Chapter 4

Transport infrastructure

Productive investment in transport infrastructure is vital for prosperity. As a middle-income economy heavily geared towards exports, investment in a high-quality transport infrastructure base has contributed significantly to the Chile's development. A fully co-ordinated approach to infrastructure spending, with investment driven by transport policy goals that are integrated with land-use and sectoral development objectives, must accompany Chile's transition from a middle to a high-income economy and should address the potentially negative impacts on social and territorial equality and the environment associated with this transition. This Chapter analyses the current and projected gaps between Chile and its OECD peers based on the ITF/OECD methodology, and identifies policy priorities that should be set to achieve the goals of Plan Chile 30/30.

Infrastructure to support economic growth and territorial equality

The economic role of transport infrastructure

The impact on growth of investment in transport infrastructure varies in the different stages of a country's economic development (OECD, 2014). In low-income countries, investment in basic infrastructure provision can make a very large difference in access to education, jobs and services (UN, 2015). As incomes rise, better transport services are needed to support the growth of business activities, exports and value creation, and the focus for infrastructure investment shifts to supporting these sectors of the economy. In more mature economies, priorities tend to shift towards addressing issues of congestion and bottlenecks in reasonably complete networks, the upgrade and maintenance of existing assets, and providing for technological innovation. Typically, the economic impact of transport infrastructure is more transformative at lower levels of development, and the incremental impact of new investment decreases at more advanced stages of development (Eddington, 2006).

Transport infrastructure plays a critical role in the transition from a middle- to high-income economy. Theoretical and empirical studies have underscored the positive relationship between high-quality infrastructure and economy-wide productivity (IMF, 2015). This relationship is underpinned by a number of economic mechanisms triggered by improvements in transport infrastructure, including the following:

- High-quality infrastructure is a precondition for the provision of efficient transport services for both freight and passenger movements, which in turn supports core economic activities and removes geographic barriers to competition.
- Well-functioning logistics systems facilitate trade through lowering access costs to international markets and by improving the competitiveness of domestic firms (Arvis et al., 2014).
- Passenger transport connectivity enhances the productive capacity of the economy by widening and deepening labour markets and through agglomeration gains, facilitating industrial specialisation and enabling face-to-face interactions between businesses and specialised workers in high-value service sectors of the economy (Graham, 2014).
- Infrastructure can be an effective policy tool to address social and territorial imbalances by connecting rural and remote areas to larger centres of production and consumption, creating more economic opportunities for residents and reducing out-migration.

Investment in infrastructure to improve connectivity is most effective at delivering long-term growth when it relieves a constraint on productivity. The effectiveness of investment in generating growth and addressing inequality can be measured and compared to alternatives on the basis of good project selection methodologies, including high-quality appraisal and transparent selection procedures (ITF/OECD, 2007; Warner, 2014). Socio-economic cost-benefit assessment (CBA) is an important tool because it provides a quantitative measure of the extent to which, over its lifetime, a project or initiative will bring the community benefits that exceed the project's costs of construction and operation (Veryard, 2016). In this respect, CBA is a powerful framework for prioritisation, through which options can be compared and selected. However, CBA also suffers from limitations, and infrastructure investment will require additional analysis to ensure that the government's policies towards social and regional equity are accounted for in project selection and the allocation of resources. The prioritisation of effective investment in Chile is discussed in Box 4.1. Concerted efforts across the government, such as those led by the Road Division in the MOP to improve the link between CBA and territorial goals, are under way to reform assessment methodologies.

Box 4.1. Project appraisal and selection in Chile

As discussed in Chapter 2, Chile has an established national system of investment appraisal (SNI) that vets all public projects, and socio-economic cost-benefit analysis (CBA) lies at the heart of project evaluation. This system has several strengths, including a uniform approach to project selection throughout the country; a simple and clear target rate of return; well-documented methodologies for undertaking CBA; and a clear institutional separation of roles between project development, evaluation and approval. Regarding the latter point, sectoral ministries such as the Ministry of Public Works and the Ministry of Housing and Urbanisation prepare and deliver projects, while the Ministry of Social Development is responsible for reviewing and approving social cost-benefit evaluations. Chile's SNI exhibits a high degree of transparency. The various methodologies and processes for undertaking social evaluations are published on the Ministry of Social Development's website, as are the shadow prices used in those evaluations.

However, the SNI has been criticised for failing to take adequate account of externalities such as environmental impacts and for incorporating biases against poorer regions. Although the SNI makes some allowances for CO_2 emissions, it does not include other potential impacts of infrastructure investment. The main policy goal is economic growth, and the project appraisal method does not consider distributional effects and territorial inequalities. Thus, the SNI historically favours investment in areas with high vehicular flows and growing demand, such as congested metropolitan areas or mining areas. The National Fund for Regional Development (FNDR), which provides resources to regional governments, allocates funds for projects in regions with the highest poverty rates and the largest cost differentials in housing and infrastructure. Given the large concentration of poor households in larger cities, the FNDR nevertheless reinforces the concentration of investment in metropolitan areas. In addition, FNDR-funded projects are still subject to the same SNI assessment criteria.

Source: Ahmad and Zanola (2016).

Transport systems generate a range of external costs (Maibach et al., 2007; Bickel and Friedrich, 2013). These include congestion and its related costs (wasted time, impaired reliability and exacerbated air pollution); environmental impacts, both at the global level (greenhouse gas emissions) and the local level (noise and air pollution); health costs arising from air and noise emissions; and the costs associated with deaths and injuries from road crashes and accidents on other modes of transport. The importance placed upon these external costs when it comes to choosing between competing policy priorities rises along with a country's income. Some of these costs are already assessed as part of existing appraisal frameworks in Chile (e.g. congestion cost, greenhouse gas emissions), while others are not (e.g. noise and air pollution).

Each part of the national transport network contributes to economic development, but the benefit of transport systems as a whole is greater than the sum of their parts. Ports are gateways to international trade, but a well-equipped port system cannot adequately cater for trade unless maritime hubs have efficient transport connections to hinterland production and consumption centres. Likewise, intercity motorways can promote economic links between cities, but the positive effects of spatial concentration may be outweighed by rising congestion costs and increasing car trips in urban areas in the absence of efficient urban transport systems. Attention to intermodal interfaces (road-rail, road-port and rail-port) within a network-wide planning approach is critical to provide the physical connectivity needed to support economic growth.

To sum up, a gap in the provision and quality of transport infrastructure compared to optimal levels can undermine a country's competitiveness, equality and ultimately long-term economic growth. The notion of a gap, however, is not straightforward – it evolves as countries transition from middle to high income levels. Accordingly, any assessment of the presence and size of transport infrastructure gaps needs to be tailored to the national and regional context for economic development, as well as linked to national and regional policy goals, to guide decision makers in prioritising investments. This requires a shift in analytical focus – from focusing on infrastructure stock (most suited to earlier stages of development) to measures illustrating the role of the infrastructure in providing access to economic opportunities.

Chile's infrastructure challenge

Chile is a middle-income country with an open economy heavily reliant on trade and a complex geography coupled with uneven population and resource distribution. While Chile has a good transport infrastructure base thanks to investment carried out in recent decades, improvements in the capacity, quality and efficiency of public infrastructure will be necessary to support the country's transition to a high-income economy.

The Plan Chile 30/30 initiative, led by the Ministry of Public Works (MOP), links infrastructure investment to the long-term goals of higher incomes and greater equality, while simultaneously addressing different dimensions of transport and water infrastructure. Analysis undertaken by the International Transport Forum at the OECD (ITF) and presented in this chapter is designed to contribute to Plan Chile 30/30 by addressing the following key question: what are the policy priorities for infrastructure investment that should be set to achieve the Agenda's goals, given current and projected gaps between Chile and OECD comparator countries?

Previous examples of infrastructure gap assessments

Several approaches are available for assessing infrastructure needs, each dependent on data availability. The transport sector often lacks core data, and when data are available, their value for making international comparisons is often undermined by inconsistent definitions. This makes the assessment of potential infrastructure gaps particularly challenging.

Historically, most macro-level studies of the relation of infrastructure investment to productivity determined elasticities of GDP to infrastructure stock. Long-run elasticities represent the relationship between infrastructure stock measures and GDP/income measures over time. These can be derived either as ratios (based on historical and/or cross-country benchmarks) or as coefficients in econometric models.[1] In turn, elasticities are used to derive estimates of the level of infrastructure provision needed to satisfy consumer and producer demand, based on forecast levels of economic activity. Box 4.2 presents examples of the estimates derived.

Elasticity-based approaches raise a number of issues and questions. First, the measures of infrastructure stocks available and chosen to represent infrastructure indicators have some limitations. Taking road infrastructure gap assessments as an example, previous work has used the following:

- km of paved roads per km^2 of land (Fay and Yepes, 2003)
- km of roads (total) per worker (Calderón and Servén, 2004)

- km of roads (total) per km^2 of land (Liberini, 2006)
- km of roads (total) per 1 000 people (Andrés, 2014).

Box 4.2. Assessing infrastructure gaps through the estimation of long-run elasticities

Econometric analysis by the World Bank (Fay and Yepes, 2003) treats infrastructure in its dual role of input in the firm's production function and consumption services for individuals. Using GDP as a proxy for aggregate demand and controlling for underlying differences in economic and technological performance across countries, the authors define a model to predict how the evolution of GDP will affect infrastructure needs. Their model predicted the amount of "infrastructure demand" based on GDP forecasts for developing countries, which was equal to about USD 465 billion per annum – or 5.5% of developing countries' GDP over 2005-2010.

Liberini (2006) developed this framework further for Latin America by disaggregating the total demand function at the level of three core infrastructure sectors (telecommunications, power generation and transport). The relationship between GDP and each sector is captured through the estimation of sector elasticities. Further control variables are added, such as population density, the urbanisation rate and the size of the countries of interest. Rather than using GDP forecasts, the author uses estimates of potential GDP published by the OECD and the IMF, aiming to measure the gap between the optimal and the current infrastructure stock for the core sectors of interest. As far as road transport infrastructure is concerned, no statistically significant effect was detected in relation to transport sector output – suggesting the possibility that no gap exists for road infrastructure in Latin America.

Other studies rely on historical ratios of infrastructure stock and GDP to assess future needs. By way of example, recent research by McKinsey (2013) estimated that investment in economic infrastructure* has historically averaged 3.8% of GDP and that the ratio of infrastructure stock to GDP is around 70%. To maintain those flow-to-GDP and stock-to-GDP ratios, McKinsey forecast a global infrastructure investment requirement of USD 57 trillion between 2013 and 2030.

*Note:** Economic infrastructure includes roads, rail, airports, ports, energy, water and telecommunications infrastructure.

Source: Fay and Yepes, 2003; Liberini, 2006; Dobbs et al., 2013.

Measures of infrastructure density can penalise countries with a large land mass, while indicators of infrastructure stock per capita may show higher levels of infrastructure provision in areas hosting large-scale logistics operations (e.g. ports, international rail freight corridors), although such infrastructure may not enhance passenger connectivity. Hence, switching from one measure to another can lead to inconsistent estimates of infrastructure endowment. Moreover, stock indicators do not reflect characteristics such as capacity and quality that would better explain whether existing infrastructure is adequate to cater for specific connectivity and accessibility needs.

In addition**, elasticities based on historical relationships between infrastructure and GDP may not necessarily hold in the future**, particularly when there are changes in demographic and economic dynamics. Structural shifts such as the growth of international trade and increasing urbanisation cannot be easily incorporated in the estimation of gaps based on GDP or income forecasts only, although adjustments can be made going forward. These adjustments can include indicators of transport demand that more closely mirror pressures on transport networks, such as forecasts of international trade volumes.

Alternatively, gaps can be measured in investment terms, using either input or output measures. Input measures focus on what is considered an optimal budget dedicated to infrastructure, such as a given percentage of GDP.[2] A gap can also be expressed as the investment needed to reach identified standards or targets (output measure). In this case, the provision or quality of infrastructure is assessed against a given standard, such as the share of paved roads. Using average unit costs, a level of investment required to close the gap is then estimated.[3]

Financial estimations are subject to two types of bias. First, historical levels of infrastructure spending influence the assessment of needs, providing a reference point that may not have been optimal itself. Second, the share of GDP spent on infrastructure across different countries reflects differences in geography, transport intensity of the country's productive sector, budget constraints, private sector involvement in the financing of infrastructure and so on, all of which affect the consistency of those comparisons.

There is little point in focusing on measuring inputs such as investment without being able to measure and evaluate outputs and to relate outputs to inputs functionally (ITF/OECD, 2013). Therefore, it is preferable to develop long-term strategies with a focus on the key goals that infrastructure investment aims to meet, such as a given level of capacity to support export growth or a given level of road quality to reduce crashes. Feasibility and affordability considerations can be introduced at the next stages of assessment, moving from strategies to plans and from plans to projects.

The limitations of traditional methodologies point to the need to develop an approach that is better tailored to the specific conditions of Chilean infrastructure and that better suits long-term national objectives such as economic growth and greater equality. This requires an evidence-based, objectives-led framework that minimises the risk of developing inconsistent standards. Even in the presence of an infrastructure gap, governments need to appraise and prioritise investment options through a transparent framework to make the best use of the limited funds available. This includes selecting projects according to expected net welfare benefit and internal rate of return based on cost-benefit analysis (CBA) and developing portfolios of priority projects on this basis. New projects can still be welfare enhancing even if the stock of transport infrastructure assets is close to its optimum level. At the same time, as noted in Box 4.1, CBA will not fully reflect the potential benefits of projects in meeting the goals of national policy towards reducing social and regional inequality. Additional indicators for informing decision making will be required, or budgets will need to be structured to prioritise a number of projects designed to address inequality, regardless of the result of CBA.

ITF/OECD methodology to assess infrastructure gaps and set standards

An evidence-based framework for long-term planning

This study develops three streams of analysis to contribute to the development of realistic infrastructure standards that reflect long-term economic objectives: a top-down, modelling approach based on the ITF Global Freight Model; a bottom-up, benchmarking approach based on data collection and analysis across OECD countries; and a review of the literature, supported by interviews with stakeholders, across all sectors and information collected during the OECD mission to Chile.

The ITF Global Freight Model

The ITF Global Freight Model (GFM) is used to assess the presence of capacity constraints and future infrastructure needs based on forecast projected trade volumes up to 2030. In the flow of international trade, quality transport infrastructure plays a crucial role, together with efficient administration and cross-border procedures. Well-maintained and well-managed ports, highways, airports, rail links and related services connect trading partners and reduce transport costs. Given that exports account for around 30% of

Chile's GDP, it is important to identify whether infrastructure will be adequate to support trade, and in turn higher economic growth, by 2030.

A large body of literature, including studies by the World Bank and the OECD, relies on econometric analysis of historical trends to establish a positive relationship between infrastructure provision and GDP growth. Assuming historical relations hold, predictions of future needs can be made. The Global Freight Model allows us to move beyond historical relationships between transport infrastructure and growth. The model includes detailed data on existing port capacity, as well as estimated road and rail capacity, to examine future infrastructure capacity constraints and needs in light of projected GDP growth and trade activity.

The modelling framework is underpinned by the OECD's global trade scenarios (see Box 4.3), and it projects international freight transport activity up to 2050. The model includes the following six main components, also described in Figure 4.1:

- a general equilibrium model for international trade, developed by the OECD, covering 26 world regions and 25 commodities
- a global freight transport network model based on 2010-14 data and detailed capacity information by mode based on current national plans
- an international freight mode choice model calibrated using Eurostat and ECLAC data
- a weight/value model, using the same data, to convert trade value into weight, calibrated for each commodity and transport mode
- an equilibrium assignment model of freight cargo in the network model
- infrastructure capacity, based on existing and planned expansion of maritime and land-based transport infrastructure.

Combined, these components provide model outputs that forecast trade volumes by origin-destination (OD) pair, commodity type and ode. Comparing the projected flows against existing and planned capacity, gaps in infrastructure for trade-related flows are identified.

Box 4.3. Modelling framework for long-term global trade scenarios

The methodology used to design trade scenarios to 2060 combines two models. The long-run growth model in the OECD Economic Outlook (Johansson et al., 2013; OECD, 2013b) provides long-term projections for GDP, saving, investment and current accounts for OECD and non-OECD G20 countries, augmented with projections by Fouré et al. (2012) for other countries. The trade model is a version of MIRAGE, a multi-country, sectorial, dynamic micro-founded model developed by the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII) (Fontagné and Fouré, 2013; for details see Château et al., 2014). This computable general equilibrium (CGE) model analyses the global evolution of bilateral trade and sectorial specialisation, and it covers the world economy for 147 countries and 57 industries, aggregated into 26 regions and 25 sectors in the ECO framework.

The OECD Economics Department (ECO) designed trade scenarios to 2060 using a framework integrating long-term macro projections for the world economy with a sectorial trade model reproducing the key evidence characterising the driving forces of past trends in trade and specialisation. The objective is to provide long-term trade scenarios on the assumption that past trends are to continue.

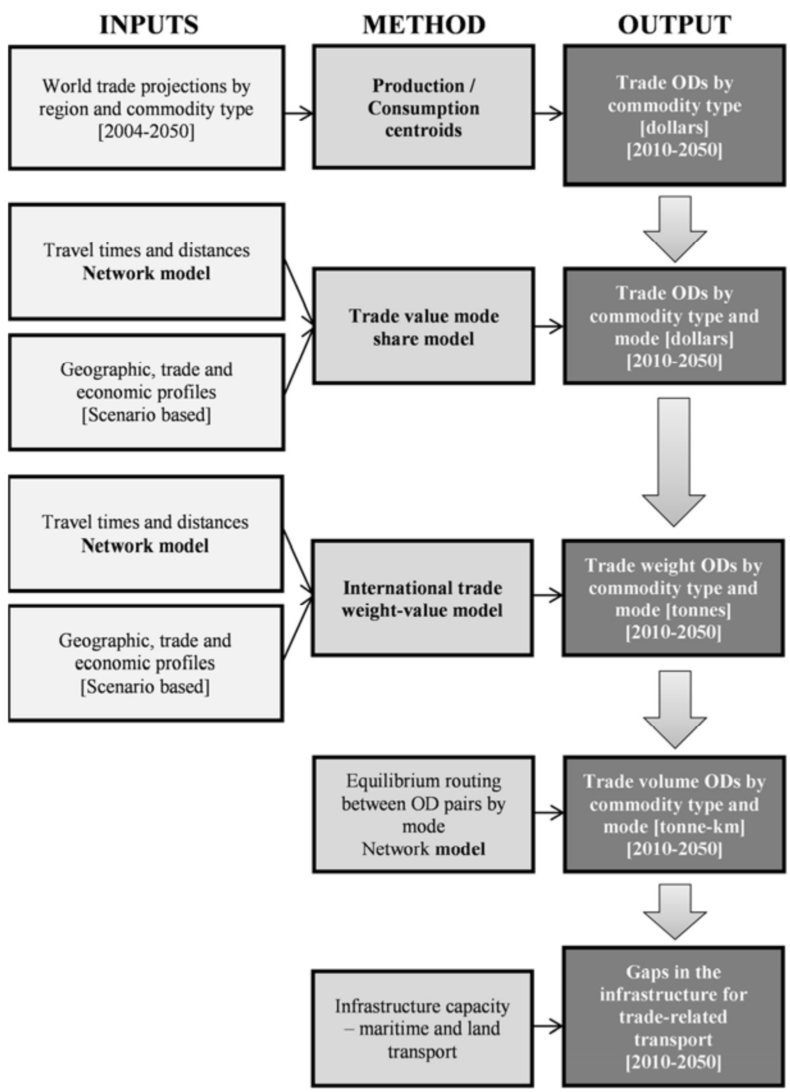
Box 4.3. Modelling framework for long-term global trade scenarios (*cont.*)

The combination of aggregate projections, which are based on a growth model, with the more detailed description of consumer and firm behaviour provided by the CGE model highlights how countries' specialisations are shaped by global trends (e.g. ageing, skill enhancement, capital investment, technology diffusion) and how structural and macro policies implemented in each country will affect future trade and specialisation patterns, taking into account inter-linkages across countries.

Combining aggregate projections and individual (consumers and firms) behaviours underlines the impact of both global trends and country-specific policies on future trade and specialisation patterns, acknowledging international spill-overs. Trade projections are presented in value terms, in constant 2004 USD.

Source: Chateau et al. (2014); Johansson and Olaberria (2014).

Figure 4.1. ITF Global Freight Model



ITF/OECD International benchmarking indicators

The transport infrastructure characteristics in Chile can be assessed against several comparators:

- historical levels of infrastructure provision, coverage and quality
- countries with similar socio-economic characteristics
- policy targets and standards.

Comparisons of trends within the same country over time are potentially more appropriate for economies with high income levels and relatively low projected growth in population and income – for those countries, a key policy objective might be to maintain their current infrastructure stock, as exemplified by EU countries, where around 50% of public infrastructure budgets are spent on maintenance costs.

International benchmarking indicators are a more useful starting point for analysing Chile's infrastructure gap, provided that two conditions are met. First, meaningful indicators need to be selected to draw the appropriate links between comparative infrastructure performance and long-term national goals (considering data availability constraints). Second, comparator countries need to be selected to control, as far as possible, for factors exogenous to infrastructure provision and to improve the robustness of the analysis.

Selection of comparators

Comparator countries were selected on the basis of having similar demographic, geographic and industrial characteristics to Chile. Under the assumption that similar levels of economic activity, population density and trade patterns require similar levels of infrastructure provision and quality, the right comparison can minimise the influence of exogenous factors on transport infrastructure performance.

It may not always be optimal to benchmark national aggregate indicators for Chile, given the large differences between the country's regions in terms of demographic, geographic and economic structure. Thus, disaggregate comparisons are made between Chile's macrozones, selected OECD countries and regions of OECD countries. As far as possible, indicators for each Chilean macrozone are compared to the countries and/or regions as listed in Tables 4.1 and 4.2 below. The rationale for selecting each comparator is explained in greater detail in Annex B, which contains an overview of transport infrastructure in the selected OECD regions.

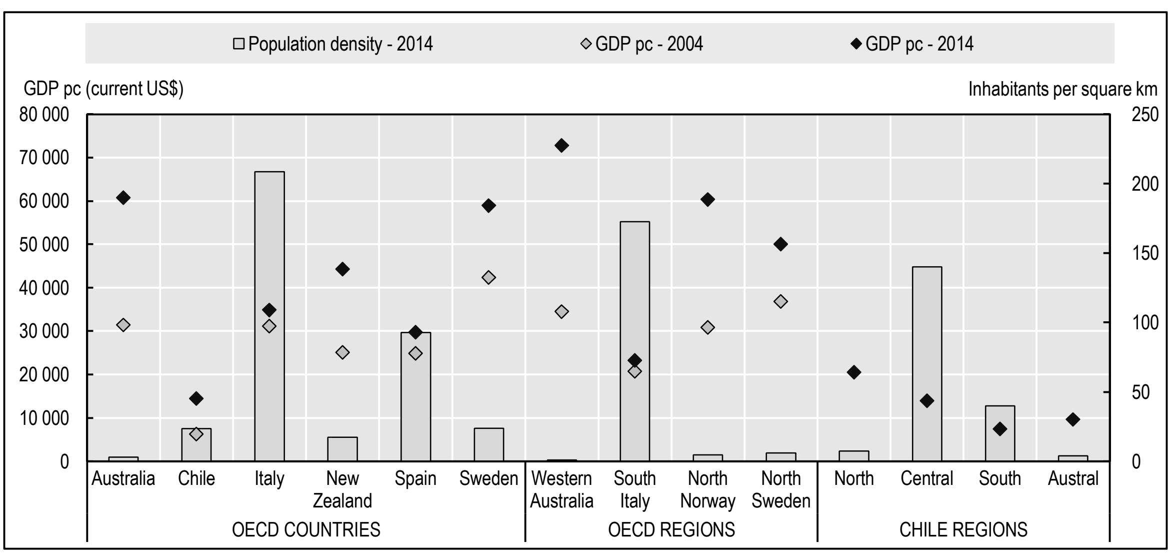
Table 4.1. Benchmark countries and regions

Chilean Macrozone	Comparator country (region if considered)
North	Australia (Western Australia)
Centre	Spain Italy (Southern Italy)
South	New Zealand
Austral	Sweden (North Sweden) Norway (North Norway)

Table 4.2. Definitions of Chilean macrozones and OECD regions

Macrozones / OECD regions	Regions	
Chile – North	Arica-Parinacota Tarapacá Antofagasta	Atacama Coquimbo
Chile – Centre	Valparaíso Region Metropolitana	O'Higgins Maule
Chile – South	Bío Bío La Araucanía	Los Ríos
Chile – Austral	Los Lagos Aysén	Magallanes
Sweden – North	European NUTS classification: SE31, SE32, SE33	
Australia – West	State of Western Australia	
Italy – South	European NUTS classification: ITG and ITF	
Norway – North	European NUTS classification: NOO7 and NOO6	

Figure 4.2. Population density and GDP per capita, 2004 and 2014



Source: Population: World Bank (2016a), Australia Bureau of Statistics (2016a), ISTAT (2016a), Statistics Norway (2016a), Statistics Sweden (2016a), Instituto Nacional de Estadísticas de Chile (2016a). Land area: World Bank (2016b), Australian Bureau of Statistics (2016b), OECD (2016b), Statistics Norway (2016a), Statistics Sweden (2016b), Instituto Nacional de Estadísticas de Chile (2016b). GDP: World Bank (2016c), Australian Bureau of Statistics (2016c), ISTAT (2016b), Statistics Norway (2016b), Statistics Sweden (2016c), Banco Central de Chile (2016).

