/sites/default/files/2018/08/metodologia-evaluacion-estado_-pavimentos.pdf

relationship between average traffic speeds and annual mileage traveled that emerges from its estimates.

- **Calculation of costs.** Based on the above, operating costs and infrastructure maintenance costs were calculated in 2022 dollars per ton-kilometer for the scenarios with and without a construction project:
  - **Type of work:** the selected projects correspond to three types of infrastructure interventions: pavement resurfacing, construction of a passing lane and construction of a dual carriageway. In the case of the pavement recomposition, it is assumed that in the scenario with the project, the average traffic speed is that corresponding to the "good" condition in the section and in the typical route. For the construction of an overpass lane or dual carriageway, it is further assumed that in the scenario with project the level of service improves to a level B and A, respectively, according to the parameters defined by the DNV, for a two-lane road and for a highway[43] . The speeds considered are as follows:

***Table 4.2:** Speed assumptions by scenario*

Nivel de Servicio	Situación	% Tiempo sin sobrepaso	Velocidad promedio de viaje (km/hora)
A	Autopista	<=35	73
B	Carril de Sobrepaso	35-50	61
C		50-65	55
D		65-80	49
E	Escenario Base	>80	47

  - **Impacted section:** these costs were calculated for the mileage corresponding to the section intervened as for a typical truck route in the Norte Grande Region, seeking to approximate a network perspective and understanding that each work is part of a broader freight route. The approximation of typical cargo routes was made by using the road MODC of the National Ministry of Transportation, from which it appears that the average distance traveled by road is 564 km for cargo originating in the Norte Grande Region and 891 km for cargo arriving in the region from the rest of the country. **Thus, the weighted average road distance of both flows is 651 km.**

Rail projects

To evaluate each of the selected projects, it was necessary to analyze the load flows of each line, identifying the traffic that uses the section to be intervened, as well as to calculate in each case the percentage of use of this section in the total trip, in order to correctly estimate the improvement in the operating parameters. For this purpose, we used the rail origin-destination matrices (MODF)[44] for 2021, which provide information on the tons transported per line between stations or loading points of the operating network. Likewise, for each origin-destination pair, the distance traveled is available, which makes it possible to calculate the ton-kilometers,[45] the most commonly used traffic unit in the sector.

In this way, the tons and ton-km with origin and/or destination at some point of the evaluated section were obtained, as well as the passing load. To determine what proportion of the stretch was used in each case, the distance between the point of origin and/or destination within the stretch with the corresponding limit was calculated, based on the differences between kilometer progressions. Clearly, in the case of the passing load, the entire section is used.

the COSFER-V3[46] was used to estimate the cost reduction resulting from the proposed interventions, which is a tool that allows simulating different scenarios of rail transport operation. Based on the determination of certain basic parameters, the model dynamically calculates the associated costs, divided into three groups:

- Mobility Costs: refers to the specific cost of transportation and maintenance of rolling stock.
- Track Infrastructure Maintenance Costs: refers to infrastructure maintenance work, which can be manual or mechanized.
- Track Infrastructure Investment Costs: refers to track renovation or improvement works, and interventions in works of art, level crossings and track devices.

The latest version of COSFER allows estimating costs up to March 2019. In order to have more current values and a more stable period, we proceeded to update to the year 2022. For this purpose, the parameters were updated taking into account the "drivers" considered in the methodological document, which are detailed below:

- Wage cost of the construction activity of the Dirección General de Estadísticas y Censos de la CABA[47]

[43] More detail can be found at: http://transito.vialidad.gob.ar:8080/web_ns/metodologia2.jsp#:~:text=Velocidad%20de%20circulaci%C3%B3n%3A%20el%20rango,70%20y%20120%20km%2Fh.

[44] Rail freight origin - destination information provided by the CNRT.

[45] The ton-kilometers (ton-km) are calculated by multiplying the tons by the distance traveled for each origin-destination pair. The sum of the ton-km divided by the sum of the tons gives the average distance of the cargo.

[46] https://datos.gob.ar/ar/dataset/transporte-cosfer-modelo-estimacion-costos-ferroviarios-carga

[47] https://www.estadisticaciudad.gob.ar/eyc/?p=27207

- BCRA Monthly Average Nominal Exchange Rate (TCNPM)[48]
- Price of GasOil type 2 in Rosario, Olavarría and Bahía Blanca from the Energy Secretariat[49]
  - Construction Cost Index (ICC) published by INDEC[50]
  - Wholesale Domestic Price Index (IPIM) published by INDEC[51]
  - Salaries by category[52]

In addition, average costs were calculated for the year 2022 to correct for possible mismatches between relative prices and monthly seasonality problems.

Given the network conception and the link with the infrastructure of this mode of transport, costs were estimated taking into account the total traffic that circulated within the network concessioned to NCA and those of the Belgrano and Urquiza lines, the latter operated by Trenes Argentinos Cargas (TAC). It should be noted that in the case of NCA, traffic of the San Martín line (operated by TAC) that used its network during 2021 was included.

Depending on the line, the type of infrastructure, its condition and the usual operating conditions, the operating parameters of traffic speed, tons per axle and length of the trains were defined[53] . For the use of COSFER, in the scenarios with and without project[54] , weighted averages were calculated for each parameter based on the ton-km of each MODF origin-destination pair, according to the characteristics of the branches used in each of them.