The comparator countries and regions have already attained a level of economic development beyond Chile's national targets. Hence, the gaps identified by benchmarking today's levels of infrastructure are indicative and represent higher-end estimates rather than lower-end estimates. Since most comparators reached average incomes per capita of around USD 30 000 in the first half of the 2000s, we benchmark current infrastructure levels in Chile with levels in comparator countries both at the beginning of the century and for the most recently available year.

For each indicator and each transport sector, the benchmarking analysis points to the presence of gaps between Chile and OECD comparators, and in turn standards and goals. Gaps are not expressed in a common “currency” but rather in terms of the unit of measure used for each indicator. Most importantly, gaps translate into policy targets and standards that Chile’s policy makers can use to support the development of the Plan Chile 30/30. In any case, gaps and standards should not be used in isolation but rather viewed as part of the wider narrative around the performance of transport infrastructure and its determinants.

Selection of indicators

For benchmarking indicators to provide the most useful and balanced information, a set of indicators, rather than a single indicator, is required. Performance indicators can play a key role in guiding policy, quantifying objectives and measuring progress, but they are open to misunderstanding and misuse (ITF/OECD, 2016b). A best-practice approach would involve a set of indicators that encompass measures of supply (physical network size, asset quality), demand (measures of traffic, user satisfaction) and externalities (environmental emissions and other external costs).

The number of indicators is naturally limited by the availability of comparable data across dimensions and countries, as this study does not include primary data collection. Although our work has previously highlighted the importance of macro-level transport infrastructure data to support policy-relevant research, major gaps in data availability persist. This, together with the lack of commonly agreed definitions and methods, undermines international comparators (ITF/OECD, 2013). We have also recently highlighted the presence of a significant data gap in Chile with respect to transport outputs (e.g. tonne-km, vehicle-km) and costs. The ITF and OECD (2016c) have previously suggested that a Logistics Observatory should be set up, which would fill the data gap in freight transport and related sectors (ITF/OECD, 2016c).

Acknowledging these limitations, our data collection efforts are focused on putting together a comprehensive set of benchmarking indicators across countries and regions, ensuring that the data chosen are comparable and derived from reliable sources. The following table summarises the benchmarking indicators selected for this study, by transport sector.

Table 4.3. Benchmark indicators

Sector	Indicator	Level of analysis
All transport infrastructure	GCI index	National
	LPI scores	National
Road infrastructure	Traffic intensity	National
	Road network density	National
	Share of paved roads	Macrozone
	Road quality (iRAP)	Macrozone
	Road safety	Macrozone

Table 4.3. Benchmark indicators (*cont.*)

Sector	Indicator	Level of analysis
Port infrastructure	Transport Intensity	National/Macrozone
	Turnaround times	Macrozone
	Inland transport modal share	Port level
Rail infrastructure	Traffic intensity	Macrozone
	Rail network density	Macrozone
	Utilisation rate	Macrozone
	Freight modal share	Macrozone
Airport infrastructure	Propensity to fly	National/Macrozone
	Surface access	Large airports
Urban accessibility and environmental indicators	Modal share	Urban level
	PM2.5 emissions	National/Macrozone
	NO emissions	Urban/rural areas
	CO_2 intensity	National

The following paragraphs provide a description of the indicators selected and some caveats on their interpretation to inform our analysis of gaps.

International infrastructure performance indicators – The World Economic Forum's Global Competitiveness Index (**GCI**) rests on unique data drawn from the Executive Opinion Survey, which surveys top business executives in all countries covered. Infrastructure is one of the 12 pillars of competitiveness covered by the index. The World Bank's Logistics Performance Index (**LPI**) is a multi-dimensional assessment of logistics performance and an international benchmarking tool focused on trade facilitation. The LPI is based on surveys of port operators, shippers and freight forwarders, producing a composite index reflecting responses to the questionnaire. Because of the nature of those surveyed, the LPI is oriented towards assessing the transport of manufactured goods rather than bulk commodities, and it is more applicable to higher-value goods. The LPI is most useful when used in conjunction with an in-depth assessment of trade and transport performance, and it has been used successfully in several countries to instigate discussions on the drivers of logistics performance and the areas in which barriers hinder performance (for example, see ITF/OECD, 2016b). Both the GCI and the LPI measure perceptions rather than physical availability or performance, and both suffer from year-on-year variations that depend on external factors (e.g. strikes, weather) as well as infrastructure quality. Nevertheless, if used in conjunction with an analysis of what determines efficiency on the ground, LPI scores can be a powerful stimulus for improvement.

Traffic intensity – Transport intensity (freight and passenger transport intensity) provides an indicator of how much freight and passenger activity "contributes" to the overall economy. However, the interpretation of these indicators is highly dependent on the type of economy and the geographical characteristics of the country. Unless these factors are controlled for, comparisons of transport intensity are better indicators of performance over time for the same entity than for comparing performance between countries. Transport intensity indicators can be calculated based on traffic data.

Network density – Indicators of network density for road and rail measure the stock of infrastructure with respect to land mass and/or population. As discussed above, these indicators can provide a distorted view of infrastructure provision. Estimates can be inconsistent across indicators depending on the choice of denominator, and they do not reflect characteristics such as capacity and quality. However, network density is often used in international comparisons, as it is often readily available from national statistics.

Share of paved roads – The share of roads that are paved is often used as an indicator of road infrastructure availability and quality, as paved roads can provide faster, safer and less vehicle-damaging links than unpaved roads, especially during extreme weather conditions such as high rainfall. However, the indicator quantifying paved roads fails to take account of road surface quality, including the status of maintenance, road support services, road connectivity to key centres and safety standards. Nevertheless, data on paved roads are readily available from national and regional authorities.

Road safety – While not an infrastructure indicator per se, road safety trends can shed light on the quality and reliability of the road network. In addition, road crashes represent a cost to the economy. Adopting safety standards that can be highlighted by benchmarking analysis can minimise this cost. The OECD hosts the IRTAD database, collecting detailed information on road safety worldwide.

Road quality – The international Road Assessment Programme (iRAP) is active in over 70 countries worldwide to measure the quality of road networks. iRAP Star Ratings involve an inspection of road infrastructure attributes that are known to have an impact on the likelihood of a crash and its severity. A ranking of between one star and five stars is awarded depending on the level of risk that is "built in" to the road. The lowest-risk roads (four- and five-star) have road safety attributes that are appropriate for the prevailing traffic speeds. The highest-risk roads (one- and two-star) do not have road safety attributes that are appropriate for the prevailing traffic speeds. Information about road attributes is collected by conducting video surveys of roads and subsequently recording data in categorical form at 100-metre intervals along the road. The road attributes include speed limit, curvature, intersections and sidewalks. Road attribute risk factors are combined with the road attribute data in multiplicative equations to produce Star Rating scores for vehicle occupants, motorcyclists, pedestrians and bicyclists for each 100-metre segment of road. These scores are then assigned range bands to produce Star Ratings, which therefore reflect a mix of road safety and road quality characteristics. The primary performance indicator being used worldwide is the percentage of travel on three-star or better roads for all road users. iRAP's indicators are linked to the UN Sustainable Development Goals.

Port turnaround times – The performance of port infrastructure is measured by a mix of commercially owned and publicly available indicators of efficiency. One of those measures is ship turnaround times, an indicator published by Lloyds Intelligence Unit, covering >95% of all vessels' movements. This captures the time spent by vessels at ports, including dwell time. Quicker turnaround and container loading times translate into more efficient port operations and lower costs for shipping lines. The average ship turn-around time of world container ports was 1.03 days in 2014. Although ship turnaround times give some indication of the efficiency of ports, some of the variation of the indicators could result from differences in ship size calling ports, which can only be addressed through detailed analysis.

Modal split – One of the indicators of the relative competitiveness of a transport mode compared to others is modal split. This is often used to characterise the road/rail/coastal shipping shares in domestic freight transport and the car/public transport shares for travel in cities. Modal split indicators need to be interpreted carefully. Among the most relevant issues is the "contestability" of traffic in a trade corridor. The availability or absence of competitive modes is fundamental to any comparison; in many cases, rail service may not be available or accessible because of an absence of track, sidings, terminals, etc. Second, mode split and choice need to be carefully assessed based on the commodities involved and the markets served. Some goods and commodities are much better suited to carriage by one mode than another. Supply chains and distribution patterns also determine which modes are relevant. Modal splits can be calculated based on overall traffic data, but splits are more meaningful when they are disaggregated into relevant markets.

Modal split and social inequality constitute a national policy priority. Providing high-quality public transport is frequently employed as a tool for promoting equality of opportunity to access jobs and services in urban areas. The availability and quality of public transport services, reflected in the modal split, are therefore relevant to social equality goals.

Environmental performance indicators – The performance of transport networks encompasses their ability to minimise negative externalities that are a common by-product of transport activity, including environmental externalities. The OECD Environment Directorate manages a database of transport-related emissions, allowing comparisons across countries and regions on relative environmental performance.

Other information sources

Further information collected through stakeholder interviews and a literature review supports the quantitative analysis undertaken as part of this study. Two OECD missions to Chile were organised to interview stakeholders in the public and private sectors. These sources were crucial to identifying examples of infrastructure gaps, framework conditions and long-term policies, as well as collecting missing information, particularly considering poor data availability for some sectors and/or macrozones.

In addition to identifying the sectors or areas in which Chile is lagging behind its comparators, we carry out **complementary analysis to shed light on the historical, financial and institutional arrangements that have determined investment levels and infrastructure performance in comparator countries**. Throughout the report and in Annex B, we provide some case-specific examples of those policy framework conditions that helped "best-in-class" comparators to achieve the levels of economic performance and infrastructure they currently enjoy. We also present examples of persisting challenges in OECD comparators.

Strategic assumptions

The analysis presented in this chapter and the policy recommendations that derive from it are based on the assumption that Chile's underlying economic and demographic trends will continue into the future. Given this assumption, the analysis and policy recommendations reflect a business-as-usual scenario, incorporating current elements such as a heavy reliance on exports for economic growth, high levels of urbanisation and uneven distribution of natural resources.

Planners and policy makers in Chile must prepare for a range of alternative scenarios considering the potentially disruptive impact that emerging trends may have on the country's economy, natural resources and population. These trends include climate change and its impact on water, arable land and temperatures; technological innovation in the form of digitalisation and automation; and demographic changes, including ageing and international migration. Considering the likelihood and magnitude of impacts from these trends is beyond the scope of this chapter, but such considerations should be part of the development and future-proofing of Plan Chile 30/30.

Analysis and results

Chile's transport infrastructure endowment, demand and capacity projections

Chile's transport infrastructure has improved considerably over past decades, and the country has a good transport infrastructure base. Concession-based PPPs have helped attract large private investment in the upgrades of motorways, ports and airports. Road infrastructure spending averaged 1.35% of GDP over 2008-2013 (more than double the share of GDP in comparator OECD countries, see Figures 4.3 and 4.4), container port capacity doubled between 2004 and 2013, and airports cater for record passenger numbers. In parallel, a number of initiatives have improved, upgraded or expanded the range of public transport in Chilean cities, with major improvements in Santiago.

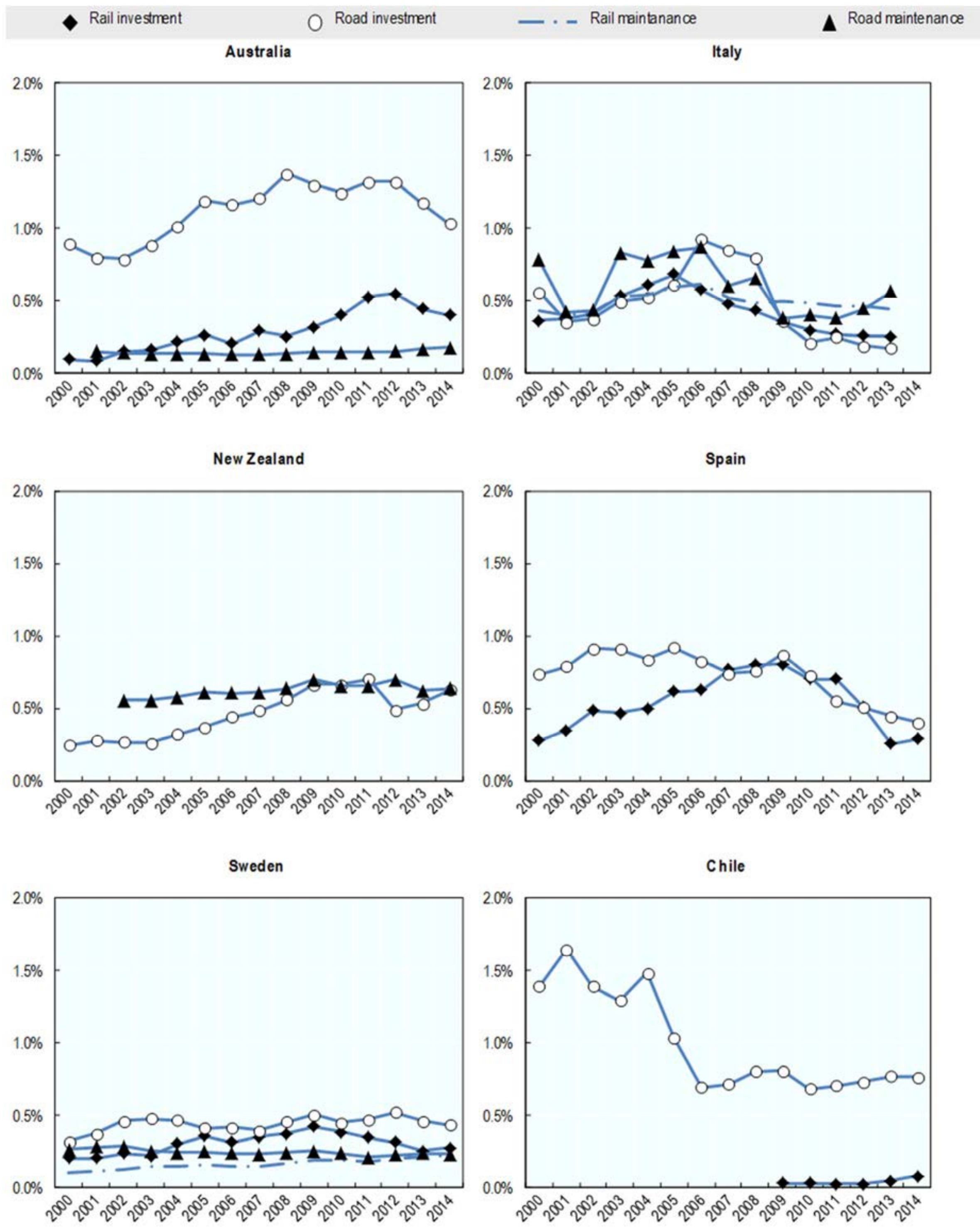
However, gaps in the provision and quality of infrastructure and related services are still present, affecting all modes of transport. The following sections provide detail on the nature of the shortcomings and their extent in comparison to other OECD countries. By way of introduction, available international comparisons are helpful to set the scene, as they offer an indication of the extent to which Chile needs to improve its transport infrastructure and which sectors have the widest gaps with global comparators.

The World Economic Forum's Global Competitiveness Index (GCI) shows that Chile's overall infrastructure score is relatively high, with considerable variation across modes. Rail infrastructure is rated particularly low, and airport infrastructure is rated the highest. Looking at a more detailed breakdown of responses (Figure 4.5), the dissatisfaction with rail services is very clear. In comparison to selected OECD peers, Chile is second from the bottom, although road infrastructure is considered to be of better quality than that in Australia and New Zealand, and port infrastructure quality is higher than that in Italy. We highlight that the GCI reflects perceptions by business leaders rather than physical availability.

The World Bank's Logistics Performance Index (LPI) shows that Chile has been among the top 50 countries globally for logistics and customs in the past four editions of the index. The LPI is widely used to highlight the efficiency of the national logistics industry. The LPI score is based on a qualitative survey of the opinions of users of the transport and logistics systems. Therefore, the LPI is not an absolute indicator of efficiency, but it can be used for comparisons across 160 countries, particularly to identify challenges and opportunities related to transport infrastructure, logistics competence and the efficiency of supply chains. Multi-national companies use the LPI as an input for decisions on where to locate various types of operations (Ojala, 2015).

In conjunction, the GCI and the LPI results indicate that Chile's logistics competitiveness can be improved further. A gap emerges when Chile is compared to selected OECD countries. ITF/OECD (2016c) recently highlighted the determinants of logistics performance that are particularly weak. Analysis showed that these weaknesses include a host of variables related to trade facilitation and regulatory issues, rather than simply infrastructure provision, including ease of arranging shipments; quality and competence of services; timeliness of deliveries, especially for international transport; and high costs of cross-border shipments.

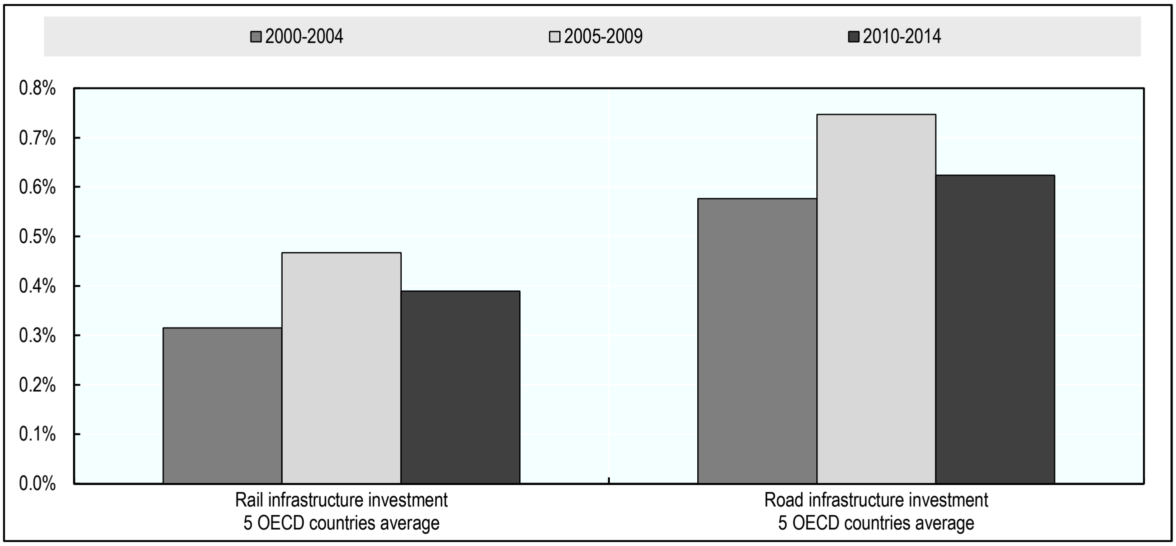
Figure 4.3. Rail and road investment and maintenance spending as a % of GDP, 2000-2014



Notes: data include both private and government investment. Australia: road investment includes tarmac at airports. Chile: rail investment does not include metro. Italy: road investment and maintenance do not include urban roads. Sweden: road investment does not include private local roads; rail investment includes trams and metros. New Zealand: data refer to fiscal years ending on 30 June.

Source: OECD (2016c), Ministerio de Obras Públicas (2016b) and Grupo EFE (2016).

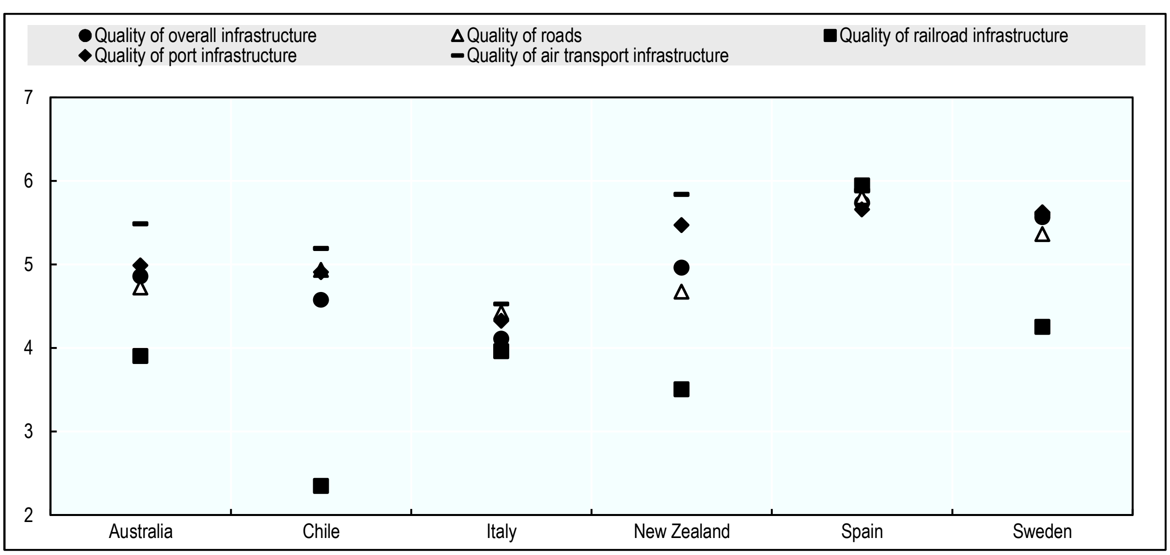
Figure 4.4. Rail and road average infrastructure investment as a % of GDP, 2000-2014



Notes: OECD average includes Australia, Italy, New Zealand, Spain and Sweden. Data include both private and government investment. Australia: road investment includes tarmac at airports. Italy: road investment and maintenance do not include urban roads. Sweden: road investment does not include private local roads; rail investment includes trams and metros. New Zealand: data refer to fiscal years endng on June 30.

Source: OECD (2016c).

Figure 4.5. Global Competitiveness Index (1 = worst, 7 = best), 2015-2016 edition



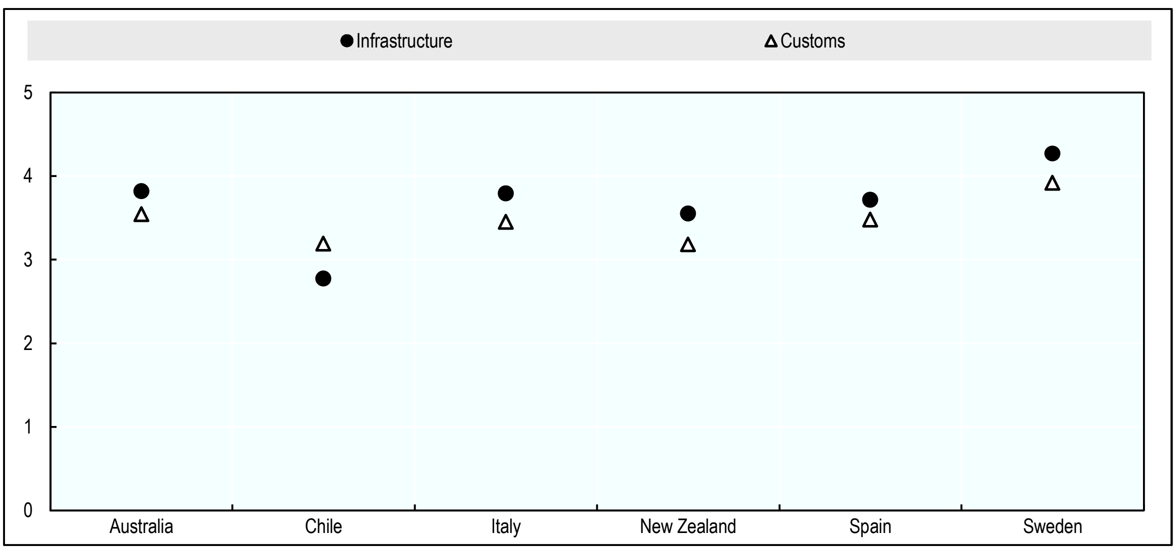
Source: World Economic Forum (2016).

Table 4.4. Quality of infrastructure, % of people responding low or very low, GCI 2015-16

	Chile	OECD average
Ports	0%	45%
Airports	17%	22%
Road	0%	25%
Rail	83%	48%
Warehousing	0%	10%
Telecommunications	29%	20%

Source: Chile's Productivity Commission (2016).

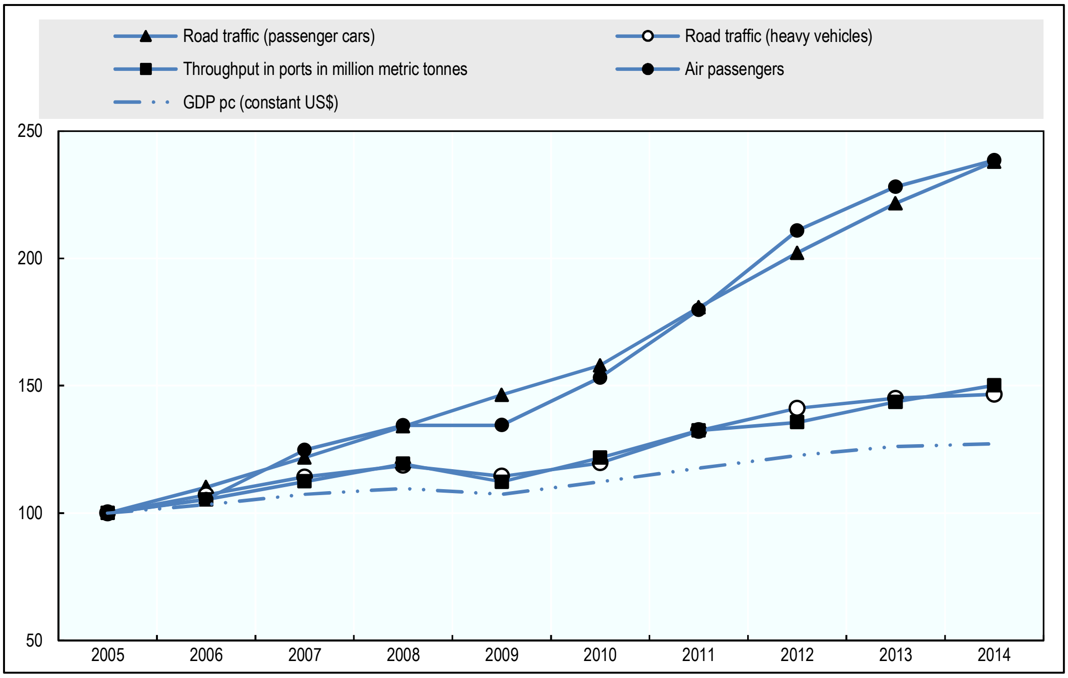
Figure 4.6. Logistic Performance Index (1= lowest, 5= highest), 2016 edition



Source: World Bank (2016d).

Existing transport infrastructure in Chile needs to cope with continuous growth in transport demand. Figure 4.7 shows the growth in road traffic, port traffic and air traffic over the period 2005-2014. Freight-related movements by road and sea have grown at a similar pace (around 50% over the period), following a similar trend as average GDP. Passenger traffic by road (motorways only) and air has grown even faster over the same period.

Figure 4.7. Evolution of available transport volume indicators in Chile (2005 = 100)



Note: road traffic is calculated as the number of vehicles counted at toll booths on inter-urban motorways.

Source: Road traffic: Instituto Nacional de Estadísticas de Chile (2016c). Throughput in ports: data elaborated by the ITF/OECD based on data from Lloyods Intelligence Unit. Air passenger: Junta de Aeronáutica Civil (2016). GDP: World Bank (2016e).

Looking ahead, the ITF Global Freight Model projections for Chile show a substantial increase in rail and road traffic linked to international trade between 2010 and 2030. Some of this growth has already materialised, although traffic growth has been weaker than expected since 2013, partly because of slower growth in trade volumes. The model indicates that:

- **rail infrastructure** will need considerable extra capacity to support projected growth – capacity will be needed for rail networks serving container ports and large cities
- **road infrastructure** serving international trade-related freight flows will be better able to cope with higher traffic levels – however, 27% extra capacity will be needed around key nodes
- capacity at **ports** will need to grow significantly – the projected capacity need (around 49% by 2030) is concentrated in the Central macrozone and will need to cater to larger container ships.

While these projections point to the need to increase capacity in selected infrastructure, they do not necessarily imply that nearly as much new infrastructure needs to be built. Chile's approach to capacity enhancements should reflect the current shift in transport policy from a "predict-and-provide" approach to a "demand-management" approach that combines investment, pricing and technological solutions to tackle capacity issues.4 The expansion of one type of transport infrastructure also affects the needs and hence the capacity required in other modes. Overall network capacity needs arise from the interaction of demand and modal split over time and across modes, thus requiring a co-ordinated approach to investment with a focus on key corridors and urban nodes.

Table 4.5. Rail, road and port (container) freight traffic in Chile, and estimated capacity needs

		Overall national estimate for Chile			Within 50 km from ports and large cities	
		Trade-related freight volumes	Capacity	% change	Capacity needs	% change
Rail		MO tonne-km	Track-km	Over 2010	Track-km	Over 2010
	2010	9 084	620	--	93	--
	2030	12 697	1 599	158%	291	211%
Road		MO tonne-km	Track-km	Over 2010	Track-km	Over 2010
	2010	59 653	17 240	--	1 760	--
	2030	84 652	19 066	11%	2 231	27%
Ports		MO TEUs	TEU capacity	Over 2010	TEU capacity	Over 2010
	2010	3.27	5.26	--	--	--
	2030	7.81	7.85	49%	--	--

Source: ITF/OECD (2016f).

These projections are also subject to several uncertainties, such as in relation to future economic growth and trade elasticities. The values provided should be viewed as the mid-point of a wide range. It is important to develop tools to adapt to these uncertainties. Tools include detailed national transport models to improve the precision of capacity projections. The possibility to adapt to uncertainties is served by flexible planning procedures within long-term strategic planning frameworks. In addition, it is critical for Chile to integrate the concepts of resilience and vulnerability, given the likelihood of natural disasters. Transport assets that integrate such considerations systemically can reduce potential uncertainties around supply shocks and temporary unavailability of infrastructure.

Road infrastructure

Key messages

Road infrastructure coverage and quality is uneven across Chile, and analysis suggests that targeted investment should be directed at addressing missing links and upgrading secondary roads. Some critical last-mile road links to ports and cities are missing, leading to bottlenecks, urban congestion and longer journey times for shippers.

Many regional and rural roads in all macrozones appear to be of low standards, although this is an issue linked not only to surface quality but also to safety features for all road users. Decisions on whether to pave more roads should be made in light of cost-benefit assessments; however, targeted investment is needed in rural and regional roads. Road authorities should adopt an incremental approach to road-paving solutions, taking into account connectivity needs, projected traffic growth and life-cycle costs, including future maintenance needs and safety implications (as Chile's performance is currently worse than OECD benchmarks). Over the next decade, maintenance needs will grow and could require a budget equivalent to that needed for investment. Multi-annual budgets that ring-fence routine maintenance of the road network should be introduced as in other OECD countries.

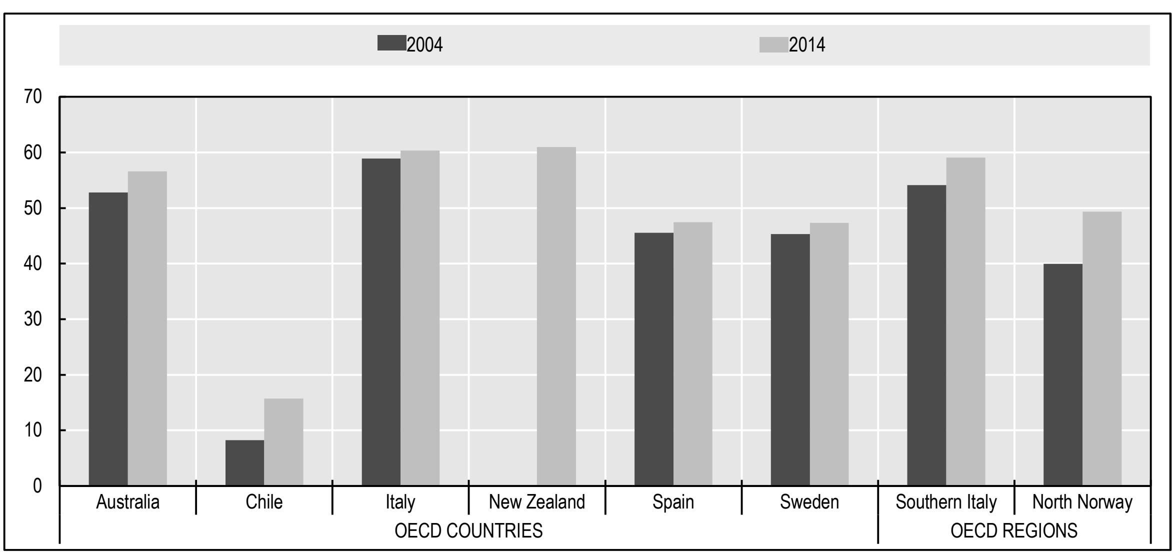
Sector overview

The Chilean road network is almost 80 500 km long and includes four main types of roads: private motorway concessions, publicly owned roads (categorised as national or regional, where the latter includes main, provincial, municipal and access roads). Notably, the MOP manages motorway concessions through its Concessions Division, and it designs, plans, builds and maintains public roads through its Roads Division.

Following a period of under-investment in road infrastructure, the government embarked on an ambitious franchising programme in the 1990s via build-operate-and-transfer (BOT) contracts. The main goal of the programme was to attract significant private investment to reduce the perceived deficit in road infrastructure (Engel et al., 2000). There is widespread agreement in Chile that the quality, capacity and resilience of Chile's motorway backbone is now of a high standard, thanks to the investment boost received in the 1990s and the provisions contained in long-term concession contracts to maintain the roads to high standards. Chile's road sector ranks 35th in the 2015 GCI (New Zealand: 43rd; Italy: 49th). This result may be disproportionately influenced by the good quality of motorways, as respondents to the GCI survey are more likely to use those roads.

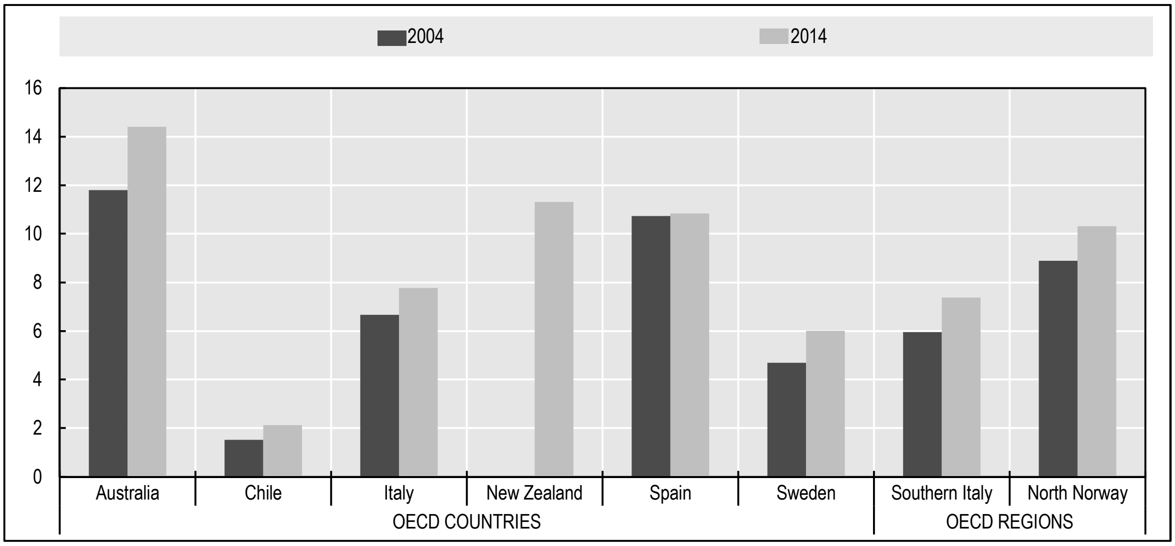
Available data[5] show sustained growth in road transport over the past decade. Toll booth counts show a large increase in the number of vehicles travelling on motorways between 2005 and 2014 (+114% overall, with large increases in both cars and trucks). These figures match those on road motor vehicle fleets (Figures 4.8 and 4.9). The number of private cars has more than doubled over the past ten years, and there were 56% more registered trucks in 2014 than in 2005. Nonetheless, the number of passenger cars per 100 inhabitants in Chile is still 70% lower than in comparator countries in which average incomes have reached $30,000 per capita. Hence, growth in car ownership is expected to continue.

Figure 4.8. Stock of passenger cars per 100 inhabitants (2005 = 100)



Source: Stock of passenger cars: ITF (2016a), ISTAT (2016c), Statistics Norway (2016c), Instituto Nacional de Estadísticas de Chile (2016d). Population: World Bank (2016a), ISTAT (2016a), Statistics Norway (2016a).

Figure 4.9. Stock of goods road motor vehicles per 100 inhabitants



Note: goods road motor vehicles include vans, trucks, and road and agricultural tractors.

Source: Stock of passenger cars: ITF (2016a), ISTAT (2016c), Statistics Norway (2016c), Instituto Nacional de Estadísticas de Chile (2016d). Population: World Bank (2016a), ISTAT (2016a), Statistics Norway (2016a).

The maintenance and building of roads outside concession schemes receive around 80% of MOP's expenditures, with a strong focus on enhancing the standards of public roads. Targeted investment is being rolled out to improve the surface quality of rural roads in particular. Since the early 2000s, the MOP has deployed a large programme to provide lower-cost solutions ("*soluciones básicas*") to paving roads with traffic flows below 500 in average annual daily traffic (AADT).[6] This solution had been applied to over 10 000 km by 2014, and the programme aims to cover a further 15 000 km by 2018. Investment in *soluciones básicas* is not subject to the BCR thresholds normally imposed by the Ministry of Social Development and is considered of high importance to reduce isolation and inequality.

At the other end of the spectrum lie a number of mega-projects to enhance Chile's national and international connectivity. Some of the larger projects are planned in more remote areas of Chile. Road concessions have not previously been established in the extreme South and North of the country; therefore, the connectivity improvements necessary to reduce isolation and support trade in these regions rely on central government funding. There are plans to connect remote areas in Chile's Austral region, including a new bridge across the Chacao Channel and a new *Carretera Austral*. Developing international connectivity by road is also high on the agenda following agreements between Chile and its neighbours. Several passes along the border with Argentina will be upgraded or built from scratch with the aim of facilitating intra-American trade, some of those as part of the so-called *Corredor Bioceanico* (see Box 4.4). Connectivity between the northern macrozone and neighbouring states (Perú and Bolivia) will also be strengthened.

Box 4.4. The Bioceanic Corridor Mercosur Chile

The 1996 Economic Complementation Agreement between Chile and other Latin American countries stipulates that Mercosur states and Chile are committed to developing infrastructure links to strengthen so-called bioceanic corridors (Pacific Ocean to Atlantic Ocean). To do so, the countries are required to “improve and diversify” land connections and to stimulate the development of infrastructure such as greater port capacities.

This commitment implies greater international co-ordination in physical infrastructure and in trading rules. With respect to infrastructure, this translates into the need to upgrade the quality, capacity and resilience of road infrastructure across the Andes to facilitate trade-related freight flows, especially to the ports in central-southern Chile. Two key projects in the pipeline are:

Paso de Las Leñas, an 11-km base tunnel (altitude: 2 000 m) linking the southern part of Mendoza province in Argentina with the O’Higgins region in Chile.

Tunel de Agua Negra, a 14-km tunnel (altitude between 3 600 and 4 100 m) linking the province of San Juan in Argentina with the region of Coquimbo in Chile.

The new tunnels will enable freight movements even in extreme winter conditions and are intended primarily to serve trade flows to and from the port of San Antonio, providing an alternative to the Paso de Los Libertadores, situated closer to the Port of Valparaiso but often closed in the winter. As European experience shows, the success of international freight corridors depends on the ability of new infrastructure to address bottlenecks and offer an attractive alternative to existing routes.

As they strengthen bioceanic corridors, Chile and its neighbours should adopt an integrated, multi-modal approach to ensuring that the entire logistics chain benefits from targeted cross-border investment in terms of reduced congestion, faster journey times and more reliable travel conditions. Lessons from the EU show that, unless co-ordinated management and intermodal integration are achieved, the potential of international freight corridors will be unmet.

Source: Ministerio de Obras Públicas (2016), “*Hacia un país con desarrollo equilibrado*”*;* Ministerio de Transporte y Telecomunicaciones (2013)*, “Conectando Chile”*.

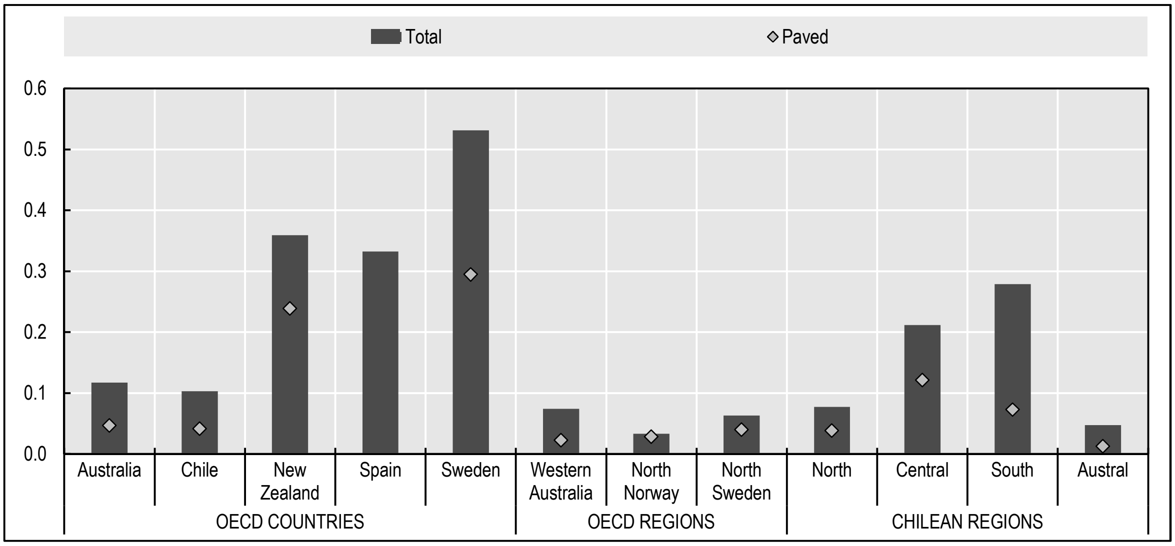
Identified gaps

When looking at the overall density of roads per capita and by area (Figures 4.10 and 4.11), Chile ranks last among OECD comparators. However, the ITF Global Freight Model’s projections show that road infrastructure serving international trade-related freight flows will need to increase by only around 10% by 2030 to cope with increased traffic. The implication of looking at these indicators in conjunction is that, although below OECD average, the overall road stock at the national level may be sufficient, but its varying degrees of quality and the presence of missing links require targeted investment.

The presence of gaps with respect to road infrastructure coverage, quality and capacity is better described in terms of geography and road type. In comparison to each benchmarking country or region, the Central and Southern macrozones in Chile show a lower road coverage by area and by population. Road density in the Northern macrozone is on par with Western Australia, but roads per capita are significantly lower. The Austral macrozone has similar levels of road provision to its comparators. From the point of view of road coverage, regional differences emerge, and the Central and Southern macrozones appear to have the largest gap.

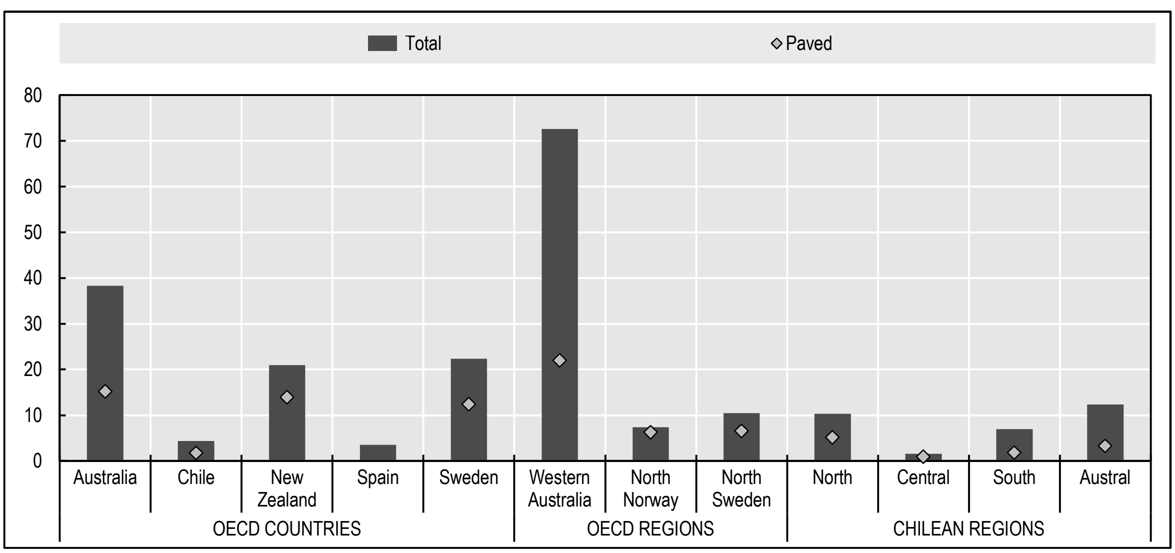
Road coverage should be looked at in conjunction with road quality; the share of paved roads is one of the available quality indicators. Again, the national result for Chile shows that the share of paved roads is the lowest among comparators. However, it is the Southern and Austral macrozones that fare worst, with just 25% of paved roads, even when roads with thin surface layers are included in the paved category.

Figure 4.10. Density of road network (km of roads per km²), latest available year



Source: Road network: BITRE (2013), Ministerio de Obras Públicas (2016c), ITF (2016b), Ministerio de Fomento (2016), Statistics Sweden (2016d), Mainroads Western Australia (2015), Roadex (2000), CIA (2016). Land area: World Bank (2016b), Australian Bureau of Statistics (2016b), Statistics Norway (2016a), Statistics Sweden (2016b), Instituto Nacional de Estadísticas de Chile (2016b).

Figure 4.11. Density of road network (km of roads per 1 000 inhabitants), latest available year



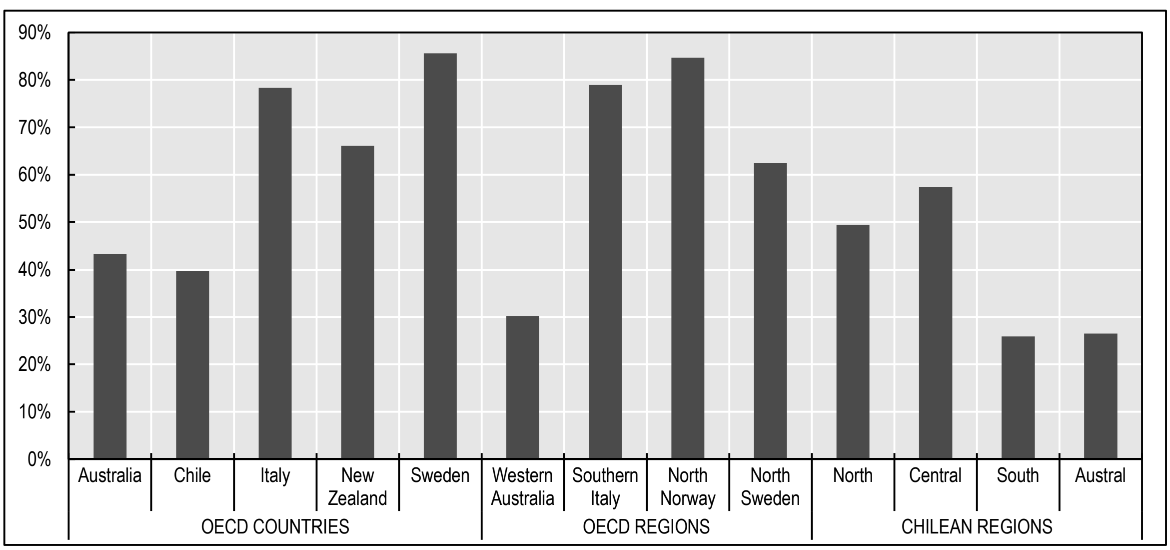
Source: Road network: BITRE (2013), Ministerio de Obras Públicas (2016c), ITF (2016b), Ministerio de Fomento (2016), Statistics Sweden (2016d), Mainroads Western Australia (2015), Roadex (2000), CIA (2016). Population: World Bank (2016a), Australia Bureau of Statistics (2016a), Statistics Norway (2016a), Statistics Sweden (2016a), Instituto Nacional de Estadísticas de Chile (2016a).