Thus, the total costs in each of the scenarios were obtained, from which the corresponding savings are derived. Taking as a reference the total ton-km transported on each line, the overall cost reduction in US$ per ton-km is obtained. Since the savings are produced by the intervention in a part of the infrastructure, the savings associated with the ton-km of the traffic that used, partially or totally, this section are also calculated, as well as the cost reduction for the ton-km associated specifically with that section. The ton-km data are presented at the end of this section, in each case.

It should be noted that infrastructure investment costs have not been considered (but the cost of its maintenance) to be able to compare with the road mode which, as explained, does not include them. Likewise, once the Vertical Separation and Open Access Management Model is implemented, the operation of the infrastructure would be separated, and operators would be obliged to pay a toll for the use of the infrastructure.

Table 4.3: *Ton-Kilometers associated with each project*

Nombre del Proyecto	Línea y Operador	BASE		
		Red	Red que utiliza el tramo	Tramo
		Miles de Ton-Km		
Proyectos seleccionados				
76 | Ramal C13 - Cerrillos - Güemes	Belgrano - TAC	1.927.266	85.156	4.952
78 | Ramal C15 - Perico - Pichanal	Belgrano - TAC	1.927.266	104.652	5.276
80 | Ramal C - Palpalá - Tucumán	Belgrano - TAC	1.927.266	437.749	82.422
84 | Ramal GM1 - Tucumán - Lte. Santa Fe	Mitre - NCA	3.808.652	1.602.179	784.994
86 | Ramal Troncal - Garupá - Lte. Entre Ríos	Urquiza - TAC	331.598	326.397	103.982
Otros alcances considerados				
Ramales C + C13 + C15	Belgrano - TAC	1.927.266	437.965	92.649
Ramal GM1 - Tucumán - Rosario	Mitre - NCA	3.808.652	1.975.296	1.912.569
Ramal Troncal - Garupá - Zárate	Urquiza - TAC	331.598	331.598	331.598

[48] https://www.bcra.gob.ar/PublicacionesEstadisticas/Tipos_de_cambios.asp
[49] http://res1104.se.gob.ar/consultaprecios.mayo.php
[50] https://www.indec.gob.ar/indec/web/Nivel4-Tema-3-5-33
[51] https://www.indec.gob.ar/indec/web/Nivel4-Tema-3-5-32
[52] https://sindicatolafraternidad.org and https://cct.trabajo.gob.ar/
[53] The length of the trains mainly responds to operational decisions of the companies based on the type and quantity of rolling stock, access to loading and unloading centers, crossing detours, transit through urban crossings, the signaling system, among others, and not directly on the condition of the infrastructure. However, it is expected that improvements in infrastructure and operating conditions will result in an increase in demand and private investments in accesses and freight consolidation centers, making it convenient to increase the length of the trains.
[54] A heavy road improvement is proposed. In general, given the transport volumes, operators and specialists are proposing improvements to restore the infrastructure to its design conditions.

Table 4.4: *Ton-Kilometers associated with each project assuming growth in the cargo volumes transported by rail*

Nombre del Proyecto	Línea y Operador	CRECIMIENTO 33%			CRECIMIENTO 66%		
		Red	Red que utiliza el tramo	Tramo	Red	Red que utiliza el tramo	Tramo
		Miles de Ton-Km			Miles de Ton-Km		
Proyectos seleccionados							
76 | Ramal C13 - Cerrillos - Güemes	Belgrano - TAC	2.563.264	113.258	6.586	3.199.262	141.360	8.220
78 | Ramal C15 - Perico - Pichanal	Belgrano - TAC	2.563.264	139.187	7.017	3.199.262	173.722	8.758
80 | Ramal C - Palpalá - Tucumán	Belgrano - TAC	2.563.264	582.206	109.621	3.199.262	726.664	136.820
84 | Ramal GM1 - Tucumán - Lte. Santa Fe	Mitre - NCA	5.065.507	2.130.899	1.044.042	6.322.362	2.659.618	1.303.090
86 | Ramal Troncal - Garupá - Lte. Entre Ríos	Urquiza - TAC	441.025	434.108	138.296	550.452	541.819	172.610
Otros alcances considerados							
Ramales C + C13 + C15	Belgrano - TAC	2.563.264	582.494	123.223	3.199.262	727.022	153.797
Ramal GM1 - Tucumán - Rosario	Mitre - NCA	5.065.507	2.627.144	2.543.716	6.322.362	3.278.992	3.174.864
Ramal Troncal - Garupá - Zárate	Urquiza - TAC	441.025	441.025	441.025	550.452	550.452	550.452

Source: Own elaboration based on CNRT (2021)

Results

Table 4.5: *Savings in Road Transportation Operating Costs in Selected Road Works. In US$ per ton-kilometer.*