Private and public investment in those regions has been historically lower than in the North and Centre for different reasons. Concessions stopped at Puerto Montt given the low appetite for private investment in lower-density regions, and public actors have traditionally found it hard to justify government spending based on established socio-economic assessment criteria, due to low densities and fragmented territories.

Investment in infrastructure for regional development will often show relatively low internal rates of return. This does not mean that CBA should not be used to help establish priorities among projects, as higher rates of return reflect benefits to larger numbers of people, among other things. However, as discussed elsewhere, additional mechanisms will need to be employed to determine the distribution of public funds for infrastructure to address issues of equity.

When publicly funded investment in roads is determined to be needed for regional development, it does not follow that design standards should be lowered to reduce costs. In Italy, the southernmost stretch of the national highway network (A3 motorway) required direct investment, ownership and management by the State because expected returns were too low to support a private concession. However, the quality and safety design standards for the A3 motorway turned out to be sub-optimal following the car ownership boom of the 1970s and 1980s. Following piecemeal adjustments including widening, overhead bridges, improved safety and new emergency lanes, this has damaged the competitiveness of Southern Italy in two ways: first, by undermining connectivity on a key north-south axis for prolonged periods of time during makeover works; and second, by diverting financial resources away from other infrastructure projects in the area to fill this gap.

Figure 4.12. Share of paved roads, latest available year



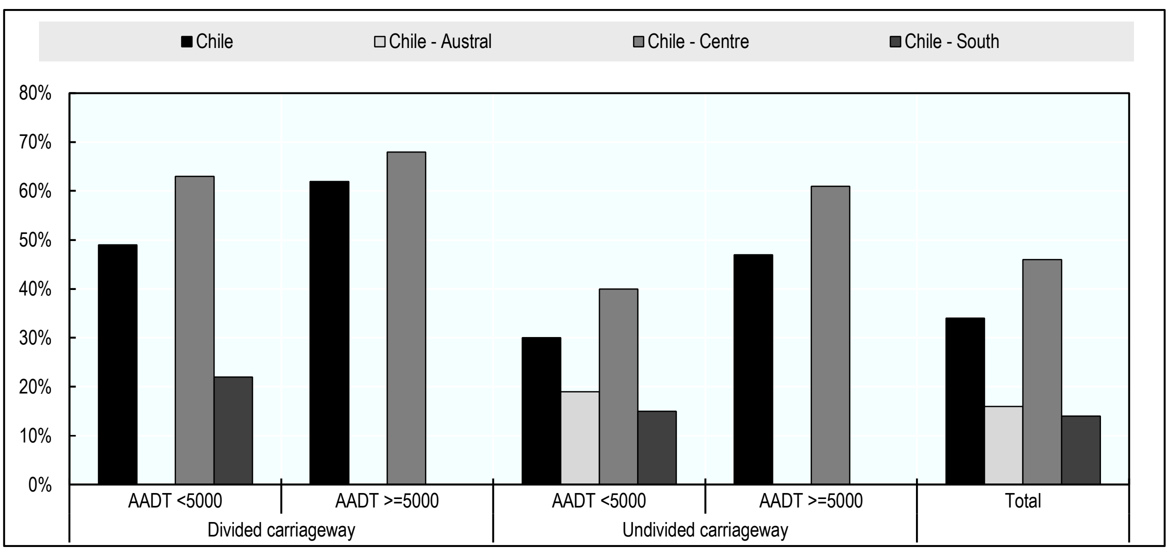
Notes: data exclude privately owned roads. In Chile, paved roads include "*soluciones básicas*".

Source: CIA (2016), Ministerio de Obras Públicas (2016c), SITEB (2012), Trafikverket (2016), Mainroads Western Australia (2015), Roadex (2000).

Within each macrozone, different types of roads show varying degrees of quality, as detailed by analysis carried out by iRAP. As Figure 4.13 shows, more than 60% of high-traffic-volume traffic roads are of good quality (three stars or above) in Central Chile. However, the share of undivided carriageway roads carrying low traffic volumes (encompassing most regional and rural roads) that is assessed to be of good quality is very low in the Southern and Austral regions compared to Central Chile (15%, 19% and 40%, respectively). In a different version of the iRAP assessment, which allows for international comparisons, even Central Chile is below best-in-class with respect to low-traffic, undivided roads. Only 24% of secondary roads are of good quality compared to 35% in Catalonia (for which data are available), although New Zealand has a worse score, with only 6% of these roads rated as good quality. Conversely, Northern Chile has higher ratings than both Central Chile and its comparators, including Western Australia.

Overall, iRAP ratings paint a national picture in which secondary roads are of much worse quality than primary roads in three macrozones, especially those with a lower share of paved roads. Within Chile, the analysis shows a 30% gap in road quality between the southern part of Chile and the centre. In an international perspective, however, Central Chile may in turn be lagging behind comparators such as Catalonia and hence might not be the standard setter. More in-depth analysis suggests the specific features that contribute to poor ratings for regional and rural roads. For instance, iRAP data show that more than 70% of curves on undivided rural roads where traffic flows at >80 km/h have hazardous roadsides across Chilean macrozones. The equivalent value for New Zealand and Catalonia ranges between 20% and 30% only. Roadsides need upgrading, and in the meantime, speeds should be restricted for compatibility with the design of the infrastructure.

Figure 4.13. Roads rated three stars or better for vehicle occupants (iRAP model V2)

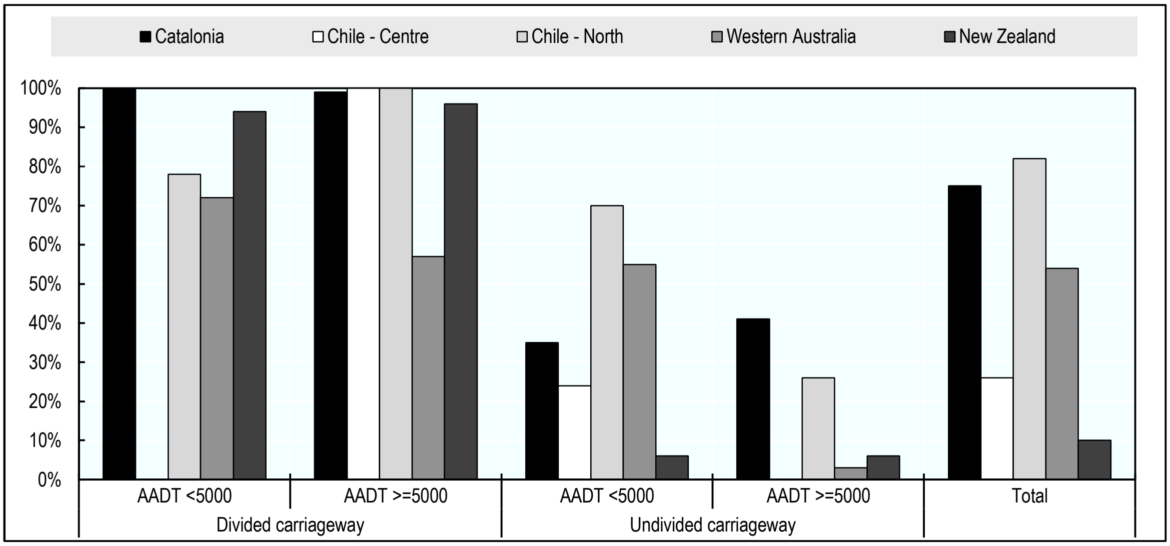


Notes: V2 and V3 stars are not directly comparable. AADT = average annual daily traffic.

Source: IRAP (2016).

Chile's road safety record also reflects the poor quality of these roads (see Box 4.5), whereby the highest number of fatalities arises on non-urban, non-motorway roads, despite lower levels of traffic. Chile has the worst rate of road fatalities (12 deaths per 100 000 inhabitants in 2014, 2.5 times higher than the average for our comparator countries) and the slowest rate of reduction of this indicator for the period 2004-2014 (-17% compared to -48% on average across OECD comparators).

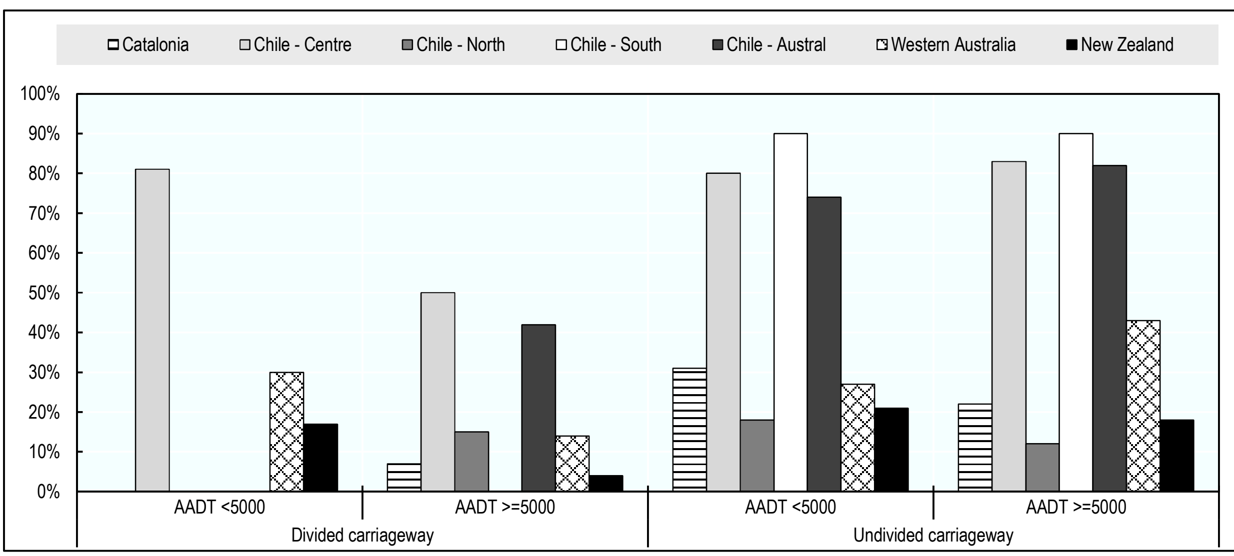
Figure 4.14. Roads rated three stars or better for vehicle occupants (iRAP model V3)



Notes: V2 and V3 stars are not directly comparable. AADT = average annual daily traffic.

Source: IRAP (2016).

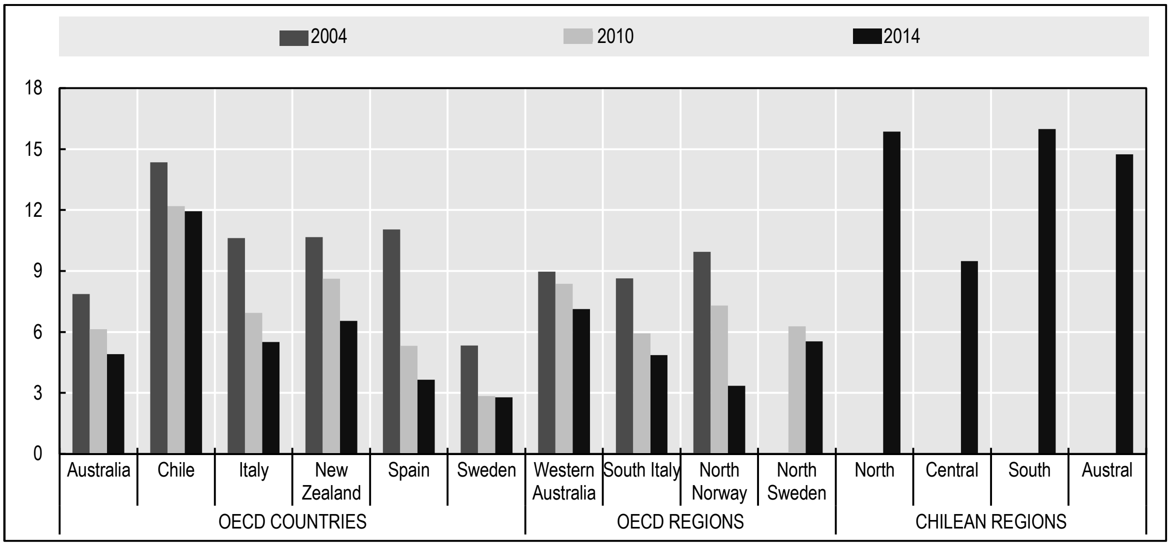
Figure 4.15. Curves on rural roads on which traffic flows at >80 km/h that have hazardous roadsides



Note: AADT = average annual daily traffic.

Source: IRAP (2016).

Figure 4.16. Number of road fatalities per 100 000 inhabitants, 2004, 2010 and 2014



Note: Fatalities correspond to death within 30 days after the accident.

Source – Road fatalities: ITF (2016c), Instituto Nacional de Estadísticas de Chile (2016e), BITRE (2016a), ISTAT (2016d), Statistics Norway (2016d), Transportstyrelsen (2016). Population: World Bank (2016a), Australia Bureau of Statistics (2016a), ISTAT (2016a), Statistics Norway (2016a), Statistics Sweden (2016a), Instituto Nacional de Estadísticas de Chile (2016a).

Box 4.5. Road safety in Chile

Between 2000 and 2014, road fatalities in Chile fluctuated, with no clear trend emerging. The lowest value (1 960) was observed in 2009, potentially linked to lower traffic volumes, and the highest value (2 317) was observed in 2008. In 2014, the latest available full year, there were 2 119 road deaths. Year on year, the number of deaths decreased among cyclists and pedestrians but increased among motorcyclists and passenger car occupants. Fatalities increased among young people (0-14 years old) and the elderly (65+ years old). Initial data from 2015 indicate that fatalities have increased again by 1%. Injury crashes decreased by 2% in 2014, but the overall trend since 2000 has been an increasing one. Measured in terms of road deaths per 100 000 inhabitants, fatalities have decreased by 17% between 2004 and 2014. This rate of decline is far lower than that witnessed in OECD comparator countries, ranging from -37% in Australia to -67% in Spain over the same period.

Road deaths represent a growing cost for the Chilean economy. Based on the human capital approach, which assesses the consequences of the crashes based on the loss of productivity resulting from a statistical death, road crash costs were equal to around 0.2% of GDP in 2013. When killed and seriously injured (KSI) statistics and the related costs of injuries are considered, the total cost of road crashes grows to 3% of GDP, per iRAP estimates.

At the mid-point of the UN Decade of Action for Road Safety 2011-20, the inclusion of road safety targets in the UN Sustainable Development Goals (SDGs) enhances the visibility, urgency and ambition of global road safety policy. Most countries have national road safety strategies with ambitious targets in place, and many of these are aligned with the objectives of the Decade of Action. Notable examples are *Safe System* approaches in countries such as the UK and *Vision Zero* in countries such as Sweden. In April 2016, the UN General Assembly confirmed SDG 3.2 in Resolution 70/260, which aims to reduce global road traffic deaths and injuries by 50% by 2020 compared to their 2010 levels.

In 2012, the Chilean government introduced a new law on drinking and driving, setting the maximum permissible blood alcohol content (BAC) at 0.3 g/l. Two important measures were further implemented in 2014: the reform of the driving licence procedure, with new theoretical and practical exams, and the adoption of more severe punishment for drunk drivers who cause serious injuries or death (including one year or more in prison).

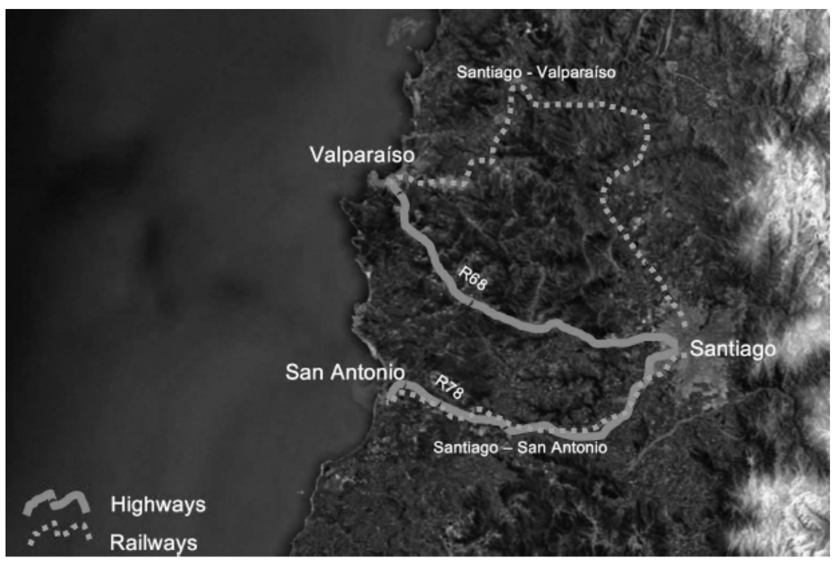
Building on these regulatory changes, Chile is currently developing a National Road Safety Strategy, led by the National Road Safety Commission (CONASET), aligned with the UN SDGs. The new strategy will need to ensure that legislation, education and construction efforts towards greater road safety are joined together. This could include developing a reference model based on criteria for safe road transport standards, setting the goal to close the gap between existing road quality standards and this reference model.

Source: ITF/OECD (2016d); iRAP (2016).

The second type of road infrastructure that shows some gaps with OECD comparators is connecting infrastructure, such as road links between ports and the motorway network, between urban motorway concessions and urban public roads, and between national and international roads. Numerous examples were provided by stakeholders during the interviews held in Chile, highlighting gaps between regions and cities of Chile. The examples of good practice provided in Annex B also show that investment in connecting infrastructure and "last-mile" has been made a top priority in the transport strategies of comparator OECD countries over the past decade.

For instance, the quality of port access roads can vary greatly, as is evident when comparing the roads linking the Port of San Antonio to Route 78 (where trucks need to drive through narrow city streets with road surfaces that are deteriorating fast due to the lack of maintenance) with the high-quality, dedicated tunnelled access to Route 68 from the Port of Valparaiso (*Camino de la Polvora*). Lower-quality access to the port of San Antonio increases congestion and pollution across the city, and it raises transport costs.

Figure 4.17. Road and rail links between Central ports and Santiago



Source: MTT elaboration.

The interface between intercity motorways and urban roads is often problematic and creates bottlenecks at major access points in urban areas. Examples include links between motorway bypasses and urban arteries in Santiago, the incomplete ring-road in Valparaiso, and gaps in the trunk road network between the urban areas of Coquimbo and La Serena, including on roads carrying traffic to the port of Coquimbo along Route 5. The gaps in Coquimbo-La Serena create bottlenecks for urban residents when mixed car and truck traffic surges at peak times and results in longer journey times than would be the case with better links or specific policies aimed at targeting congestion.

Some of these gaps in Chile are the result of fragmented governance arrangements. For instance, port authorities only exercise their functions within port areas and are not responsible for access roads, whose funding relies on either MOP or municipal funding. The city authorities' ability to invest is hampered by financial constraints and unclear governance arrangements over the roles and responsibilities for those roads (see Chapter 2).

Examples of good practice encompass models of co-operation between ports and different tiers of government as well as restructuring of responsibilities. In Australia, the WestConnex project aims to provide progressive upgrades in the motorway network linked to the Port of Sydney between 2015 and 2023. The project is funded with a mix of distance-based tolls on all vehicles, including trucks; an availability charge from the New South Wales Government; and a grant from the Australian Government. In New Zealand, uncoordinated planning for transport and land use was the main rationale for merging the eight previous bodies governing the Auckland metropolitan area into a single body, the new Auckland Council. The council was required to develop the Auckland Plan, which, among other things, sets out co-ordinated strategies for building infrastructure to reduce Auckland's congestion, particularly in relation to port traffic, over the next 30 years.

Conclusions on road infrastructure

Results from the ITF Global Freight Model confirm the need to invest in additional road capacity around maritime and population hubs. Our projections suggest that one-quarter of the additional road capacity required by 2030 will be needed in the proximity of ports and large cities, translating into a 27% increase for these types of roads compared with 2010.

Importantly, the need for maintenance across all roads will grow over time. In the case of motorway concessions, existing contracts are already in place to ensure that the concession holders have asset management plans for the appropriate level of scheduled maintenance and that toll revenues provide sufficient funds for those activities.

A large-scale implementation of thin paving solutions could create a serious gap with respect to maintenance in the long run. For public roads, the ambitious roll-out plan for sealing surfaces at lower costs (*caminos básicos*) across the non-metropolitan areas of Chile is seen as a short-term option to address the current gap in road surface quality on secondary roads. However, these low-cost treatments are susceptible to accelerated wear and vulnerable to severe damage from excess loads, as the experience in Sweden in the 1980s has shown. Hence, the MOP would be required either to impose strict bans on heavy vehicles on these roads or to allocate an increasing share of its budget to road surface treatment (see Box 4.6), in addition to the increase in maintenance needs foreseen along the typical road wear cycle. A focus on incremental improvements to the network to standard levels of pavement quality and thickness, based on clearly defined criteria such as connectivity to transport hubs and current and projected traffic levels, would appear to be a more sustainable policy.

Box 4.6. To pave or not to pave, and to which standards? The case of Sweden

Decisions on whether to pave or not to pave roads, and to which standards, are often based on current and projected traffic flows. However, through neglecting future phases of the project lifecycle including operation and maintenance, countries run the risk of over-investing in new infrastructure, under-investing in maintenance, operating infrastructure inefficiently and under-estimating costs (see Chapter 2, Section 1.6). For road surfaces, a whole-of-life approach should be adopted to include the impact of different paving solutions on long-run maintenance needs and road users' safety.

The maintenance needs of a road network can be predicted fairly accurately from a set of structural characteristics, including age, climate, traffic, design standards, construction quality and subsequent maintenance. First, maintenance needs differ for paved and unpaved roads. For paved roads, there is a trade-off between higher investment costs at the time of paving and lower subsequent maintenance costs, and vice-versa. Unpaved roads, such as gravel roads, cost as much as three times less than paved surfaces to build but require more frequent maintenance, especially in areas with extreme weather conditions such as heavy rainfall.

Box 4.6. To pave or not to pave, and to which standards? The case of Sweden (*cont.*)

Experience from OECD countries shows that age is particularly important to the condition of paved roads because of the time path of their deterioration. Following a period of large-scale road construction, a grace period of several years – during which roads remain in good condition even without maintenance – is followed by a period in which the need for maintenance surges. In many European countries, the need for maintenance has coincided with budgetary pressures due to financial crises. The result has been a fast deterioration of road surface quality over the past decade. In countries with fast-expanding economies, traffic growth is instead one of the key determinants of road conditions.

In Sweden during the 1980s, most low-traffic-volume roads were paved with thinner and weaker structures, mainly using "Y1G" (surface dressing with one layer, 0-18 mm – a layer of stone is stuck with bitumen emulsion on the underlying gravel layer). The Y1G method was aimed at gravel roads to make the surface more even and reduce dust.

Although cheaper, the Y1G method revealed its limitations over time. Gravel roads on which the solution was applied were not built with the appropriate standards, and new surfaces were already subject to heavy damage after a few years, especially in frost-sensitive areas like Northern Sweden. It was then necessary to impose bearing capacity restrictions (12-ton maximum weight), particularly during the spring thaw. This negatively affected transport by heavy vehicles dependent on these roads.

Thin-layer paving solutions were almost entirely abandoned in Sweden as a result of this experience, which highlighted the risks of using thin layers directly on gravel roads. Thin layers today are used only for bituminous road surfaces and only when the road has good bearing capacity, a base course and good drainage. Importantly, thin layers are applied only on roads with very low AADT (below 250) and almost no heavy traffic. In Chile, some roads with AADT of up to 400 can be beneficiaries of *soluciones básicas*.

The experience of Sweden can provide valuable lessons to policy makers in Chile and points to the importance of a whole-cost approach when assessing options for road surfaces. While it is no substitute to applying sound CBA to sift and prioritise investment based on Net Present Values, this approach requires balancing considerations of the short-term benefits for road users and the future impacts, including on maintenance budgets. In the case of *soluciones básicas*, the appropriate standards should be set with a view on current and future traffic levels and the expected degree of deterioration given this forecast utilisation.

Source: World Bank (1988, 2005, 2009); Written submission to the ITF/OECD by Trafikverket officials.

Port infrastructure

Key message

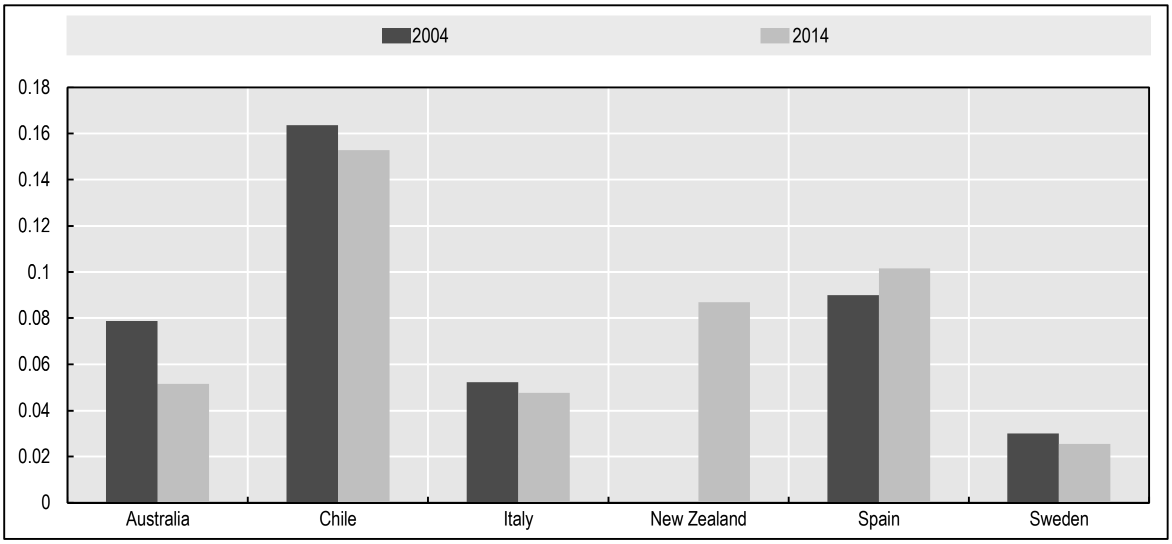
Port infrastructure is fundamental to the success of Chilean exports, and improvements in port efficiency and investment in hinterland connectivity are needed to support projected growth. Given the expected growth in trade-related flows and changes in average vessel size, capacity for growth is needed, especially in the Central macrozone. Compared with ports in OECD countries, the efficiency of port operations in Chile shows room for improvement, particularly at southern ports. Across all macrozones, hinterland access upgrades are a priority to reduce costs for shippers, manage port-related traffic in cities and reduce congestion. As for other transport sectors, policies to complement infrastructure investment appear necessary, especially integrated transport and land-use development planning and the relaxation of cabotage restrictions.

Sector overview

Chile's economy is highly dependent on maritime transport, given that around 95% of external trade is handled through ports. Overall throughput was 144 million tonnes in 2015 (Directemar, Boletin Estadistico 2016), double the amount transported in 2000. Moreover, annual container traffic reached 4 million TEUs in 2015, which equates to four-fold growth over 15 years, pushed by the increased containerisation of trade flows.

As such, Chile has the highest ratio of maritime traffic per unit of GDP among comparator countries (Figure 4.18). Chilean ports mainly serve Asian Pacific Coast destinations. China is now Chile's largest trade partner – an entirely new phenomenon compared to the situation in the mid-1990s (OECD, 2015).

Figure 4.18. Maritime container transport intensity of the economy (TEUs per 100 000 units of GDP)



Source: Metric tonnes: data elaborated by the ITF/OECD based on data from Lloyds Intelligence Unit. GDP: World Bank (2016c).

More than 90 ports – some public and some private – are located along the 4 300-km coast of Chile. The largest ports are publicly owned, and the public sector's role is to manage and develop ports and terminals, either directly or through concessions to private terminal operators. There are also a number of private ports, some of which are vertically integrated with mining or industrial companies and specialise in the export of specific products – mostly bulk cargo of minerals, forestry and fuels. Many ports are located within or adjacent to urban areas. This is an advantage in terms of proximity to related services and workforce but a disadvantage due to the congestion and pollution impacts of port-related activities.

Chile has an implicit ports hierarchy. A strict maritime cabotage policy has meant that more than half of all container volumes are concentrated in the two largest ports: San Antonio and Valparaiso. Cabotage laws[7] hinder the development of coastal shipping, which accounted for less than 20% of tons moved in national ports in 2013. In the Northern macrozone, ports are specialised in the movement of mining products (mainly bulk cargo), but they are increasingly trading a larger share of containers. For instance, the ports of Iquique and Arica provide access to maritime trade for landlocked countries like Bolivia and Paraguay. In the Southern macrozone, maritime activities have a seasonal profile, as ports there specialise in forestry, fishery and agricultural products, many of which are perishable. In the Austral macrozone, maritime transport is often the only means of transport for both cargo and passengers.

In this context, the government views as necessary further port investment in the Central macrozone (MTT, 2013). The two largest ports are working on expansion and efficiency-enhancing projects to be implemented between 2015 and 2020. In addition, a consensus has been reached around the need for a mega-port to be developed (*Puerto de*

Gran Escala) in the Central macrozone. This will provide for longer and deeper terminals that are able to handle increasingly large container vessels (ITF/OECD, 2014). Many ports in the North are also adding capacity. ITF's Global Freight Model projections confirm the need to add 50% TEU capacity by 2030, with an emphasis on Central ports. The new port development will be located either in San Antonio or Valparaiso, with the final decision yet to be confirmed.

Identified gaps

The ITF/OECD has previously outlined (ITF/OECD, forthcoming) areas for improvement of Chile's port performance at the maritime, port and hinterland levels. Maritime connectivity depends on market decisions by shipping lines, but in turn, these decisions depend on the organisational and operational performance of ports and the quality of hinterland transport connections. Improvements to port operations can enhance performance even without investment in infrastructure. For example, changes to operational rules such as introducing port gate truck appointment systems are often the priority in the short term.

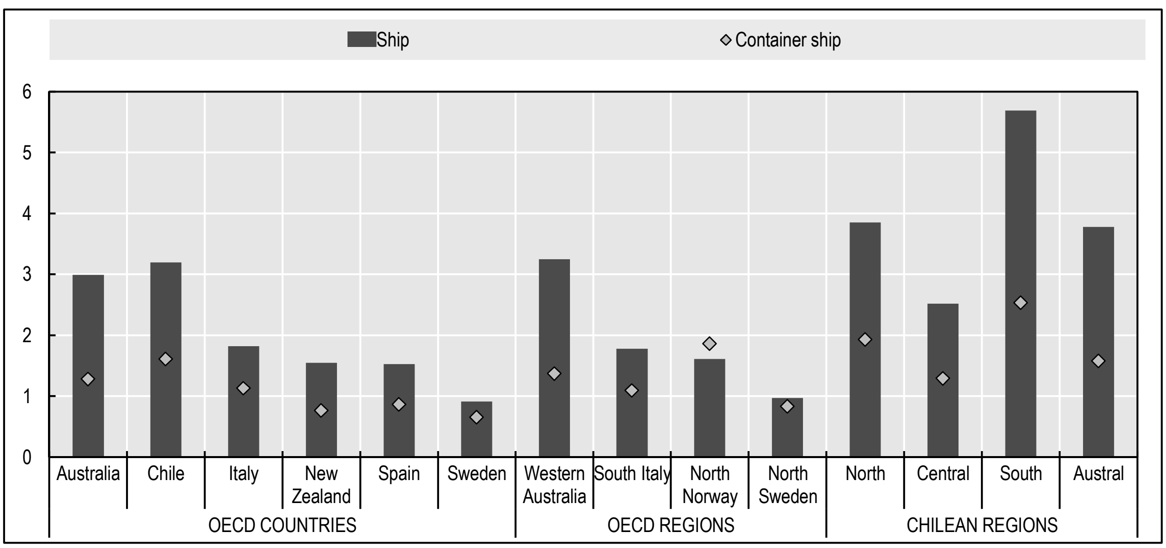
Investment in terminals can contribute to promoting operational efficiency. A measure of efficiency is ship turnaround time (Figure 4.19). Quick turnaround times reduce total trip costs; this is especially important for shipping lines' vessels. Chile's Central ports perform better than the rest of the country, but turnaround times are still about one-third longer than in comparator regions (Spain, Southern Italy). The performance of Northern ports is not far from Western Australia's port performance, while Southern ports lag further behind their comparators. Improvements in ship-to-shore operations, crane deployment and terminal layout can raise efficiency, including by reducing turnaround times (ITF/OECD, 2014).

For instance, in 2011, the New South Wales government introduced a range of measures at Port Botany to improve the operational efficiency of the supply chain through the port.[8] These measures included performance management standards to deal with truck congestion, whereby stevedores and truck carriers incur financial penalties if they do not meet those standards. In addition, a Cargo Movement Co-ordination Centre and teams of industry and government stakeholders in the road and rail sectors have been established, working to improve operations along the supply chain and at the port. The on-time performance of trucks arriving at Port Botany increased from 72% in February 2011 to 93% in March 2013.

Chile's maritime container port concessions regime has been effective in delivering optimal investment in container terminals. Concessions to develop container terminals inside the ports are awarded by competitive tender. Unlike other OECD countries, the concessions cover the development of wharves and piers as well as terminal buildings. Tenders are opened periodically and used to test demand: when there is insufficient interest to award a concession, this is taken as a signal that demand is not yet sufficient to warrant investment rather than signalling a failure of the tendering process. This mature approach has resulted in incremental expansion of capacity in step with demand, minimising investment risk and costs. Competition policy has ensured that no terminal operator holds significant market power in the overlapping hinterlands of competing ports. This regime is well suited to the expansion of capacity required to meet national goals in the context of Plan Chile 30/30.

The mega-port to be developed in the Central macrozone will require some additional attention, as a major breakwater will need to be built first and a series of terminals concessioned over time behind the breakwater. As discussed in ITF 2015, separating breakwater construction from concessions for terminal development would greatly simplify financing arrangements and allow competition for terminal concessions to proceed in the normal way. The life span and risk profile of such a breakwater is very different from terminal and pier infrastructure. Unbundling would allow the port authority to finance the breakwater and charge terminal concessions for its use on an equal basis. Construction might be financed by the MOP directly or through a separate concession. Opting for public finance would minimise the cost of finance; however, private finance might be preferred to transfer construction risk to a company with a recent track record in construction of similar projects (outside of Chile). A concession would also take the burden of paying for construction off the books of the port authority.

Figure 4.19. Average ship and container ship turnaround time (days), 2013



Note: global average is one day.

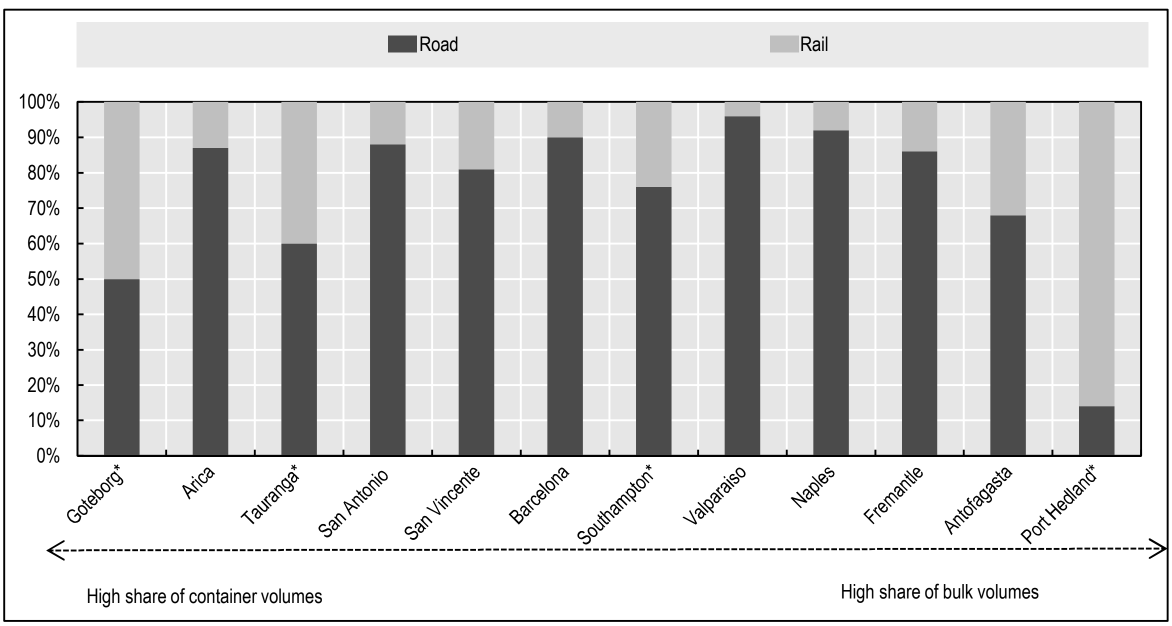
Source: data elaborated by the ITF/OECD based on data from Lloyds Intelligence Unit.

Infrastructure investment in areas that currently lie outside port authorities' jurisdiction is needed to promote the integration of port systems in multi-modal transportation networks and to improve market access and the fluidity of trade. Ports need efficient links between oceanic maritime port activities, inland terminals and the end-user markets they serve (Notteboom and Rodriguez, 2005). Poor hinterland access is often cited as an obstacle to efficient operations, raising the costs of international transport and thus trade competitiveness. Some Chilean ports have invested to create dry ports, freight corridors and port-information systems, such as the ZEAL logistics site 10 km from the Port of Valparaiso and the Portezuelo logistics platform in Antofagasta. However, there is no national policy on port hinterland connections, (OECD, forthcoming) and responsibilities for providing access to ports are fragmented.

In many OECD countries, investment in hinterland transport links has become the priority for the development of port systems. Ports such as Port Botany in Australia, Barcelona in Spain and Naples in Italy (see Box 4.9) have taken stakes in inland terminals and distribution centres, creating dry ports to facilitate hinterland transport and reduce congestion at port sites. While some of the investment comes directly from port operators, this is often accompanied by support from public authorities, either financially or through institutional facilitation of co-ordination, for the development of maritime-hinterland interfaces. With respect to hinterland transport, arrangements are similar across the three countries: typically, a private company develops and operates the inland terminal, and public funds complement it either by covering the capital costs of building new rail connections and adjusting existing lines, such as with new sidings, or by subsidising rail freight operations to improve their attractiveness.

Most of the transport of goods to and from ports is by road, with negative impacts on congestion and air pollution.[9] When Northern ports are excluded, the modal share of rail at Chilean ports is lower than at ports with similar characteristics in comparator countries (Figure 4.20). Some of the road traffic moving freight from Central Chilean ports to the North and South of the country could be shifted to other modes, notably short sea shipping. However, imports are concentrated in San Antonio and Valparaiso, as demand is centred in the Santiago region. From these ports, current rail links can only cater for a small proportion of containers going to Santiago. Congestion and pollution are likely to be exacerbated by growing trade volumes and the persistence of restrictive cabotage rules.

Figure 4.20. Modal share of rail at ports, latest available year



Note: * indicates the presence of dedicated port-hinterland rail shuttle services.

Source: European Parliament (2015), data elaborated by the ITF/OECD based on data from port authorities, BITRE (2014b), Ministerio de Transporte y Telecomunicaciones (2011).

Box 4.7. Trends and challenges in maritime transport in Latin America

Port development in Latin America and the Caribbean (LAC) has been driven by significant and continued growth of container movements, which in turn drives the development of liner shipping networks. Shipping lines may select the ports at which they operate according to the density of trade flows to and from the port/region, and port selection can be based on several criteria, from physical characteristics and geographical location to port efficiency, strategic carrier considerations and hinterland access. From the carrier's perspective, the economies of scale, scope and density in shipping, port operations, and inland operations would favour a very limited number of load centres in a region. However, there is some evidence that, in recent years, secondary ports in Latin America are starting to engage in more integrated development strategies that also include the consideration of logistics platform development.

The introduction of larger vessels on the world's mainline routes can be expected to initiate a process whereby vessels cascade down to the secondary LAC routes and create requirements for new infrastructure not only in the region's main ports but also in the secondary ones. A recent study forecasts that 13 000-TEU ships will start to call regularly on the coasts of South America between 2016 and 2020, which will have direct implications on the liner shipping networks and port infrastructure in the region.

If some of the secondary ports are unable to handle larger ships due to having insufficient handling capacity to accommodate them, this would support the growth of regional second-tier hubs, which can then serve the smaller ports either by smaller feeders or even land transport (thus raising issues relating to the quality and capacity of hinterland infrastructure links). Additionally, the introduction of ever larger vessels on mainline routes may be attractive for shipping lines but will strain ports severely. Ports invest large sums in upgrading their facilities and compete to receive vessel calls, but handling such demand spikes is difficult. Large container drops can result in inefficient crane utilisation, as the numerous large cranes required to service large ships are not all required between calls. Furthermore, moving this high number of containers in and out of the port will require new services, such as trunk rail shuttles, to be introduced.

Source: Adapted from Wilmsmeier et al., 2013.

Rail infrastructure

Key message

A number of factors (both infrastructure and policy related) hold back the development of rail services in Chile and prevent rail from being a viable alternative to road for freight. As new port capacity is added in the Central macrozone, there is a clear opportunity for modern rail freight infrastructure to be built and integrated with a wider logistics system. Rail infrastructure in the South could also be strengthened to support the competitiveness of industrial areas upon which the local economy depends. There is also an opportunity for the growth of passenger rail in specific suburban corridors, but this may require separate infrastructure for passenger and freight services to ensure that passenger train priority does not impair the development of freight services. Clearer policies and dedicated investment will be needed to turn around rail performance, currently below that of OECD comparator systems.

Sector overview

The share of goods and people carried by the rail network in Chile is relatively small. As a percentage of total inland transport, less than 10% of goods are carried by rail, and around 1% of passenger journeys are by train. In contrast, at the peak of their popularity in the 1950s, Chilean railways carried around one-third of the freight and passenger transport in the markets in which they operated (Soto, 2010). The success of railways then depended as much on the absence of suitable alternatives by road as the performance of rail transport. The average modal share of rail freight in comparator OECD countries was 25%[10] in 2013 (Table 4.6).

Table 4.6. Land transport – modal share of rail, 2013

	Freight rail modal share	Passenger rail modal share
Western Australia	63%	<1%
Chile North	17%	<1%
New Zealand	23%	<1%
Sweden	35%	9%
Chile Centre-South	6%	<1%

Source: data elaborated by the ITF/OECD based on data from Western Australia rail operators' reports and data from Grupo EFE, Ministerio de Transporte y Telecomunicaciones (2015), OECD (2016d), OECD (2016e).

The growth of some economic sectors such as forestry and especially mining is dependent on rail transport, and as a result, the private sector has invested in rail freight infrastructure. In Northern Chile, specialised private operators carry copper and other minerals from mines to ports over a network that is around 1 100 km long. These operators are often integrated with ports and/or mines, such as FERRONOR. In Central and Southern Chile, private operator FEPASA (owned by the Port of Ventanas) carries mainly cellulose and timber from inland forests to ports. Another private company (TRANSAP) is specialised in sulphuric acid transport to the port of San Antonio. FEPASA and TRANSAP use EFE's[11] network under a Railway Access Contract.

Passenger services by rail used to provide an alternative to roads. While many intercity passenger services have been cut back, new suburban services have been launched and are expanding. The national rail operator owns and manages the rail network in the Centre and South of Chile, which extends for over 2 100 km of tracks. It operates a limited number of long-distance intercity trains. Rail networks extend only as far as Puerto Montt in the South. Suburban services are provided by EFE's subsidiaries, mainly around the conurbations of Valparaiso and Concepción. In Valparaiso, this resulted in the rail line serving the port being converted to an urban metro, no longer suited to carrying containers[12]. In Santiago, sections of the rail network suitable for a rail freight alignment towards San Antonio are also used for passenger services. Suburban and long-distance operations are not integrated.

Clearer, better integrated policy objectives for railway development will be required if any of the nominal targets for expansion of rail services are to be met. Plans for rail infrastructure enhancement are fragmented. As emerged in discussions with stakeholders, EFE is currently unable to fund major investment and maintenance projects. Some of the government's plans to revitalise the network appear to be contradictory. For instance, the long-term plan (*PICAF*) presented by the MTT in 2013 lays out a vision for rail freight growth (reaching a 30% modal share), in contrast to the passenger-focused investment projects launched by EFE (with the goal of trebling passenger numbers by 2030) (MTT, 2013; EFE, 2015). Since freight and passenger share the same rail infrastructure in busy parts of the Central macrozone, achieving growth in both sectors will be impossible without major investment and some dedicated freight lines. In parallel, rail regulation needs reform. An update of rules on technical norms, safety and the environment is needed. Specific responsibilities for implementing today's general policy objectives need to be assigned.[13] The Ministry of Transport, or possibly a dedicated agency, should be charged with developing a detailed strategy. Underfunding and the lack of an integrated long-term strategy are some of the root causes of the gaps discussed in the following section.

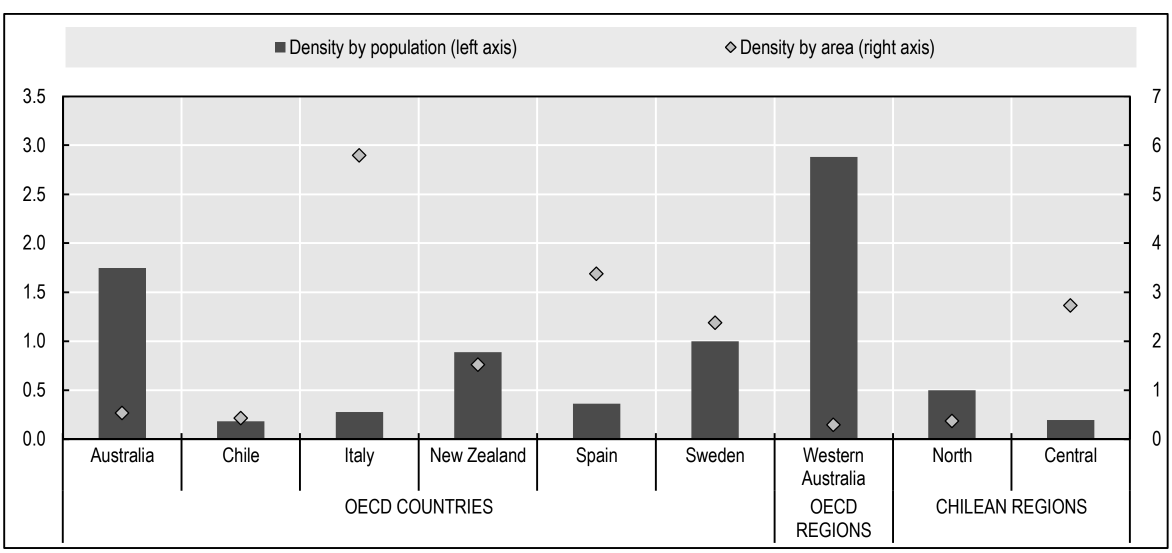
Identified gaps

The role of rail passenger transport in Chile is clearly very marginal, but the gaps with OECD comparator countries differ by types of service. Two types of passenger services can be compared in more detail:

- Intercity services: compared to more densely populated European countries such as Italy and Spain that have built dedicated infrastructure to develop fast intercity links as an alternative to motorways, Chile has a large gap.
- Suburban services: conversely, countries with vast land areas and a complex geography, such as Australia and New Zealand, have prioritised investment in metropolitan rail services, and Chile's suburban rail infrastructure is comparable to that of those countries.