Nombre del Proyecto	Tipo de Obra	Longitud del Tramo intervenido	Tipo de Suelo	TMDA Camiones Promedio	ESCENARIO SIN PROYECTO		IMPACTO ESCENARIO CON PROYECTO				
					a.1 Costos de Operación - En el Tramo	a.2 Costos de Operación - Para Recorido Típico Norte Grande	a.1 Costos de Operación - En el Tramo	a.2 Costos de Operación - Para Recorido Típico Norte Grande	a.1 Costos de Operación - En el Tramo	a.2 Costos de Operación - Para Recorido Típico Norte Grande	Ahorro anual Costos de Operación -En el tramo
		(km)		Unidades	US$/ton-km (Año 2022)		US$/ton-km (Año 2022)		Variación en %		US$
1-Ruta N 9-ACC.A BANDA DEL RIO SALI (D) - INT.R.P.306	Doble Calzada	2	Llano	2.462	0,0519	0,0519	0,0437	0,0519	-15,7%	0,0%	**174.331**
2-Ruta N 9-INT.R.P.306 - B/N R.N.38 (ACC.SUR A TUCUMAN)	Doble Calzada	2	Llano	2.767	0,0519	0,0519	0,0437	0,0519	-15,7%	0,0%	**238.624**
39-Ruta N 34-Desde S. Pedro de Jujuy hasta Embarcación	Carriles de sobrepaso	154	Llano	973	0,0519	0,0519	0,0483	0,0510	-7,0%	-1,6%	**2.773.448**
88-Ruta N9 - Lte. Córdoba - Ciudad de Stgo. del Estero	Recomposición del estado del pavimento	239	Llano	2.446	0,0533	0,0533	0,0437	0,0498	-18,0%	-6,6%	**28.613.164**
89-Ruta N9 - Ciudad de Stgo. del Estero - Ciudad de Salta	Recomposición del estado del pavimento	461	Llano	1.822	0,0547	0,0547	0,0437	0,0469	-20,0%	-14,2%	**46.951.777**
91-Ruta N11 - Lte. Santa Fe - Ciudad de Formosa	Recomposición del estado del pavimento	364	Llano	1.194	0,0517	0,0517	0,0437	0,0473	-15,5%	-8,6%	**17.747.267**
94-Ruta N12 - Posadas - Puerto Iguazú	Recomposición del estado del pavimento	298	Llano	1.266	0,0515	0,0515	0,0437	0,0479	-15,0%	-6,9%	**14.910.704**
95-Ruta N14 - Lte. Entre Ríos - Santo Tomé	Recomposición del estado del pavimento	342	Llano	2.089	0,0530	0,0530	0,0437	0,0482	-17,5%	-9,2%	**33.985.698**
96-Ruta N14 - Santo Tomé - Bdo. De Irigoyen	Recomposición del estado del pavimento	442	Llano	850	0,0494	0,0494	0,0437	0,0456	-11,4%	-7,8%	**10.847.656**
99-Ruta N34 - Lte. Santa Fe - Rosario de la Frontera	Recomposición del estado del pavimento	576	Llano	1.804	0,0545	0,0545	0,0437	0,0450	-19,7%	-17,4%	**56.978.920**
100-Ruta N34 - Cabeza de Buey - Pocitos	Recomposición del estado del pavimento	360	Llano	1.255	0,0555	0,0555	0,0437	0,0490	-21,3%	-11,7%	**27.224.954**
107-Ruta N51 - Gral. Alvarado - Lte. Chile	Recomposición del estado del pavimento	289	Llano	467	0,0492	0,0492	0,0437	0,0468	-11,2%	-5,0%	**3.790.565**
114-Ruta N79 - Chamical - Emp. RN60	Recomposición del estado del pavimento	125	Llano	226	0,0576	0,0576	0,0437	0,0549	-24,0%	-4,6%	**1.994.304**
116-Ruta N81 - Emp. RN95 - Emp. RN34	Recomposición del estado del pavimento	498	Llano	180	0,0458	0,0458	0,0437	0,0442	-4,5%	-3,5%	**949.247**
127-Ruta N157 - Emp. RN60 - SM. Tucumán	Recomposición del estado del pavimento	310	Llano	1.083	0,0519	0,0519	0,0437	0,0480	-15,7%	-7,5%	**14.005.398**

Source: Own elaboration based on DNV, MCC- Ministerio de Transporte de la Nación and interviews to sector specialists.

Table 4.6: *Rail Transportation Operating Cost Savings in Selected Projects. In US$/ ton-km*