Given Chile's geography, an international comparison suggests that the development of higher-quality suburban railways may be a more suitable objective than reinstating intercity rail infrastructure. The majority of Chile's territory has similar geographic conditions and population densities to those seen in Australia and New Zealand. In both countries, fast intercity connections have been the object of detailed studies, but any decision to invest in this type of infrastructure has been put off following cost-benefit assessment. New investment in intercity rail passenger services should only be considered on the basis of robust cost-benefit analysis identifying large enough demand for such services, which compete with air and road alternatives. Decisions about investment in metropolitan rail services are more straightforward in the presence of large flows of commuters and other passengers from residential suburban areas to one or more centres of economic activity in the city.

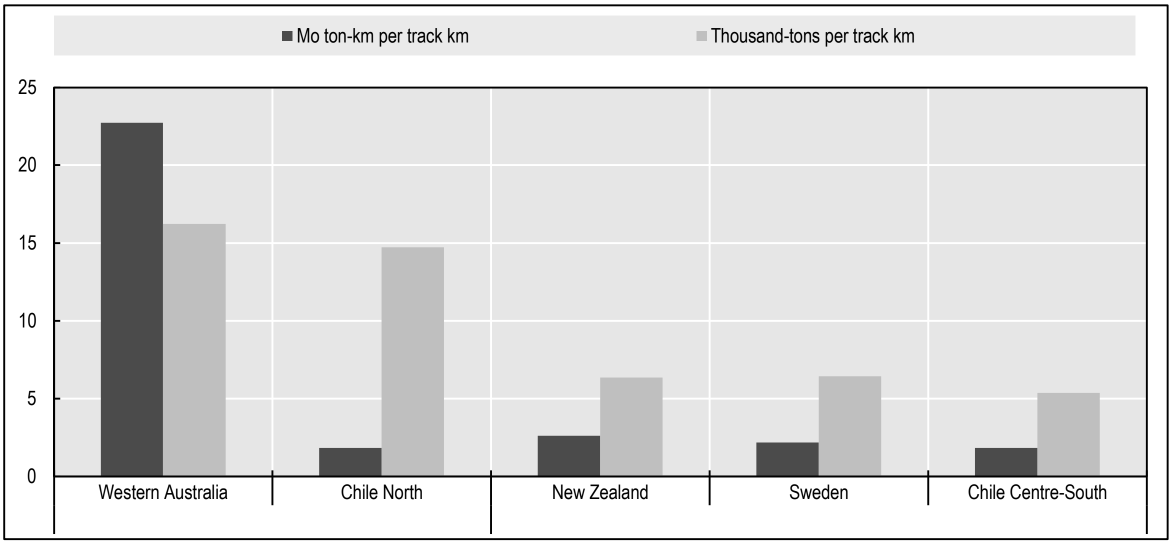
Figure 4.21. Density of rail network by area and population, latest available year



Source: Rail network: World Bank (2016f), BITRE (2015), Ministerio de Transporte y Telecomunicaciones (2015), data elaborated by the ITF/OECD based on data from Western Australia rail operators' reports. Population: World Bank (2016a), Australia Bureau of Statistics (2016a), Instituto Nacional de Estadísticas de Chile (2016a). Land area: World Bank (2016b), Australian Bureau of Statistics (2016b), Instituto Nacional de Estadísticas de Chile (2016b).

A more thorough analysis can be carried out in the case of rail freight transport, in which a gap in the provision and performance of infrastructure emerges. When the density of rail networks currently in use is analysed (Figure 4.21), Chile comes in at the bottom of the ranking. This is consistent with prior analysis showing that only around 15-20% of the original rail network in Chile is in use (Soto, 2010) and that operations are confined to self-contained networks over short distances.

Figure 4.22. Rail freight performance indicators, 2013



Source: Rail freight: data elaborated by the ITF/OECD based on data from Western Australia rail operators' reports and Grupo EFE, Ministerio de Transporte y Telecomunicaciones (2015), OECD (2016d). Rail network: World Bank (2016f), Ministerio de Transporte y Telecomunicaciones (2015), data elaborated by the ITF/OECD based on data from Western Australia rail operators' reports.

To ensure that the specificity of rail market segments (by product and geography) is taken into account and that only relevant comparisons are made, we benchmark the Central-Southern rail network carrying forestry and industrial products to that of Sweden and New Zealand, and we benchmark the Northern network serving mining ports to that of Western Australia (WA) (Figure 4.22).

Rail infrastructure in Northern Chile carries a similar number of tons per track-km as that in Western Australia, partly because the main product carried in Chile, copper, is denser than iron ore, the chief commodity carried in WA. However, given the much shorter distances of rail freight lines in Chile, tonne-km per track-km is 12 times as high in WA as in Northern Chile. The corresponding modal share of rail computed on this basis is thus lower in Northern Chile (17%) than in WA (63%). It should be emphasised that the performance of rail freight in the North falls outside of the public policy sphere of influence, given that networks are owned and operated by private companies.

EFE's network in Central-Southern Chile compared to Sweden and New Zealand. The network in use is far less dense in Chile than that in Sweden and New Zealand. The most apparent gap is in the provision of high-capacity, high-reliability rail infrastructure links to major public ports, resulting in a low proportion of freight transported by rail at the ports of San Antonio, Valparaiso and San Vicente. Existing rail infrastructure to these large container ports is often not ideal for the movement of containers themselves, given that the rail links share a number of unfavourable characteristics:

- Lines are predominantly single track.
- Low speeds are imposed (15-20 km/hour) given the lack of regular maintenance, compared to speeds of 50-60 km/hour in European rail corridors.
- Numerous bridges are not fit for carrying heavy trains, as exemplified by the collapse of the Pitrufquén viaduct in August 2016.
- Gauge restrictions do not currently allow double-stacking.
- Inland ports are lacking, limiting the growth of intermodal transport services.

The combined impact of inadequate infrastructure and an implicit policy of rail capacity allocation favouring passenger services over freight penalises rail freight in Central and Southern Chile. Network utilisation in Central and Southern Chile is between 15% and 25% lower than in Sweden and New Zealand, and this figure is even bigger when the total length of the Chilean network, and not just the proportion in use, is considered. The modal share of rail freight is below 6%, compared with 23% in New Zealand and 35% in Sweden, and it has been declining in recent years. Reversing this, as proposed in the government's aspirational target of a 30% modal share, will require a clear policy for either attracting private investment in dedicated freight operations or securing public investment in dedicated freight lines to key ports. The Bothnian Line (Box 4.8) is an example of such investment, as it aims to fill a clear gap in the availability of rail freight services for bulk exports from Northern Europe while introducing new passenger services. The approach adopted avoids mixing freight and passenger traffic while exploiting synergies in the construction and operation of this large rail corridor.

Box 4.8. The Bothnian Line in Northern Europe

The Bothnian Corridor extends along the Swedish and Finnish sides of the Gulf of Bothnia. The northern part of the corridor, which will extend between Umeå and Luleå, is recognised as a "missing link" in Sweden's strategic infrastructure. Original plans envisaged the construction of the North Bothnian Line as a key freight link, connecting to the existing Bothnian Line in the south for onward transport towards Europe, the Iron Ore Line in the west leading to Norway and the sea routes, and to the east via the Haparanda Line to the Finnish and Russian rail networks. Upon completion, the Bothnian Corridor would bring together several rail networks and facilitate potential east-west interchange of freight between the east coast of the United States and the Far East.

However, numerous studies during the 2000s showed that there would be considerable benefits for passengers travelling between Northern Swedish cities and towns as well. Currently, around 300 000 people live along the rail route, and all passenger movements take place by road. New rail services would significantly reduce journey times for different categories of users, including commuting trips for professionals, workers in key service sectors and students. For instance, travelling between Luleå and Umeå would be 20 minutes faster.

After years of delays linked to changes in political circumstances and budget availability, the presence of these large benefits for both freight and passenger services resulted in the project being reintroduced as a priority project by the Swedish government in 2014 and consequently marked as part of the part of the European Core Network, to be completed by 2030.

Construction of the 270-km North Bothnian Line is planned to commence in 2018 for a total estimated cost of around EUR 3 billion. The project will be co-funded by the European Union and some of the municipalities located along the line, which have pledged to contribute with direct funding as well as investment in related infrastructure such as railway stations. The Corridor is planned from the outset to accommodate both freight and passenger traffic on separate dedicated tracks, thus reducing potential conflicts.

Source: "The last link in the Bothnian Corridor" (2013), *European Railway Review*, Issue 5; written submission to the ITF/OECD by Trafikverket officials.

There may be an opportunity to develop a dedicated hinterland freight railway from the central ports to logistics centres in Santiago. The road congestion and air pollution issues identified in the sections on port and urban infrastructure could be relieved by investment in inland ports and logistics centres in the greater Santiago region served by rail links from the Central ports and the new mega-port. While rail service in Valparaiso has been compromised by the decision to cover over tracks, restrict loading gauge and run suburban passenger trains on the line through the port, in San Antonio, rail access to the terminal could be expanded substantially if land adjacent to the port is protected from encroachment by new urban development and rights of way are preserved. Given the potential for increased trade, private investors might be attracted to invest in a dedicated freight railway if national rail and port hinterland policy were developed to provide for such stand-alone investment. Alternatively, the government might invest in enhanced rail freight infrastructure. The scale of investment required might make private investment the preferred option. In either case, a clear separation of freight from passenger operations would be required. Positive examples of publicly and privately funded dedicated investment in port-rail connections are presented in Box 4.9, covering Australia, Spain and Italy.

Box 4.9. Hinterland ports

Investment in hinterland transport links has become the priority for the development of port systems in many OECD countries. Various ports have taken stakes in inland terminals and distribution centres, creating dry ports to facilitate hinterland transport. This is often accompanied by public authorities supporting, either financially or through institutional facilitation of co-ordination, the development of maritime-hinterland interfaces. Some of these developments are driven by policies to promote modal shift from road. Some examples are provided in this box.

Port Botany landside access, Australia

Port Botany is the largest container port in New South Wales (NSW), serving Sydney and the wider region. In 2014-15, the port handled approximately 2.28 million TEUs, including 0.14 million TEUs in trans-shipments. The port’s private sector operator projects that this volume will grow to between 7.5 million and 8.4 million TEUs by 2045. Approximately 85% of containers originate from or are bound for a destination within 40 km of Port Botany. The rail mode share of container movements to and from Port Botany declined from 25% in 2002 to 14% in 2012. The NSW Government has set a target of doubling the rail mode share by 2020.

To improve landside access to the port, several actions have been pursued over the past five to seven years, including development of the Southern Sydney Freight Line (SSFL) at a cost of approximately AUD 1 billion to provide a dedicated rail line that improved access for interstate and intrastate freight trains passing through the southern part of the Sydney rail network. The project also extended an existing dedicated rail freight connection to a new intermodal terminal in southwestern Sydney (Moorebank), about 35 km from the port.

There has also been progressive upgrades of the motorway network, notably the development of the WestConnex project, which will be carried out over three stages between 2015 and 2023 (at a nominal cost of AUD 16.8 billion). The project will be funded with a mixture of: distance-based tolls on all vehicles, including trucks; an availability charge from the NSW Government; and a grant of AUD 1.5 billion from the Australian Government.

Development of intermodal terminals, both at an existing rail marshalling yard 15 km inland and at a new terminal at Moorebank, will be carried out on a 241 ha former military site. The terminal will operate as an open access facility. The site adjoins the dedicated freight rail network and the motorway network. The terminal is to be developed by Qube Holdings, a private operator, which is investing approximately AUD 1.5 billion in the project. The Australian Government is contributing a further AUD 370 million (principally for a rail connection to the SSFL) and leasing the land for the terminal. The terminal is expected to commence operations by the end of 2017.

Source: Written submission to the ITF/OECD by Infrastructure Australia officials.

Box 4.9. Hinterland ports (*cont.*)

Port of Barcelona's tmZ inland terminal

The Terminal Marítima de Zaragoza (tmZ) is an initiative that was led by the Port of Barcelona and Mercazaragoza, the largest food logistics platform in the Ebro Valley. This project is part of the wider Port of Barcelona strategy to extend its activities and services beyond the boundaries of the port to facilitate hinterland connectivity and ensure high service quality as part of its strategic development plan. The tmZ is strategically located within the Mercazaragoza Logistics Area and at the crossroads of some of the country's main road corridors. Between Barcelona and Madrid, it lays within a 300-km range of some of Spain's most important industrial areas. This project enables the port to bring together port services with other maritime logistics services to the largest importers and exporters of the region. Combining tmZ's ability to transfer containers to all these destinations with Barcelona's deep-sea shipping connections offers logistics solutions that are efficient, economical and environmentally sustainable.

The first part of the facility was opened in 2001 as an inland logistics centre. A direct rail connection between the terminal and the Port of Barcelona was later completed in 2007. The Port of Barcelona is still contributing a large chunk of the infrastructure, such as the facilities for refrigerated goods. It will also continue to fund the 10 to 12 railway sidings of at least 750 meters in the railway corridor Barcelona-Zaragoza-Madrid, through the Fondo Financiero de Accesibilidad Terrestre Portuaria, an initiative led by the Ministry of Development that plans to dedicate over EUR 450 million to the development of port hinterland projects throughout the country between 2016 and 2019. The operation of the rail connection was granted to Depot tmZ Services S.L., owned by Spanish companies Terminal de Contenedores de Barcelona (TCB, 45%), tmZ (35%) and Hutchinson since 2015 through its subsidiary BEST, the company's new Barcelona semi-automated terminal and a competitor of TCB (20%).

The terminal has been a success, with considerable traffic increases since its creation. Between 2013 and 2015, traffic more than doubled, from 135 000 TEUs to over 305 000 TEUs, in part due to container traffic increases at the Port of Barcelona, which is now connected to tmZ by six trains per day. In total, 125 000 containers where moved by rail between the port and the terminal in 2014. Along with other factors such as the inclusion of the Opel Mokka assembly lines within the Zaragoza General Motors plant, this led tmZ's board to approve expansion projects in 2015 to double the terminal's capacity to be able to accommodate growing demand for the services it offers. Since the beginning of this project, the Port of Barcelona has decided to invest in other logistics platforms along strategic supply chains for the port, including across the border in France.

Source: ITF/OECD, 2016e.

Naples' hinterland port, Italy

The Port of Naples is one of the largest in Southern Italy, with a capacity of just over 500 000 TEUs. More than 430 000 TEUs, mainly container traffic for import goods, have been handled annually at the port (traffic has remained fairly constant since the early 2000s), which operates close to capacity. Only 8% of all goods are typically moved to and from the port by rail. In this context, plans for an "extended Port of Naples" were developed over the past few years, focusing on two twinned objectives: increasing the modal share of rail and decongesting the port by moving some key functions inland.

The plan has taken shape with the creation of a large hinterland logistics centre around the existing rail freight depot of Nola, about 30 km inland from Naples. Owned by a private company (Interporto Campano), Naples' hinterland port occupies an area of 3 million m^2, hosting a large intermodal terminal (7.5 ha) and parking areas that can accommodate up to 3 000 trucks. It sits at the intersection of the A30 and A16 motorways. However, road transport only makes up 20% of traffic at the site. The port is linked to the national rail freight network by a short stretch of 13 railway lines, of which six are electrified; in turn, this is linked to a major European Freight Corridor. Daily rail shuttles have been introduced to move containers arriving on different ships from the Port of Naples to the hinterland port as a single load, achieving the densities needed to make rail the preferred mode of transport. Inland ports further away, linked to Naples by rail, have similarly been developed, for example in Bologna. Such initiatives are particularly successful when customs and other inspection activities can be moved to the inland port, relieving overstretched or inefficient services in the ports.

The hinterland port can reduce capacity constraints at the Port of Naples and decrease road congestion in and around the city. The site will be strengthened through new rail services planned by national freight operators and the expansion of border control facilities. The hinterland facility, however, would not have been possible without the close co-operation between public actors and the private sector, with respect to co-ordinated planning across modes and to financing. For instance, state contributions amounted to around 30% of the start-up costs of new rail services.

Source: Interporto Campano website, ACAM (2015), European Commission C (2009) 4508.

Urban accessibility and environmental quality

Key message

Chile's ability to address its economic, social and environmental challenges largely depends on developing the right investment and planning policies at the urban level. A prerequisite is improved co-ordination, which involves planning and governance reforms as discussed in other chapters of this report. However, a shift in infrastructure investment priorities is also necessary to address inequality of access between and within urban areas. Public transport risks a decline in ridership with rapid growth in car ownership towards levels seen in other OECD countries. In parallel, congestion and pollution from transport activities are affecting the health of urban residents and the quality of life in cities. Investment in higher-quality public transport and urban spaces, together with more integrated land-use and transport planning to manage car use, will need to become a more prominent part of urban strategies.

Issues overview

Around 90% of Chile's population lives in urban areas. The metropolitan region of Santiago hosts more than 40% of the total population and jobs, and it accounts for over 45% of national GDP. From the 1990s onwards, urban expansion also took place in other regional centres, typically port cities such as Valparaiso, Concepcion and Antofagasta. The concentration of economic activities in urban areas has attracted internal migration from rural areas to regional centres, accelerating the pace of urban population growth (Ahman and Zanola, 2016).

The challenge of providing access to jobs and services for a growing urban population has predominantly been met by the growth of private motorised transport. Chilean cities increasingly face the challenge of providing access to jobs and services, including health and education, for a growing number of urban residents and daily commuters. The number of passenger cars per inhabitant in Chile doubled between 2004 and 2014, and urban congestion has increased. The response to growing car traffic has often been the construction or widening of road infrastructure, such as Santiago's East-West road links and the ring road in Valparaiso.

Considerable investment has also been directed at public transport systems, although mainly concentrated in the capital. In Santiago, the reorganisation of the Transantiago bus network is considered one of the largest public policy experiments ever conducted in Chile, and it has set a precedent for improving public transport provision.[14] In parallel, the capital's metro has continuously expanded since the 1970s. In other cities, while buses remain the most popular public transport mode, local stakeholders believe that the quality standards of these services are far lower than in Santiago as a result of insufficient funding. Plans are nonetheless in place to expand suburban rail systems in Valparaiso (new stations along the corridor that goes from Valparaiso to the East joining several small centres to the regional capital) and Concepcion (*Biotrén* extension to Coronel), providing better-quality access for residents of the cities' conurbations.

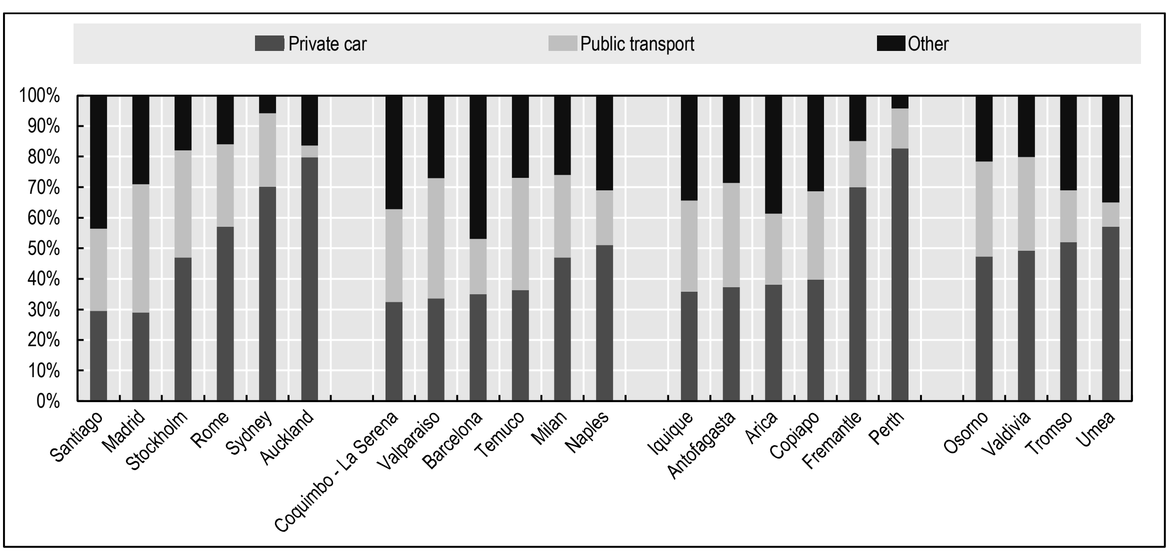
Chile's weak land use planning framework and fragmented urban governance (see Chapter 3) negatively affect the ability to improve urban accessibility. Given the lack of co-ordination between land-use and transport policies, housing and transport investment have often not been carefully managed. This has resulted in urban sprawl, fuelled by the growing cost of living in central areas, the unbalanced provision of transport and urban amenities between neighbourhoods in the same city (Salazar-Burrows and Cox, 2014), and failures to set aside land that could facilitate the future expansion of transport assets such as airports, ports and logistics centres. Improved accessibility therefore relies not only on more investment in urban infrastructure and public transport but also on better governance at the metropolitan level to tackle the root causes of inequality.

The presence of large ports and clusters of maritime activity is a further challenge for policy makers. According to a recent study (Zrari and Alvarez, 2015), 66% of actors in the port system (including port authorities, municipalities and regional *Intendentes*) believe that ports in Chile have not developed in a harmonious way with cities, and only 4% of respondents consider that the relationship between ports and cities has been "very harmonious". Conflicts arise when port-related traffic exacerbates congestion in cities at peak times, as exemplified in areas of San Antonio in relation to truck traffic and Antofagasta in relation to rail traffic on a system without grade separation. In a similar fashion, the growth of national and regional airports can raise co-ordination challenges with respect to surface access, land use and negative externalities such as noise.

Identified gaps

The growth in urban population and city-based economic activities will continue to exert considerable pressure on urban transport infrastructure in Chile. If the country follows a similar path to other OECD members, the number of private motor vehicles in the country could double or even treble by 2030. In addition, in cities hosting large ports, infrastructure will come under increased pressure given the projected growth in truck movements under a business-as-usual scenario. Likewise, the expected growth of the aviation sector will exacerbate urban traffic conditions in the proximity of airports and may raise conflicts over land use.

Figure 4.23. Modal share in cities, latest available year (2012-2014)



Note: Modal share calculations may differ on survey methodology adopted.

Source: SECTRA (2016), Ministero dell'Economia e delle Finanze (2016), data elaborated by the ITF/OECD based on data from national travel surveys.

The costs associated with growing road congestion are wide ranging, and they can hold back economic growth and increase inequality. Evidence from the United States, United Kingdom and France shows that the rise of negative externalities such as urban congestion translates into lower potential and actual economic growth, for instance by discouraging investment in cities, lowering productivity and inflating the costs of goods and services (INRIX, 2014). In addition, greater congestion can lead to poorer accessibility to jobs and services for the "captive users" of public transport, particularly the poorer section of urban populations, as exemplified by the case of Santiago described in the following section. In the capital, the car ownership gap is stark: there are 0.38 cars per person in households earning less than USD 1 000 per month and 1.27 cars per person in households with incomes above USD 2 000 (Hurtubia et al, 2016) (rates elaborated based on SECTRA, 2015).

Box 4.10. Urban congestion in New Zealand

Road carries the majority of traffic in New Zealand, especially in and around cities. There is heavy reliance on private motorised vehicles for urban transport. Public transport accounts for only 2.8% of all trips. Private vehicles account for almost 80%.

There are several factors that appear to encourage private vehicle use in New Zealand cities. These include:

- Spread-out, low-density urban areas (hindering cost effectiveness of public transport)
- historical low levels of public investment in infrastructure, including public transport
- administrative boundaries not matching the real boundaries of built-up areas (hindering planning co-ordination).

Together with economic and population growth, along with New Zealand's geography, the factors encouraging private vehicle use have resulted in substantial congestion in New Zealand's main cities. In fact, congestion in New Zealand's main cities is higher than comparable, though larger, cities in Australia (Tom Tom Index 2016).

Auckland especially suffers from high levels of congestion. Just over 90% of Aucklanders commute to work by car, and the number of kilometres travelled by car has increased by 30% since 2000. In addition, the policy drive for greater asset utilisation has created larger traffic volumes at the port of Auckland. However, the port is adjacent to the city's central business district. Thus, land near the port is limited, and an increased number of truck movements has been exacerbating congestion in the area in recent years.

Therefore, the New Zealand government has sought to address congestion and other issues in Auckland through a range of interventions including:

- increased investment in transport infrastructure, including public transport infrastructure – motorways, busways and electrified urban rail have been introduced or expanded in recent years
- reforming governance and planning systems, such as merging the eight previous bodies governing the Auckland metropolitan area into a single body, the new Auckland Council, since 2010, and creating a new agency for urban mobility – Auckland Transport
- requiring the Auckland Council to develop the Auckland Plan, which, among other things, sets out strategies for building infrastructure to improve Auckland's congestion over the next 30 years.

While there are signs of improvement, the Auckland Plan acknowledges that forecast population growth means that congestion will worsen over the next 30 years, even with very substantial investments in transport infrastructure.

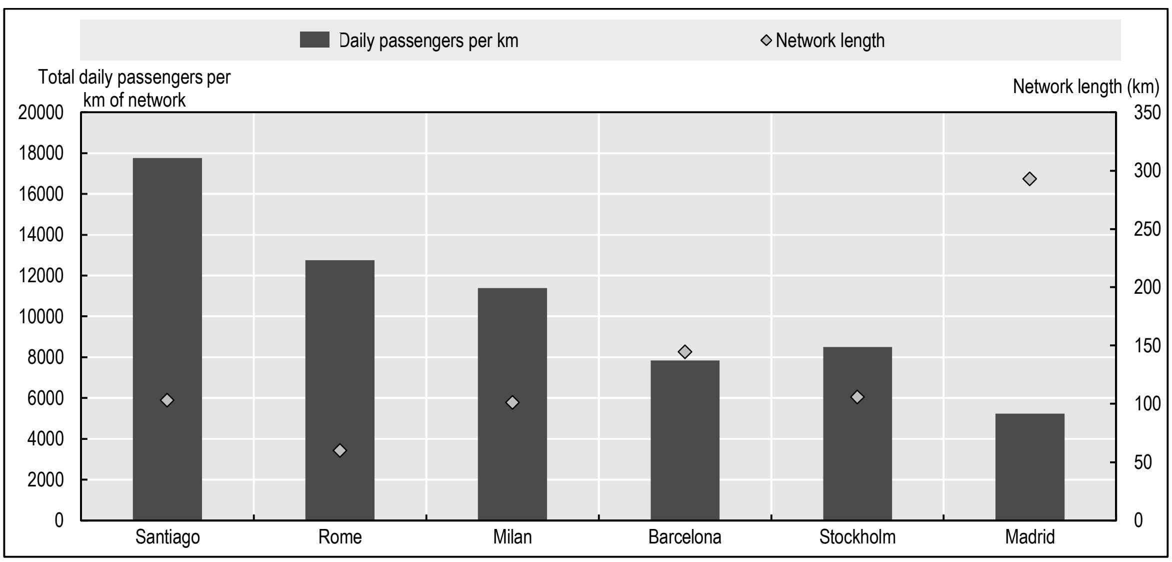
Source: Tom Tom Index 2016, Auckland Plan 2012.

Recent work in the area of accessibility and inequality sheds light on the extent to which Santiago's public transport system meets the need for access to opportunities and basic services (Ibid). In the capital, the north-eastern area hosts the richest section of the population, and this area has grown much faster than the rest of the city in recent decades, attracting productive activities, commerce and services that were historically concentrated in the central business district (CBD). In parallel, poorer households have been offered social housing in the periphery of Santiago and have moved away from informal settlements closer to the centre.

These trends have resulted in longer journeys by public transport for poorer residents to access jobs and services, not just those located in the north-east of the city but also in the historical CBD. Higher infrastructure spending per capita in richer districts increases the accessibility gap across the city, negatively affecting lower-income areas and thus increasing the inequality of travel conditions.[15] For example, whereas pavements and metro entrances are constructed to high quality in the wealthier neighbourhoods, pavements are frequently absent in poorer districts, making access to bus stops difficult and sometimes dangerous.

A related issue affecting the attractiveness of public transport is over-crowding. Using the example of Santiago again, comparisons of overall utilisation between the capital's metro and similar metro systems in other OECD cities show that utilisation is far higher on average in Santiago. Further analysis has confirmed that the most negative attribute of the city's metro system is that it is too crowded at peak times, with over-crowding acting as a deterrent for people to choose public transport over cars. An increase in public transport convenience often reduces the generalised cost of travel and thus provides benefits to passengers that is equivalent to an increase in speed (ITF/OECD, 2014).

Figure 4.24. Passenger utilisation of selected metro networks, 2014



Source: data elaborated by the ITF/OECD based on data from cities' annual reports.

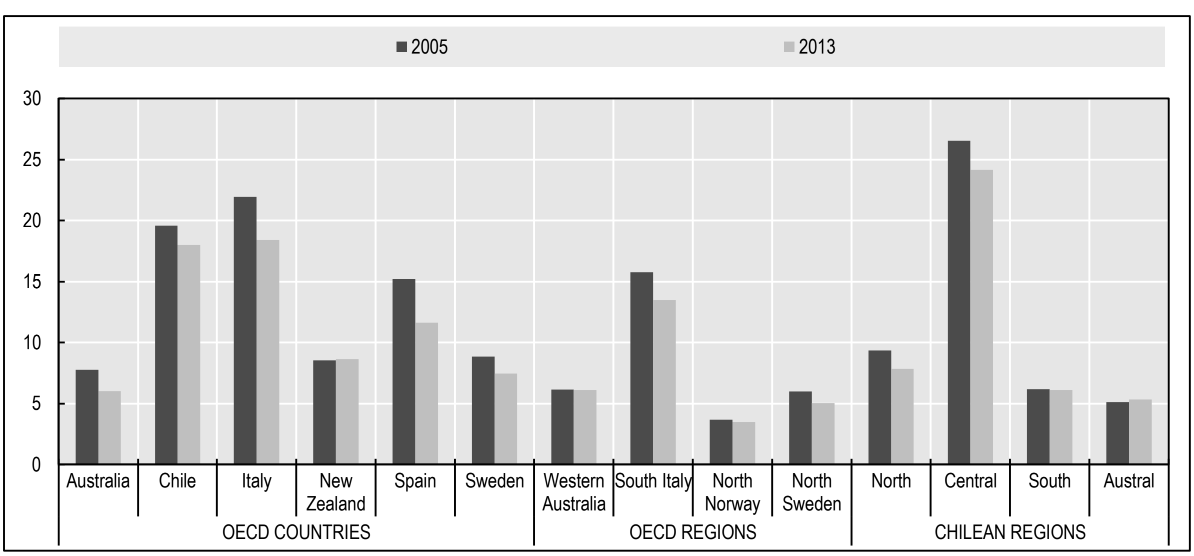
Another dimension of accessibility relates to the ability of people who are mobility impaired[16] to travel using public transport. While legal instruments to guarantee universal accessibility are in place (*Ley no. 20.422*), Chilean cities have been slow in the implementation of measures such as lifts, bus ramps, pedestrian walkways, visual and audio information, and other elements that enhance the accessibility of urban public transport systems. Investment in accessible transport, when co-ordinated with better access to public spaces, homes and offices, has a direct impact on equality of opportunities for mobility-impaired passengers and yields benefits to all passengers in terms of comfort, reliability, quality and information provision.

Mainly as a result of road traffic, urban residents in Chile are exposed to air pollution levels well above OECD comparator countries. In line with the UN Sustainable Development Goals, we compare air pollution levels as measured by the population-weighted annual mean levels of small particulate matters (PM2.5) in cities (Figure 4.25) and by prolonged exposure to photochemical smog (NO_x and NO_2). The World Health Organisation (WHO) estimates the health impact, in terms of mortality and morbidity, attributable to these emissions. The latest estimates for Chile show that 2 822 deaths were attributable to ambient air pollution in 2012. This translates into 13 deaths per 100 000 inhabitants (age adjusted), on par with Italy but above Spain (7), New Zealand, Sweden and Australia (all three countries have rates between 0.2 and 0.3) (WHO, 2016). Our analysis shows that the Central macrozone has the highest levels of air pollution from PM2.5 given the high concentration of population and activities in large metropolitan areas and that Chilean cities are second only to Italian cities with respect to photochemical smog.

Transport-related greenhouse gas emissions per capita are on an upward trend, as shown in Figure 4.27. Transport is the second largest contributor to CO_2 emissions in Chile, accounting for 30% of emissions from fuel use. Over 90% of those transport emissions are from road transport. Although the average fuel efficiency of Chile's vehicle fleet is improving, this is not enough to offset the increasing demand for road-based travel. Under a business-as-usual scenario, the climate change mitigation action plans (MAPS) for Chile project an increase in transport-related greenhouse gas emissions by 61% to 95% by 2030, depending on GDP growth (OECD/ECLAC, 2016).

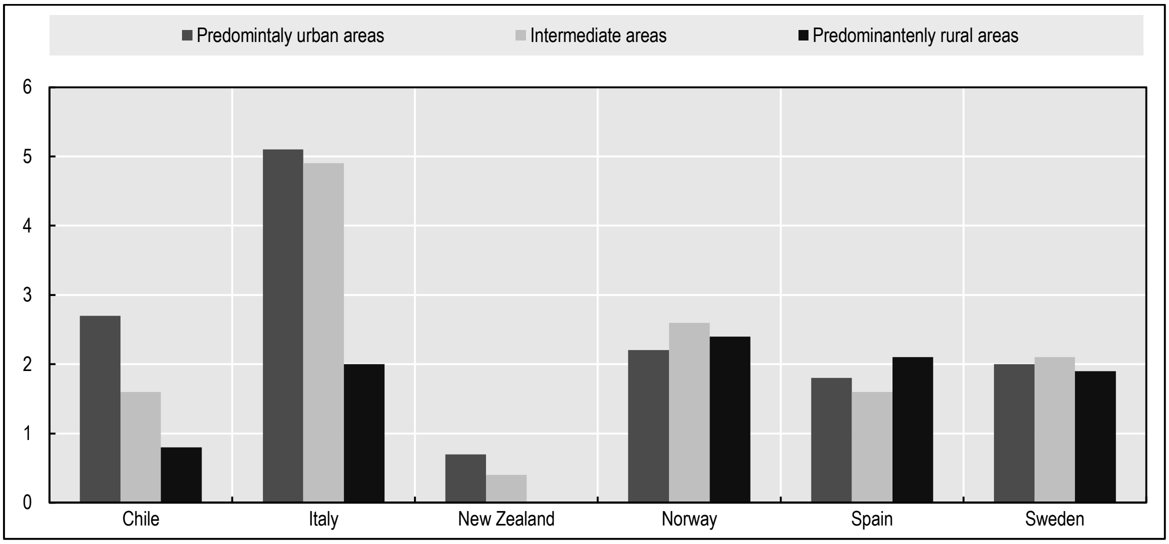
Modal shift targets in cities need to be set, and strategies should be implemented to reduce reliance on car movements. Policies to restrict the use of cars, including through pricing mechanisms and the introduction of stringent environmental standards, as well as investment to improve infrastructure for cycling and walking and to attract people to public transport through higher-quality services and reserved road space for buses and BRT systems, are essential elements of the policy mix needed to reduce car movements and contain emissions.

Figure 4.25. Mean population exposure to PM2.5 (micrograms per cubic metre), 2005 and 2013



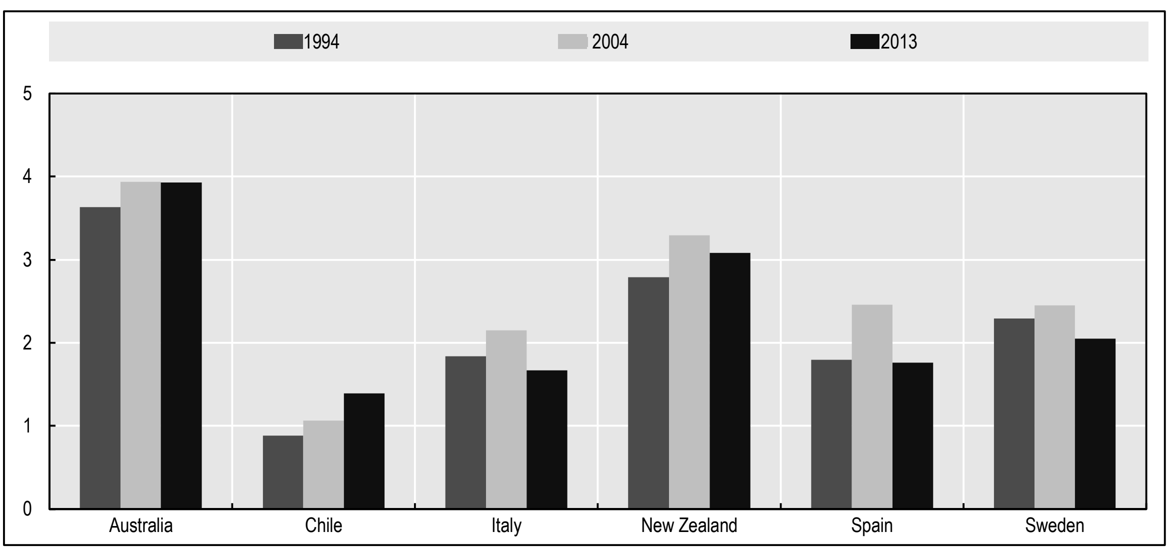
Source: OECD (2016f).

Figure 4.26. NO_2 Emissions (10^n molecules/cm^2) in urban, intermediate and rural areas, 2012



Source: OECD (2016g).

Figure 4.27. Transport-related greenhouse gas emissions (CO_2 equivalent tonnes) per inhabitant, 1994, 2004 and 2013



Source: CO2 emissions: IEA (2016). Population: World Bank (2016a).

Airport infrastructure

Key message

Air transport infrastructure in Chile plays an increasingly important function in connecting the country to the rest of the world, different parts of the country to each other and remote areas without land-based connections to regional capitals. The continued development of air connectivity relies on a stable regulatory framework that is conducive to attracting bidders at airports under concessions to further develop airport infrastructure and to attracting air carriers to strengthen connectivity and promote competition and new routes.

The priorities for this sector should encompass a range of strategic elements in Chile's airport system. These include greater integration of urban planning and airport development in large cities to accommodate growth and reduce negative externalities, ensuring that public funds currently cross-subsiding non-commercially viable airports are spent efficiently, and providing adequate surface access alternatives by public transport to reduce congestion. In light of continued growth, detailed analysis at the airport system level should continue to be carried out to ensure that investment and regulation are tailored to the changing strategic needs and to the role that aviation will play in ensuring national and international connectivity.

Sector overview

Most cities and towns in Chile are served by airports and airfields, with Santiago's airport acting as a national hub. The airports sector comprises 15 primary airports, operating under concessions, seven of which serve international destinations; a secondary network of airports and airfields linking regional capitals to international hubs and local airfields; and other local, very small airports linking remote areas and operating under "public service obligations" established by the State.

Airport services are provided by a public body, the General Civil Aviation Authority (DGAC), while the Ministry of Public Works is responsible for tendering and monitoring airport terminal concessions awarded to private bidders. Other ministries are also included in this process, and the Ministry of Finance ultimately approves all concession contracts. Airport BOT contracts were promoted from the mid-1990s onwards, with the goal of attracting private investment (ICAO, 2013). An innovative aspect of private concessions in Chile is the bundling of profitable and unprofitable airports into a single concession, as is the case for the airports of Punta Arenas and Balmaceda.

Companies operating across the country rely on air connectivity for short journeys between cities, particularly for business trips between Santiago and regional centres. Flying between these cities and Santiago is always a faster alternative than driving, except when travelling within Central Chile.

Air connectivity is also particularly important for those remote regions without any land-based transport links to the rest of the country. Smaller airports, even if not financially viable, can provide an essential service to their community and support the existence of local economic activities.

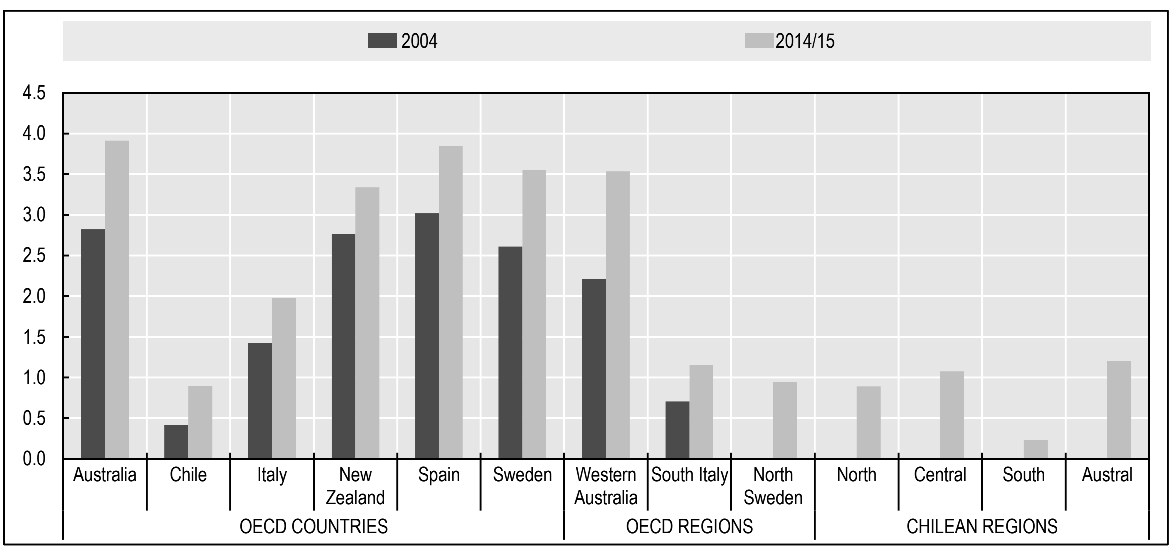
As Chileans are flying increasingly for work and leisure, expansion plans are in place at airports to cater for continuous growth in the number of passengers. More than 15 million passengers travelled to and from the country's airports in 2014, an increase of 170% over 2000. Around 70% of passenger movements are handled at Santiago's Arturo Merino Benitez airport. When the airport's concession was re-let in 2013, covering the period 2015-2030, the agreement included a plan to expand terminal capacity given the projected doubling of passengers by 2030. Similarly, terminal expansion is planned for other airports, from Iquique to Los Lagos.

Several factors have contributed to passenger growth and the development of national and international connectivity. Some of these factors include rising incomes and a growing number of destinations offered by airlines at more competitive prices as a result of open-skies agreements, with new entries to the market, including from low-cost carriers and the building of global alliances by national airlines. Improvements in airport infrastructure can also attract air carriers to develop new routes, as shown by the introduction of two direct flights from Santiago to Puerto Natales following the expansion of terminal capacity in the small airport of the Austral macrozone.

Identified gaps

National forecasts predict continued growth in air passenger numbers (CChC, 2016), and our benchmarking analysis confirms that this is a likely trend (Figure 4.28). The propensity to fly in Chile was just under one flight per person per year in 2014/15, vis-à-vis an average of 3.3 for OECD comparators. When incomes in OECD comparators were around the USD 30 000 mark in 2004, propensity to fly was already 2.5 on average, and this continued to grow over the following decade. Regional differences are wide, however: while Northern and Central Chile have a score in line with the national average, the propensity to fly is much higher in the Austral macrozone (similar to levels seen in Southern Italy). Levels are well below average in the Southern macrozone. These differences reflect underlying differences in average incomes, as well as the high dependency on air transport and the growing tourism market in the more remote Austral regions.

Figure 4.28. Propensity to fly, 2004 and 2014/15



Note: propensity to fly is the ratio of the number of national and international passengers in the country/region to the population.

Source: Number of passenger: BITRE (2016b), Junta de Aeronáutica Civil (2016), ISTAT (2016e), World Bank (2016g), AENA (2016), Statistics Sweden (2016e) Population: World Bank (2016a), Australia Bureau of Statistics (2016a), ISTAT (2016a), Statistics Sweden (2016a), Instituto Nacional de Estadísticas de Chile (2016a).

The development of air connectivity relies on a stable regulatory framework that is conducive to attracting bidders at airports under concessions to further develop airport infrastructure and to attracting air carriers to strengthen connectivity and promote competition and new routes. The following strategic elements need to be examined in more detail as the national airport system grows:

- **Integrating land-use development and transport planning with airport site planning in large cities.** Land-use conflicts are common when airport sites are located in close proximity to large urban areas. Integrated development plans can ensure that potential conflicts are contained and that land uses are clearly assigned to accommodate both airport and urban growth. Integrated planning should also address issues such as noise and air pollution that are typically associated with air traffic growth. Major airports are large generators of road traffic. Transport to and from Santiago International Airport is entirely by private cars. Public transport options, beginning with bus services, will be required to cope with demand in the future.
- **Providing public funds to support non-commercially viable airports**. At present, cross-subsidies are allocated from profitable to unprofitable airports, a policy that differs from most OECD countries (see Box 4.11). Using revenues from profitable activities to expand networks with investments that show a positive socio-economic return but are not viable on purely commercial terms is a system successfully applied to France's passenger railway, but it always bears the risk of overextending the system and building unsustainable infrastructure.

Box 4.11. Cross-subsidies for smaller airports in Chile

Airports are characterised by having high fixed capital costs, relatively low marginal operating costs and capacity that is expanded in steps rather than incrementally. Airports also face numerous costs derived from maintaining a safe and compliant facility, even when there is no direct return on investment from meeting regulatory requirements. For airports to achieve economies of scale and declining cost curves, they need a critical mass of traffic. This poses significant financial challenges for small regional airports.

ACI (2014) shows that profit margins for airports with less than 1 million passengers per year (MPA) fell by 11.9% in 2013, compared to industry average growth of 15.9%. The most profitable airports were those in the 15-25 MPA range and those with over 40MPA. Adler et al. (2013), in a sample 85 regional airports worldwide, modelled a financial break-even point for airports at 463 569 passengers per year. This was more than double the 200 832-passenger threshold in 2002.

Regional airports, even if not financially viable, can provide an essential service to their community and support the existence of local economic activities. In Chile, they provide these communities with connectivity to Santiago and from there the rest of the world. However, regional airports require long-term financial support to absorb financial losses and remain operational. Support in Chile is at present provided in the form of cross-subsidies from more profitable airports such as Santiago's Arturo Merino Benitez.

Abeyrante (2009) presents a number of arguments for and against cross-subsidies. While there may be advantages for small airports to operate as part of a network to share some common costs, there is an inherent issue of fairness in having users of one airport pay for infrastructure in another airport that they do not use. The International Civil Aviation Organization discourages making passengers pay for infrastructure they do not use in its guidance on airport charges (ICAO, 2012). Cross-subsidisation also results in passengers on one carrier subsidising passengers on another. It can also foster inefficiencies, as the airport being subsidised has less incentive to achieve profitability by reducing its own costs. At the same time, cross-subsidies can result in lower air fares for travel from the smaller airports, stimulating demand and supporting a larger number of routes. Miller et al. (2016) found that this could create a feedback effect whereby the welfare gains from subsidies might outweigh the value of the subsidy.

In Norway, the state-owned company Avinor operates 46 airports under a cross-subsidisation model. A study by GAP (2012) found that the break-even point for its airports grew four-fold between 2002 and 2010 to reach 800 000. During that period, real operating costs doubled, and the value of cross-subsidies tripled. The study proposed a management or franchised contract model with competition to replace the system and drive efficiency. Studies in other countries with large networks and cross-subsidies (e.g. Spain and Portugal) found that operating efficiencies were much lower at airports that were being subsidised.

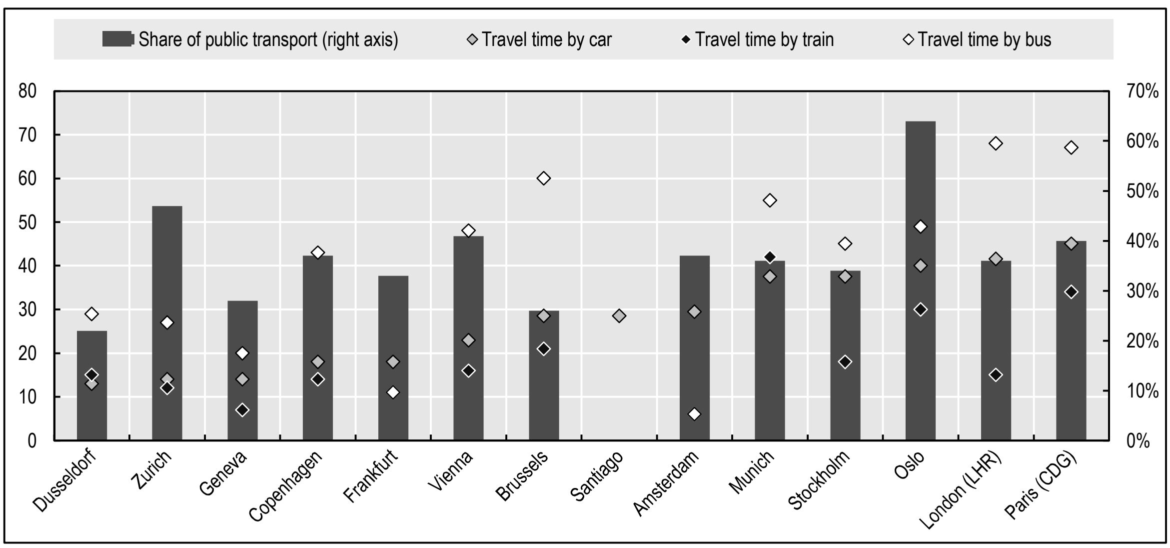
Box 4.11. Cross-subsidies for smaller airports in Chile (*cont.*)

Preserving regional connectivity for smaller, less financially viable airports may be achieved by way of direct subsidies by the state instead. For instance, the Australian Government announced a four-year fund for remote aerodrome updates in the 2015-16 budget. Complementary measures include the Remote Air Services Subsidy (RASS) scheme, which subsidises a regular weekly air transport service for the carriage of passengers and goods such as educational materials, medicines, fresh foods and other urgent supplies to communities in remote and isolated areas of Australia.