					Escenario sin proyecto	Escenario con proyecto						
Nombre del Proyecto	Línea y Operador	Tipo de Obra	Longitud del Tramo intervenido	Densidad del tramo	Costos de Operación	Costos de Operación - En la red	a1. Costos de Operación en el Tramo	a2. Costos de Operación para las cargas que utilizan total o parcialmente el Tramo	Costos de Operación - En la red	a1. Costos de Operación en el Tramo	a2. Costos de Operación para las cargas que utilizan total o parcialmente el Tramo	Ahorros Anuales
			km	ton por km	US$/ton-km (año 2022)				Variación %			US$
Proyectos seleccionados												
76 | Ramal C13 - Cerrillos - Güemes			63	78.775	0,0250	0,0249	0,0215	0,0248	→ -0,04%	↓ -13,69%	→ -0,80%	16.915
78 | Ramal C15 - Perico - Pichanal	Belgrano - TAC		167	31.592	0,0250	0,0249	0,0184	0,0246	→ -0,07%	↓ -26,34%	↓ -1,33%	34.677
80 | Ramal C - Palpalá - Tucumán		Mejoramiento	337	244.242	0,0250	0,0249	0,0230	0,0246	→ -0,33%	↓ -7,68%	↓ -1,45%	157.865
84 | Ramal GM1 - Tucumán - Lte. Santa Fe	Mitre - NCA		474	1.654.709	0,0279	0,0274	0,0257	0,0268	↓ -1,59%	↓ -7,72%	↓ -3,78%	1.689.232
86 | Ramal Troncal - Garupá - Lte. Entre Ríos	Urquiza - TAC		487	213.406	0,0413	0,0356	0,0229	0,0355	↓ -13,95%	↓ -44,50%	↓ -14,18%	1.912.369
Otros alcances considerados												
Ramales C + C13 + C15	Belgrano - TAC		567	163.311	0,0250	0,0247	0,0203	0,0240	→ -0,90%	↓ -18,70%	↓ -3,96%	432.376
Ramal GM1 - Tucumán - Rosario	Mitre - NCA	Mejoramiento	851	2.248.493	0,0279	0,0236	0,0194	0,0197	↓ -15,23%	↓ -30,33%	↓ -29,37%	16.174.811
Ramal Troncal - Garupá - Zárate	Urquiza - TAC		1.063	311.945	0,0413	0,0259	0,0259	0,0259	↓ -37,33%	↓ -37,33%	↓ -37,33%	5.115.482

Source: Own elaboration based on CNRT (2021), COSFER - Ministerio de Transporte de la Nación (2019) and interviews to sector specialists.

Table 4.7: *Total Cost Savings (operating + maintenance) of Rail Transportation in Selected Projects. In US$/ ton-km.*

					Escenario sin proyecto	Escenario con proyecto						
Nombre del Proyecto	Línea y Operador	Tipo de Obra	Longitud del Tramo intervenido	Densidad del tramo	Costos Op + Mant. Infra	Costos Op + Mant. Infra. - En la red	b1. Costos de Operación + Mant. Infra. en el Tramo	b2. Costos de Operación + Mant. Infra. para las cargas que utilizan total o parcialmente el Tramo	Costos Op + Mant. Infra. - En la red	b1. Costos de Operación + Mant. Infra. en el Tramo	b2. Costos de Operación + Mant. Infra. para las cargas que utilizan total o parcialmente el Tramo	Ahorros Anuales
			km	ton por km	US$/ton-km (año 2022)				Variación %			US$
Proyectos seleccionados												
76 | Ramal C13 - Cerrillos - Güemes			63	78.775	0,0656	0,0656	0,0622	0,0654	→ -0,01%	↓ -5,20%	→ -0,30%	16.915
78 | Ramal C15 - Perico - Pichanal	Belgrano - TAC		167	31.592	0,0656	0,0656	0,0591	0,0653	→ -0,03%	↓ -10,01%	→ -0,50%	34.677
80 | Ramal C - Palpalá - Tucumán		Mejoramiento	337	244.242	0,0656	0,0656	0,0637	0,0653	→ -0,12%	↓ -2,92%	→ -0,55%	157.865
84 | Ramal GM1 - Tucumán - Lte. Santa Fe	Mitre - NCA		474	1.654.709	0,0613	0,0608	0,0591	0,0602	→ -0,72%	↓ -3,51%	↓ -1,72%	1.689.232
86 | Ramal Troncal - Garupá - Lte. Entre Ríos	Urquiza - TAC		487	213.406	0,1122	0,1064	0,0938	0,1063	↓ -5,14%	↓ -16,40%	↓ -5,22%	1.912.369
Otros alcances considerados												
Ramales C + C13 + C15	Belgrano - TAC		567	163.311	0,0656	0,0654	0,0610	0,0647	→ -0,34%	↓ -7,11%	↓ -1,50%	432.376
Ramal GM1 - Tucumán - Rosario	Mitre - NCA	Mejoramiento	851	2.248.493	0,0613	0,0570	0,0528	0,0531	↓ -6,93%	↓ -13,80%	↓ -13,36%	16.174.811
Ramal Troncal - Garupá - Zárate	Urquiza - TAC		1.063	311.945	0,1122	0,0967	0,0967	0,0967	↓ -13,75%	↓ -13,75%	↓ -13,75%	5.115.482

Source: Own elaboration based on CNRT (2021), COSFER - Ministerio de Transporte de la Nación (2019) and interviews to sector specialists.

Annex 5: Estimation of employment generation effects of the pre-prioritized road and rail infrastructure works

According to the Input-Output Matrix (IMP) methodology, a vector of employment coefficients is used, which is the quotient between the number of workers and the gross value of production (GVP) of each sector of the matrix. In the case of Argentina, the most recent version of the IPM prepared by INDEC corresponds to the base year 1997. It allows working with a breakdown into 124 economic activities. The World Bank team developed a new IPM for 2017, taking as a basis the Social Accounting Matrix of Chisari et al. (2020), which considered 30 sectors of the economy.

Since the construction sector appeared as a single aggregate sector in the 1997 IPM, and it was of interest to be able to evaluate different types of work, the team that developed the model disaggregated it into 6 subsectors: water and sanitation infrastructure, public housing, private residential construction, road construction, road maintenance and rehabilitation, railroad construction, and other construction activities. Likewise, and in a complementary manner, 15 other subsectors were developed for which cost vectors and labor requirements were estimated. The model allows the construction of specific cost structures that can then be introduced to evaluate their impact on employment. Since the IPM used is valued at 2017 prices, it is necessary that the amounts and cost structures of the works are valued at 2017 prices. The model considers households as another "productive sector" within the matrix, which is defined as a Closed Input-Output Model.

The occupational classification accounts for the complexity of work processes. INDEC breaks it down into four categories:

- **Occupations of professional qualification:** those in which multiple, diverse and changing sequence tasks are performed, which involve theoretical knowledge of a general and specific order about the properties and characteristics of the objects and instruments of work and the laws and rules governing the processes. These occupations require knowledge acquired through specific formal training and equivalent work experience.

- **Technical qualification occupations:** these are occupations in which multiple, diverse and changing sequence tasks are generally performed, involving manipulative skills and specific theoretical knowledge about the properties and characteristics of the objects and instruments of work and the specific rules governing the processes involved. These occupations require specific knowledge and skills acquired through prior formal training or equivalent work experience.

- **Operational skill occupations:** these are occupations in which tasks of a certain sequence and variety are performed, involving attention, speed and manipulative skills as well as certain specific knowledge about the properties of the objects and instruments used. These occupations require specific knowledge and skills acquired through previous training or work experience.

- **Unskilled occupations:** these are occupations in which tasks of little diversity are performed, using simple objects and instruments, or, in many cases, the worker's own body. These occupations do not require prior skills or knowledge to be performed, except for some brief starting instructions.

Road works

First, it was necessary to evaluate each of the investment projects according to the type of work to be done, type of road (size of roadway, number of lanes), road surface (pavement, gravel, dirt), current pavement condition, length of the section to be intervened and the cost of each job. The attributes of the current infrastructure for the characterization of the section to be intervened were taken from the information available in different databases and geographic information systems of the Dirección Nacional de Vialidad (DNV).

For the costing of the works, cost structures by type of work were used, which arise from a report periodically prepared by the Argentine Chamber of Construction, based on the review of average costs identified in the last tenders carried out for works of similar characteristics to those analyzed here.[55] These works costs published by CAMARCO are valued in 2019 U.S. dollars (US$). Table X summarizes the values considered for the three types of works.

Since the WB impact model works with values in 2017 pesos, it was necessary to deflate the values using the average BCRA exchange rate for each year and the Construction Cost Index. (ICC)[56] published by INDEC. Thus, construction costs were expressed in 2017 pesos and dollars.

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[55] Plan de Obras Viales 2016-2020 y Plan de Obras Viales 2020-2029, CAMARCO. https://biblioteca.camarco.org.ar/PDFS/Serie%2038/10.%20Plan%20de%20Obras%20Vial(dig).pdf

[56] El INDEC publica el ICC para Gran Buenos Aires, no disponiéndose de información similar para el resto de las regiones del país. Se estima que aunque los costos de la construcción no son homogéneos en las distintas provincias argentinas es razonable suponer que, salvo eventos extraordinarios o puntuales, su variación sea semejante y, por tanto, el ICC GBA resulta una aproximación adecuada en este caso.

Table 5.1: *Unit Costs of Selected Works.*

RUBRO	Costo por Km	Composición		
Repavimentación	**US$ 2019**		**US$ 2019**	**%**
ruta simple - calzada ancho 7,3m	180.000	capas asfáltica calzada principal	126.000	70%
repavimentación calzada + banquina		capa asfáltica banquinas	31.000	31%
		preparación superficie, bacheo, otros	23.000	13%
doble calzada - calzada ancho 7,3m	325.000	capas asfáltica calzada principal	223.000	69%
repavimentación calzada + banquina		capa asfáltica banquinas	62.000	19%
		preparación superficie, bacheo, otros	40.000	12%
Nueva Pavimentación				
	1.000.000	capas asfáltica calzada principal, aporte estructural + rodamiento	500.000	50%
		capa asfáltica banquinas	50.000	5%
		capas granulares, ensanche y capas inferiores banquinas	400.000	40%
		pintura, señalización y otros	50.000	5%
Duplicación				
	2.500.000	GENERAL		
Ampliación 3ª o 4ª carril				
	2.000.000	GENERAL		

SOURCE: OWN ELABORATION BASED ON CAMARCO (2019).

Rail works

Among the rail infrastructure works within the Model is "railroad construction", the equivalent of a total renovation of the track infrastructure, requiring the removal of the existing infrastructure, the recomposition of the embankment and the construction of the new track. In our case, the proposed works are mostly improvement works, except for a 40 km section on the Belgrano line C branch, between Metán and Rosario de La Frontera, in Salta. Unlike renewal, improvement works consist of the partial replacement of components of the existing infrastructure, so the scope and tasks carried out differ considerably. Given the state of the infrastructure in the considered branches, significant improvement is assumed, which includes replacement of 60% of the sleepers, 30% of the rails and 20% of the fastenings, treatment of 100% of the future joints and replacement of 60% of the eclipses of those joints, track machining and addition of 1000 tons of ballast per kilometer. For this purpose, a specific cost structure was built for a track improvement, taking as a basis the figures considered in COSFER for 2017, which were adjusted based on input cost information provided by Trenes Argentinos Cargas. As a result, a cost per kilometer is estimated at US$ 270,300 (excluding VAT), for a heavy upgrade, and US$ 802,500 (excluding VAT), for a track renewal.

When proposing a new cost structure, the model requires the completion of certain parameters that would otherwise be calculated automatically, specifically, the amount of direct employment and its characterization. To calculate the direct employment of heavy improvement, the man-hours required for 1 km of track were divided by the effective annual man-hours (260). This resulted in 1.15 equivalent annual jobs per kilometer of improved track. In the case of a renewal, this para meter rises to 5.82 jobs.

For the characterization of direct employment by gender, age and occupational qualification, the percentages established in the "railroad construction" typology were considered as a proxy.

Table 5.2: *Direct, Indirect and Induced Employment Impact of Selected Road and Railway Works. In jobs.*

Tipo de Infraestructura Terrestre	Nombre del Proyecto		Tipo de Obra	Longitud del Tramo intervenido	Inversión Estimada	IMPACTO EN EMPLEO			
						Efecto directo	Efecto indirecto	Efecto inducido	Efecto total
Red Vial Relevante	**Tramo Ruta**	**Tipo de Camino**		**(km)**	**US$ 2017**				
	1-Ruta N 9-ACC.A BANDA DEL RIO SALI (D) - INT.R.P.306	Calzada Simple	Doble Calzada	2	6.453.196	14	56	40	110
	2-Ruta N 9-INT.R.P.306 - B/N R.N.38 (ACC.SUR A TUCUMAN)	Calzada Simple		2	7.721.454	17	67	48	132
	39-Ruta N 34-Desde S. Pedro de Jujuy hasta Embarcación	Calzada simple	Carriles de sobrepaso	154	6.177.163	13	54	38	105
	88-Ruta N9 - Lte. Córdoba - Ciudad de Stgo. del Estero	Calzada simple	Recomposición del estado del pavimento	239	64.073.300	962	529	401	1.892
	89-Ruta N9 - Ciudad de Stgo. del Estero - Ciudad de Salta	295 km CS y 166 km AU		461	159.725.930	2.397	1.320	999	4.716
	91-Ruta N11 - Lte. Santa Fe - Ciudad de Formosa	Calzada simple		364	97.631.412	1.465	807	611	2.883
	94-Ruta N12 - Posadas - Puerto Iguazú	5 km CMulticarril y 293 km AU		298	143.425.082	2.153	1.185	897	4.235
	95-Ruta N14 - Lte. Entre Ríos - Santo Tomé	188 km CS y 154 km AU		342	125.169.624	1.879	1.034	783	3.696
	96-Ruta N14 - Santo Tomé - Bdo. De Irigoyen	Calzada simple		442	118.725.082	1.782	981	742	3.505
	99-Ruta N34 - Lte. Santa Fe - Rosario de la Frontera	Calzada simple		576	154.740.631	2.323	1.278	968	4.569
	100-Ruta N34 - Cabeza de Buey - Pocitos	354 km CS y 5,5 km AU		360	97.741.676	1.467	807	611	2.886
	107-Ruta N51 - Gral. Alvarado - Lte. Chile	136 km C Ripio y 153 km CS		289	244.012.878	1.057	2.104	1.513	4.674
	114-Ruta N79 - Chamical - Emp. RN60	Calzada simple		125	33.523.198	503	277	210	990
	116-Ruta N81 - Emp. RN95 - Emp. RN34	Calzada simple		498	133.751.704	2.008	1.105	836	3.949
	127-Ruta N157 - Emp. RN60 - SM. Tucumán	Calzada simple		310	83.222.506	1.249	688	520	2.457
	1. Subtotal Obras Red Vial Relevante			**4461**	**1.476.094.836**	**19.289**	**12.291**	**9.217**	**40.797**
Red Ferroviaria	**Tramo**	**Línea - operador**							
	76-Ramal C13 - Cerrillos - Güemes	Belgrano - TAC	Mejoramiento	63	16.991.223	72	176	114	362
	78-Ramal C15 - Perico - Pichanal			167	45.142.354	192	467	303	962
	80-Ramal C - Palpalá - Tucumán		Mejoramiento + Renovación	337	112.505.138	574	1.189	731	2.494
	84-Ramal GM1 - Tucumán - Lte. Santa Fe	Mitre - NCA	Mejoramiento	474	128.236.724	544	1.327	860	2.731
	86-Ramal Troncal - Garupá - Lte. Entre Ríos	Urquiza - TAC		487	131.710.253	559	1.363	884	2.805
	2. Subtotal Obras Red Ferroviaria			**1529**	**434.585.692**	**1.941**	**4.521**	**2.892**	**9.354**
	Otros alcances considerados								
	Ramales C + C13 + C15	Belgrano - TAC	Mejoramiento + Renovación	567	174.638.715	838	1.831	1.148	3.817
	Ramal GM1 - Tucumán - Rosario	Mitre - NCA	Mejoramiento	851	229.928.663	976	2.379	1.543	4.898
	Ramal Troncal - Garupá - Zárate	Urquiza - TAC		1063	287.343.250	1.220	2.973	1.928	6.121
	3. Subtotal Obras Red Ferroviaria otros alcances			**2481**	**691.910.628**	**3.033**	**7.183**	**4.618**	**14.835**
TOTAL PROYECTOS SELECCIONADOS (1+2)				**5.990**	**1.910.680.528**	**21.230**	**16.812**	**12.109**	**50.151**
TOTAL PROYECTOS + OTROS ALCANCES (1+3)				**6.942**	**2.168.005.464**	**22.322**	**19.475**	**13.835**	**55.633**

SOURCE: OWN ELABORATION BASED ON THE WORLD BANK MODEL (2021), BANCO CENTRAL DE LA REPÚBLICA ARGENTINA, CAMARCO, COSFER (2017), DNV, INDEC, AND TAC.

Annex 6: Estimation of expected macroeconomic effects of the pre-prioritized road and rail infrastructure works

Within the framework of regional computed general equilibrium (CGE) models, the study estimated the potential economic benefit from sectoral efficiency improvements and reduction of overland transport costs of the shortlisted road and rail infrastructure works. The results to be extracted in terms of gross geographic product (GGP), household welfare, expenditure and tax collection at the provincial level, as well as value added and production at the level of the productive sectors of each province.

Regional Social Accounting Matrices

As a first step, it is necessary to have a sufficiently representative database for the economies studied. 5 input-output matrices were constructed in this study for the provinces of Catamarca, Chaco, Corrientes, Salta and Jujuy with a base year of 2018. The choice of the latter is not trivial since these matrices should constitute a representative picture of the regional economy. Therefore, 2018 is considered the most recent macroeconomically stable year for which, in addition, there is sufficient regional information to perform this type of estimation.

To develop a multisectoral model, such as CGE models, a considerable amount of information is needed. This information must be structured to maintain consistency across sources. Thus, a CSM must meet this consistency condition by representing the circular flow of an economy through a double-entry table, where the revenues of each sector and agents are shown in rows and their expenditures in columns. Consistency must be observed for each account of the CSM, since the basic budget constraint (revenues equal expenditures) must be met not only at the aggregate level, but also for each individual sector and agent.

The first objective of the SAM is to organize coherently and comprehensively the economic information of a country (or region) during a specific period, usually a stable year for macroeconomic variables. In this sense, the SAM is similar to the national accounts and includes data from the System of National Accounts (SNA). In addition, the SAM requires an input-output (IP) matrix that reflects the inter-industry relationships in an economy; that is, the purchase of an intermediate input by one sector is equivalent to the sale of that input by another sector, extending this inter-industry relationship to all transactions occurring in an economy.

The income and expenditure budgets of households, government and the rest of the world, in addition to the companies represented at the sectoral level within the IP matrix, are other relevant information for constructing a SAM. As already mentioned, initially the budget constraints must be met at both the individual and aggregate level.

A second objective of the CSM is to provide the statistical basis for creating a simulation model that is the tool for the evaluation of different policies or exogenous shocks. Once the information for a particular country in a given year is organized in the form of a CSM, it represents a static picture that reveals the economic structure of the country under study.

A SAM is generally composed of 5 types of accounts: goods, factors, agents (households, government) and rest of the world, and all of them must be represented implicitly or explicitly. The disaggregation within each of these accounts is a matter of choice depending on the conditions and objectives of the study. The structure of the SAM limits the model to be used and its scope. Therefore, the disaggregation of the matrix is fundamental when thinking about simulations within a model.

For this project, 5 CSMs were developed for the provinces of Catamarca, Chaco, Corrientes, Salta and Jujuy with base year 2018. To ensure comparability between the different provinces, each one presents the same sectoral disaggregation within their respective IP matrices.

For the preparation of these matrices, the data on value added, gross value of production and regional intermediate consumption published by the Ministry of Economy of the Argentine Republic[57] were used. On the other hand, the INDEC's International Trade Consultation System was used to characterize regional imports and exports. The data related to provincial government income and expenditures were taken from the Savings-Investment-Financing Table (Cash Basis) prepared by each province. Data regarding household consumption and income come from the use of the National Household Expenditure Survey 2017/2018 and the Permanent Household Survey. Likewise, in the absence of data, recourse was made to the 2004 census and the 2004 regional GDP publications, which are the latest census references in Argentina for the estimation of regional variables.

In order to create a regional matrix, it is necessary to have a national matrix to serve as a starting point. In this case, the national matrix of Argentina 2018 was taken from the work of Mercatante (2024) where a national matrix with sufficient sectorial openness is estimated to cover the needs of this project. As a result, in this project the five matrices mentioned above were successfully estimated with a sectoral characterization sufficiently accurate to assess the impact of the proposed policies.

Development of Computational General Equilibrium models

CGE models are an extension of classical analytical equilibrium models offering numerical solutions for large multi-sector models and allowing a more detailed and complex representation of economic flows. CGE models are flexible analytical and simulation tools that can capture the multiple effects of implementing a set of combined policies on the economy. In this context, labor market

[57] https://app.powerbi.com/view?r=eyJrIjoiODBhYTkyMjctZjRjOS00NWYwLTljODAtYWY1MjMzZWQzZGRlIiwidCI6ImNiODg0ZGI1LTI0ODUtNGY5Yi05MzhlLTNlNjIxZjIyMjU3YiIsImMiOjR9&pageName=ReportSection701711dd6924bbbca92c

modeling must go beyond a simple supply and demand approach to capture dynamics such as labor heterogeneity and unemployment.

CGE models are numerical representations of an economy that consider the actions of households, firms, government and the rest of the world, with interactions occurring in various markets (Burfisher, 2011). The distinguishing feature of CGE models is that they capture not only the direct impact of policies in a particular market, but also the indirect effects through second and third order interactions between different economic agents.

From the supply side, the model developed for this study assumes that, in each productive sector, there is a representative firm operating under constant returns to scale, using both intermediate inputs and productive factors, such as capital and labor.

On the demand side, firms can demand both domestic and imported goods and services, using them as complementary inputs for intermediate consumption. On the other hand, households, governments and the RM also demand these goods and services for their final use, while maximizing their preferences subject to their budgetary constraints. Agents' income comes from the remuneration they receive from their factors of production and from inter-agent transfers, such as social transfers, remittances, loans through asset markets and tax collection for the government.

Ultimately, the equilibrium of the economy is reached when all markets - namely goods, services and factors - are emptied under conditions of perfect competition and all agents optimize their decision making subject to their respective constraints.

In summary, the development of a CGE model is an intensive process in which data and economic modeling are reconciled. This process generates a numerical representation of the economy under analysis. This policy evaluation tool is a very useful tool for studying the impact of different shocks or policies on the economy at different levels of detail (i.e. sectors, factors, agents).

Simulation of scenarios

The third step required a scenario design to make the transport cost estimates (described in Annex 4) compatible with the structure of a CGE model.

Road projects represented the most significant challenge for this study. Not all of the projects presented cross the modeled provinces geographically. However, they do connect various freight distribution points between the provinces. Therefore, although their influence on the provinces may not be direct, they may be impacting interprovincial trade.

it was necessary to have a magnitude of the trade flows between the different provinces to evaluate the relative importance of each project on the production and trade of each province. According to the data provided by the World Bank team, 147 tons of products were traded from origin and destination for 123 urban centers in the country. As a result, a base of more than 46 thousand data related to origins and destinations throughout the country was used.

A first step in the manipulation of this base was to make the 147 products compatible with the sectoral openness of each of the CSMs. Consequently, each of the products was assigned to the sectors of Agriculture, Livestock, Forestry and Fishing; Mining and Quarrying; and Manufacturing Industry. Making such an assignment was able to reduce the dimensionality of the base allowing for easier manipulation.

The second step consisted of determining which routes the different cargo trucks take to transport goods from one urban center to another. It is important to note that this study was not limited to considering flows between the provinces modeled, but covered trade with the entire country. For example, tons traded from distant provinces and urban centers, such as Buenos Aires and even cities in Patagonia, were considered.

To determine which routes are adopted, the "web scraping" technique was implemented in Google Maps using Python as an analysis tool. Specifically, a programming code was created that, based on a database of origins and destinations, performed successive searches in Google Maps to identify the most efficient land route along national routes between two urban centers. Once these routes were identified, the code verified whether any of the routes involved passed through any of the road projects considered in this study. If so, the number of kilometers actually traveled by that project was calculated. Finally, with this information, the cost reduction parameters calculated by Sant & García (2024) were applied to the kilometers that each route passed through the different projects, in order to estimate an improvement in efficiency.

For rail projects, a different approach was taken. Since rail routes are not publicly accessible and are exclusively for freight transport, it is not possible to use Google Maps to determine the optimal routes. Rather, the starting point was a database, also provided by the World Bank team, which contained information related to the transportation of tons of goods with origin and destination, but also specifying which branches of the Belgrano Railway Line were used. In this case, the database was reduced only to consider the transit of goods to and from the modeled provinces. Then, after identifying the branches used in each transit, the parameters estimated by Sant & García (2024) were applied to those branches affected by the road projects.

As a result of these assumptions, the only relevant projects for the provinces modeled were Project 78 (Branch C15) and Project 80 (Branch C).[58]

The average improvements found due to the implementation of the project were incorporated into the model in order to measure the associated impact. The simulation of these improvements implied a reduction in operating costs for the trucking industry, which was reflected in a higher return on activity. Another equivalent way of thinking about this simulation is that, after the project, the trucking

[58] It is important to mention that Project 76 (C13 Branch) was also excluded from the analysis since trade flows to and from the provinces of interest do not transit through the C13 Branch.

industry is able to make a greater number of trips at the same cost. In this sense, the impact of the project will spill over to the rest of the participants in the economy where the strongest indirect impacts will be centered on the main consumers of transportation activities.

In terms of the model, these shocks imply a modification of the intermediate cost structures of the firms operating road and rail transport services. In particular, the amount of output that can be obtained with one unit of value added (labor and capital) was increased with respect to the base scenario. This improvement implies an improvement in relative prices in favor of transport activities, benefiting, to a greater extent, those activities that are transport-intensive, such as agricultural activities. Thus, the gains of these simulations in terms of the variables analyzed are computed as the difference with respect to the counterfactual scenario without productivity improvements in transportation.

It is important to note that the results of these simulations are only linked to productivity improvements and there are no impacts associated with the construction of these sections.