Compared to cross-subsidies from larger airports, direct subsidies are more transparent in accounting terms and enable the fiscal burden of providing what is essentially a public service to be spread across the entire taxpayer base. Direct subsidies can be combined with regulatory regimes that incentivise cost and revenue optimisation. For instance, governments can tender out the management of smaller airports and provide a subsidy cap.

Source: Abeyrante, 2009; Miller et al, 2016.

Figure 4.29. Surface access to airports, passenger modal share and travel time (minutes)



Note: travel times are calculated for a trip on Tuesday leaving from the city centre at 9AM.

Source: Share of public transport: ACRP (2008), data elaborated by ITF/OECD based on data from Google Maps.

One of the issues that could become more pressing as the economy grows is the lack of infrastructure for surface access to airports by public transport. Travel to and from airports in Chile takes place almost exclusively by car and taxi. Public investment in surface access plays a complementary role to airport development in many OECD countries (see Box 4.12), in which the share of passengers reaching airports in capitals by public transport ranges from 22% to 64% (Figure 4.29).

Alternatives to private vehicles can encompass dedicated bus routes to start with, maximising timetabling and fare integration opportunities with existing public transport systems. An additional benefit of comprehensive public transport access is that it maximises the catchment area of an airport, reducing time and cost for passengers in neighbouring areas to reach the airport site. Improving surface access by public transport should be a priority for Santiago and could be considered at some of the regional airports. At higher levels of demand, rail links may be considered if the flow of passengers to and from the airport is high enough to justify investment.

A number of countries that, like Chile, have not yet developed strategic plans to incorporate airports and surface access in their wider transport strategies are also aiming to rectify this. In New Zealand, surface access to Auckland International Airport has been a growing concern, given the increasing difficulty that passengers, staff and businesses experience in accessing the airport. Airport managers commissioned a surface access study in 2005, and the study confirmed the presence of severe travel-time delays to and from the airport as a result of bottlenecks on the regional road network. It also highlighted the weaknesses in public transport services. A number of planning and feasibility studies are under way to prepare for the construction of a dedicated public transport link, possibly by rail, to better serve the airport and reduce congestion.

Box 4.12. Airport surface access – the role of public transport

Large transport flows to and from main airports are generated by the movement of passengers, airport workers and freight traffic to and from airport sites. These flows can have negative impacts on road traffic congestion and air pollution. When airport operations expand in the absence of complementary surface access investment, these impacts can worsen and affect the reliability of travel times and hence depress demand at the airport itself.

Most OECD capital cities have developed strategic transport plans and land-use planning controls applicable to large property and infrastructure developments (including airports). These typically make the approval of construction projects conditional upon the provision of adequate surface access, including by public transport and rail. Additionally, limits may be set regarding acceptable levels of air quality. In some systems, infrastructure managers also directly contribute to the funding of access links.

As a result, airports in OECD capital cities are generally linked to urban areas by bus, metro and/or rail links. In Australia, Sydney's Kingsford Smith Airport was connected to the existing rail network by a tunnelled rail link in 2000, ahead of the Olympic Games. At London Heathrow Airport, the prominent role of public transport surface access can be seen in the planning, design and layout of Terminal 5, which opened in 2008. Before construction, the terminal's design directly incorporated a station and rail tunnels for extensions to existing rail services (Heathrow Express/Connect and the Piccadilly Line). The station also embeds two additional platforms to allow for the potential future (westward or southern) expansion of the rail network. Incheon Airport in Korea opened in 2010 and is served by 117 bus lines as well as a railway station that is integrated into the existing national and regional railroad network.

Even in smaller cities such as Bari, Southern Italy, airport rail links are being built. Bari Airport handles 4 million passengers per year, travelling to both national and international destinations. Over the summer months, it is one of the main points of entry for tourists arriving to the region. The rail link was built over 2009-2012 as a spur of the existing regional rail network. The airport rail link is 8 km long and fully electrified, and it adopts an automatic train control system. Trains can reach maximum speeds of 110 km/hour, but on average, they travel at 60 km/hour. The overall cost of the link was just over EUR 80 million, co-financed by the Region of Apulia and the European Commission. The new infrastructure connects the airport to the city of Bari in 15 minutes, as well as to other regional cities and towns.

Ultimately, fast and reliable access is one of the conditions for an airport's long-term success. A reduction in the share of journeys by car and taxi also contributes to reducing air pollution and congestion, with positive effects across the city as well as at the airport site.

Source: UK Airport Commission (2015), https://www.gov.uk/government/publications/airports-commission-final-report-surface-access; New South Wales Parliament (2014); Ferrovie.it (2013).

Summary of the analysis

The analysis of infrastructure gaps by transport sector reveals that gaps in the provision, quality and efficiency of transport infrastructure are present across the macrozones of Chile. Notable deficiencies and emerging themes from the analysis are described in this section and summarised in Table 4.7.

Last-mile connectivity gaps exist at the interface of different modes and limit the efficiency of transport networks as a whole:

- Suburban motorways are not always linked to urban roads, and bottlenecks are present along key access routes to large cities.
- There is a lack of high-quality links between ports and the national highway network in San Antonio and Concepcion, resulting in heavy vehicles using inadequate and inappropriate urban streets to access port terminals.
- The quality of rail freight connections to ports is poor, and the logistics network lacks inland ports and distribution centres connected to the ports by trunk rail or road links, especially in the Central and Southern macrozones.
- Access to all major airports is exclusively car based, and public transport options are not integrated with urban mobility systems.

Large differences exist in the quality of infrastructure and accessibility across the country and in cities:

- The capacity of port infrastructure is under pressure from increasing trade flows and the emergence of larger container ships, particularly in the Central macrozone, where the development of a new port will be necessary.
- Gaps in surface quality and safety standards of roads exist not just between Chile and OECD comparators but also between Chilean macrozones and within these zones, as seen by large differences in road paving rates and road crash rates.
- Even starker differences are evident across areas of large cities, such as in Santiago, where poorer neighbourhoods are not only located further away than richer ones from jobs and services but also suffer from lower-quality infrastructure, such as the lack of pavements and other infrastructure for pedestrians.

The potential for rail services to contribute to passenger mobility and logistics is not fulfilled:

- On the one hand, the rail network's ability to accommodate both passenger and freight services has been undermined by low investment and the lack of a national strategy for rail transport, in turn undermined by ineffective institutional governance of the sector.
- This leads to low utilisation of existing tracks, particularly in Central and Southern Chile, where the potential for rail to move freight to and from ports is high and there is extra pressure on road infrastructure.
- On the other hand, rail services are not considered an integral part of the transport network, apart from mining railways in the North. Unclear choices for investment and capacity allocation raise conflicts between passenger and freight services that are detrimental to the development of both services.

Across all sectors, data for policy making are not collected systematically:

- The lack of comprehensive data (e.g. on freight and passenger flows, origin-destination movements, quality of services and users' satisfaction) hinders the compilation of transport statistics and the development of performance indicators and related analysis.

The external costs of transport (safety, congestion and environmental impacts) are a growing challenge in urban areas:

- Chile's transport networks are generating high external costs, reflected in the number of deaths caused by road crashes, the exposure of urban residents to pollutants at levels higher than in OECD comparators and growing transport-related greenhouse gas emissions.
- Externalities derive from an over-reliance on road transport for both freight and passenger movements. Public transport and infrastructure for walking and cycling are often inadequate in major cities, and traffic demand management systems are not in place.
- The rise of negative externalities such as urban congestion translates into lower potential and actual economic growth, and it has a negative effect on quality of life.

The need for maintenance across all transport modes is growing:

- Experience from OECD countries shows that, following a period of large-scale road construction, a grace period of several years – during which roads remain in good condition even without maintenance – is followed by a period in which the need for maintenance surges.
- In many European countries, the need for maintenance has coincided with budgetary pressures due to financial crises. The result has been a fast deterioration of road surface quality over the past decade. Maintenance needs are already evident in Chile's rail infrastructure and will grow as road, port and airport assets age.
- In addition, extreme weather events linked to climate change and natural disasters will continue to be a challenge for the resilience of transport networks across the country.
- Greater priority should be assigned to maintenance in multi-annual infrastructure budgets.

Table 4.7. Chilean transport infrastructure scorecard – strengths and challenges

Sector	Strengths	Current challenges	Future challenges
All transport infrastructure	Some good-quality assets following high investment	Inequality in the provision of infrastructure	Accommodating economic growth while fostering competitiveness across economic sectors
		Gaps at the interface of different modes	Resilience to extreme weather and natural disasters
		Missing data for assessment and strategy	Changing socio-economic appraisal methodologies to reflect policy goals
Primary road network	Good asset condition	Unreliable cross-border connections	
	Good intercity connectivity (C, S)	Missing links to ports and cities	Missing links to growing ports and cities
		Lower quality standards (N, A)	Congestion and bottlenecks
	Good safety record		Worsening of safety
Secondary road network	Good asset condition (N)	Low share of paved roads (N, C, S)	Poor asset condition
		Poor asset condition (S, A)	Maintenance bulge
		Poor safety record	Worsening of safety

Table 4.7. Chilean transport infrastructure scorecard – strengths and challenges (*cont.*)

Sector	Strengths	Current challenges	Future challenges
Port infrastructure	Good asset condition (N, C)	Efficiency gap (S, A)	Capacity for larger vessels Maintenance bulge
	Good global connectivity	Low rail modal share (C, S)	Poor hinterland connections
Rail infrastructure		Poor asset condition	Network assets decline (C, S)
		Lack of interconnections	Lack of intermodal options for freight transport (C, S)
		Low utilisation rate	No passenger services
Urban accessibility and environmental quality	High modal share of public transport	Lack of integrated planning leading to inequality of access	Growing motorisation levels displacing public transport Road maintenance bulge
		High levels of transport-related emissions and air pollution	Growing emissions from higher traffic volumes Impacts of emissions and congestion
Airport infrastructure	Good asset condition at most airports	Lack of surface access by public transport	Sustainability of concession models and cross-subsidies

Note: Letters in brackets indicate macrozones where the strength/challenge is particularly relevant. N = North; C = Centre; S = South; A = Austral.

Policy recommendations

The challenges ahead

Productive investment in transport infrastructure is vital to keep Chile on the road to greater prosperity. As the country transitions to a high-income economy and the population continues to grow, it is likely that today's gaps and negative externalities will worsen. The potential impacts of not addressing Chile's infrastructure gaps through an integrated infrastructure strategy are three-fold:

- First, national economic growth would be constrained, as deteriorating infrastructure can negatively affect the competitiveness of export industries and inflate the prices of imported goods. Poor connectivity can also act as a drag on labour and capital productivity.
- Second, disparities in economic performance between regions and within metropolitan areas could widen. Investment in public transport and infrastructure for cyclists and pedestrians is a key policy for improving equity in cities. Targeted investment in standard-quality road infrastructure will be more sustainable in rural and remote areas than large-scale programmes to surface roads with low standards.
- Third, future resources that could be allocated to strategic infrastructure investment may need to be diverted towards actions to reduce the deterioration of inadequate infrastructure.

In the context of the new Plan Chile 30/30, the government needs to devise targeted and co-ordinated actions to address the identified gaps and raise the standards of transport infrastructure. ITF/OECD policy recommendations are presented through six strategic themes based on the quantitative and qualitative analysis presented in this chapter.

There are limits to what infrastructure investment alone can do without co-ordinated government policies across ministries, a consistent framework for pricing and regulation (including subsidy reforms), and integrated transport policy and land-use planning and development strategies. There are numerous examples from OECD countries as to how an effective planning system can be established.

For instance, Western Australia has a detailed hierarchy for developing long-term planning strategies across all sectors of its economy, including for the development of transport infrastructure. The Western Australian Planning Commission works in consultation with a range of government and non-government stakeholders to produce long-term planning strategies. The strategy is the highest-order planning instrument. While the document does not bind government agencies to specific actions, it is used to guide, shape and inform a hierarchy of State, regional and local planning tools, instruments and decisions within the Western Australian planning system. All other planning documents seek to be consistent with the planning strategy.

The recent *Red Logística de Gran Escala* joint initiative between the Ministry of Public Works and the Ministry of Transport and Telecommunications with the State Railway Company, which will focus on developing logistics centres and a rail link to the San Antonio port, is an excellent initiative in this respect. A new institutional approach to rail infrastructure can build on the experience accumulated in other transport sectors to attract private investment and develop sustainable long-term financial plans for the construction, maintenance and operations of new connections.

Strategic recommendations

1. The development of an integrated logistics strategy is a priority to support trade and growth

- To ensure well-functioning logistics, Chile should develop a national multi-modal strategy. The main goal of the strategy should be to identify, upgrade and interconnect the assets that contribute to trade competitiveness. The priorities already highlighted in this chapter include addressing last-mile connectivity issues and providing better intermodal links to ports.
- The national logistics strategy should aim to co-ordinate new infrastructure investment and land-use planning. Specifically, the *Puerto de Gran Escala (PGE)* provides a nationally significant opportunity to develop a logistics system to improve trade competitiveness in central Chile that includes ports, inland ports and dedicated freight corridors. Rail and highway rights of way should generally be preserved in the land-use development plans of the major port cities.
- The national logistics strategy should have medium-term and long-term goals that link to the Plan Chile 30/30 objectives. This will be an opportunity to assess different options for funding and financing of new infrastructure and long-term maintenance needs, as well as to develop new governance models to streamline decision making at the central level while devolving responsibility for implementation at the regional level – as detailed in Chapters 2 and 3.

OECD comparator countries have developed multi-modal and long-term strategies to strengthen logistics competitiveness, either as part of a national transport strategy or by joining up road, rail and port planning. Strategies range from a 12-year plan in Sweden to a 30-year strategy in New Zealand to a vision towards 2050 in Western Australia.

2. Infrastructure planning and investment should be better co-ordinated at the metropolitan level

- Chile's prosperity inevitably depends on the success of its cities, where most of the population and economic activities are concentrated. Metropolitan authorities need to be better equipped with transport infrastructure planning instruments and co-ordinate transport and land-use policies to ensure the effectiveness of comprehensive strategies to relieve congestion bottlenecks and improve the attractiveness of public transport and active modes.
- This requires reforms that strengthen planning powers at the right metropolitan level of authority, such as by overcoming district-based decision making on strategic issues. In parallel, further better co-ordination of investment across ports, airports and urban transport assets is needed to align investment in metropolitan areas.
- Two priorities at the urban level are the provision of more equitable access to jobs and services for all citizens and the reduction of negative externalities from transport systems. Both priorities can be addressed through targeted investment in higher-quality public transport and urban spaces, coupled with policies to manage car and truck traffic flows.

Issues such as congestion, pollution and inequality of access are a common feature across OECD metropolitan areas. Most urban authorities have been given a mix of planning and financial instruments to tackle these challenges through co-ordinated policies at the appropriate level of governance. Particularly in Europe, priorities have progressively shifted from simply providing more road capacity to investing in public transit.

3. A territorial approach is needed to promote targeted investment and reduce inequality

- More productive investment in transport infrastructure for logistics and metropolitan areas will not exempt policy makers from addressing the needs of rural and isolated populations in remote regions where the availability and quality of transport infrastructure shows significant gaps with the rest of the country.
- A territorial approach requires targeted investment to make the most of the public funds spent to address these gaps. This requires specific allowances to be made in national and regional budgets, or appraisal methodologies could be reformed to better address territorial inequalities.
- Specifically, road-paving solutions can be rolled out incrementally in more peripheral regions, taking into account connectivity needs, projected traffic growth (by vehicle type), life-cycle costs including future maintenance needs and safety implications. With this in mind, the share of paved roads can be increased over time where appropriate.
- In addition, many remote regions in Chile are not accessible by land transport and rely on connections by sea and air. The provision of public funds to support non-commercially viable airports should be carefully monitored to ensure that the system does not lead to building unsustainable infrastructure and that investment is funded in a transparent way.

OECD countries with remote and isolated areas have been developing targeted strategies to promote investment. Examples include direct subsidies for the local airports providing essential connectivity to the residents of North Sweden, changes to the national system of transport project appraisal that recognise the importance of "life line" infrastructure in Australia and co-funding of infrastructure projects by local Maori communities in New Zealand.

4. A life-cycle approach needs to promote the long-term resilience of the transport network

- Long-term investment strategies require the introduction of asset-management techniques by all authorities responsible for transport assets in Chile, learning from sectors that already do so. Investment in public roads is an example of how a systemic approach to asset management would help decision makers assess what level of paving is best for secondary roads.
- Better data can support the mapping of asset conditions and key service-level outcomes, which in turn will feed into an asset-management strategy for rural roads, rail infrastructure, etc. The strategy needs to be linked to long-term financial planning. The risk of not doing so is that, as assets age, maintenance funding will not be available when needed.
- Besides making allowances for what can be foreseen, Chile needs to develop studies to map and quantify the potentially disruptive impacts of natural disasters and climate change. Based on the findings of these studies, mitigation and adaptation strategies should be developed. In addition, the cumulative impact of deferred maintenance increases the transport network's vulnerability to local or systemic disruptions.

A challenge for virtually all OECD countries is applying a whole-of-life perspective to infrastructure investment, especially when asset conditions are subject to uncertainties such as earthquakes and extreme weather events. Some of the initiatives undertaken include measures to identify alternative lifeline infrastructure such as parallel roads or complementary ports in the case of a natural disaster in New Zealand, as well as linking maintenance needs to long-term budgets in Australia.

5. The external impacts of transport activity need to be minimised

- Reducing transport-related emissions, which are already above OECD average despite relatively lower levels of motorisation, should be a made a policy priority across sectors. Measures to reduce emissions include modal shift and technological efficiency. Actions targeted at shifting transport activity from road to other modes include the following:
- promote rail transport to meet freight and passenger demand by providing reliable infrastructure and dedicated links that support commercial speeds and accommodate higher loads and by reducing conflicts in the allocation of capacity between freight and passenger traffic.
- develop costal shipping, including by liberalising cabotage, as an alternative to land-based transport, especially for imports that arrive at deep-sea ports in Central Chile but carry goods going to other regions.

- contain the growth of private motorised vehicles in urban areas in favour of public transport options and active modes, including by adding surface access alternatives at airports.
- These measures can be effective at reducing emissions while tackling congestion and bottlenecks, mainly on the road network and around key economic hubs such as ports.
- In parallel, the development of Chile's National Road Safety Strategy will need to ensure that legislation, education and infrastructure investment efforts towards greater road safety are joined up and adhere to international best practices.

Efforts to tackle externalities from transport activity have been wide ranging in OECD comparator countries. These include initiatives to raise the attractiveness of rail transport for shippers sending cargo to and from major ports in Spain, Italy and Australia, as well as policies to promote integrated public transport solutions for commuters and for travellers to and from airports. Long-term road safety strategies that include specific targets are also very common in OECD countries.

6. Policy makers will need better data to make better decisions

- Data availability, particularly in relation to transport demand and performance measures, has been a limitation of this review and affects policy making in Chile more generally. Standardised data-collection methodologies should be deployed across transport sectors, and a key goal should be bridging the knowledge gap between private and public actors, as well as between different government agencies.
- To this end, ITF/OECD (2016c) have suggested that a Logistics Observatory for Chile should be set up, and this would contribute to fill the knowledge gap in freight transport and related sectors. This recommendation can be strengthened and broadened to support the creation of a transport infrastructure observatory in the near future.
- Data-collection efforts should focus on several Key Performance Indicators (KPIs), in line with most OECD countries. Table 4.8 provides some examples of KPIs by sector, beyond those presented in the rest of the chapter. These KPIs could be developed further in each macrozone.

Table 4.8. Key Performance Indicators by mode

Sector	Sample indicator	Market	Indicators units
All transport modes	Traffic	Freight/Passenger	Traffic volumes (by user and vehicle types where appropriate); distances travelled
	Modal share	Freight/Passenger	Evolution over time of traffic share of each passenger and freight mode
	Life-cycle costs	Freight/Passenger	Life-cycle costs of maintenance regime
	Customer satisfaction	Freight/Passenger	Regular surveys of users for each mode (passenger) and logistics sector (freight)
	Time to market	Freight	Average export and import lead times in days
	Accessibility indices	Passenger	Contour indices or location-based indices that express access to jobs and services in terms of time/cost

Table 4.8. Key Performance Indicators by mode

Sector	Sample indicator	Market	Indicators units
Road	Congestion	Passenger	Lane occupancy rate, travel speed, idle time spent in traffic for an average journey, variability over expected travel time
	Reliability	Freight	Travel speed; average delays of shipments, such as average lost time per truck-km
	Asset condition	Freight/Passenger	Surface roughness, rutting and cracking; skid resistance; bridge load capacity; height and width clearance
Port	Productivity	Containers	Truck and vessel turnaround time, TEUs per berth area and/or port area
	Productivity	Bulk	Vessel turnaround time, tonnes per hour and/or berth occupancy rate
Rail	Crowding	Passenger	Number of passengers in excess of capacity at peak time
	Punctuality	Passenger	Share of late services compared to schedule, such as >10-minute delay for journeys >1 hour
	Reliability	Freight	Average speed, average delays of shipments

Box 4.13. Reforming regional road project appraisal and funding in Australia

In 2013-14, Australia spent approximately AUD 19 billion maintaining, expanding and operating its extensive road network. Despite constant growth in expenditure in recent years, parts of the road network are poorly maintained, particularly in remote and regional areas. In the same areas, accessibility is a concern, as some roads experience closures on a routine basis mainly due to flooding. Future road expenditure liabilities are large, and inaction will lead to further deterioration of road performance.

The current economic evaluation system is based on conventional traditional cost-benefit analysis (CBA) techniques. Prioritisation of investment is based on two main types of benefits, namely time savings and operating cost reductions. However, the system used to prioritise road project funding in Australia is not well suited to ensure that future funding streams are allocated to roads in remote and regional areas.

The rationale for investment in these roads is not based on reducing travel times and vehicle operating costs. Based on these criteria, remote road projects have very low net present values. Given lower traffic volumes, road projects in remote areas generate lower benefits than in densely populated urban areas. In addition, construction costs are higher for roads of equivalent standards due to the higher cost of inputs, access to contractors and the impact of extreme weather events.

Instead, road projects in remote and regional areas yield other types of benefits, such as direct cost savings thanks to road improvements (such as reduced storage costs for food and fuel, avoided costs of delivering goods by barge/air) and access to jobs and services in the nearest towns and cities. If those benefits are not taken into account, standard economic evaluation techniques will fail to prioritise projects that improve accessibility and are of high value to the communities and regions that they support.

In this context, the Australian Transport and Infrastructure Council has committed to reviewing the National Guidelines for Transport System Management and investigating new approaches to the appraisal of remote and regional transport infrastructure projects. The new approaches are part of a wider nationally co-ordinated effort to address key transport infrastructure that is specific to remote and regional Australia, known as the National Remote and Regional Transport Strategy (August 2016). The strategy aims to raise the profile of these areas and highlight the challenges to growth and development, so as to maximise investment opportunities in transport infrastructure and services.

One of the proposed approaches consists of a Risk Indicator to support the evaluation of "Life Line" freight routes. These are roads that do not deliver high positive outcomes under CBA but whose resilience and reliability is critical for more remote populations. The Risk Indicator has been developed to help road managers identify whether routes qualify as a "Life Line" and hence determine which roads have greater justification for receiving upgrade funding, rather than relying on assessments based on CBA. The Risk Indicator uses a scoring methodology (1 to 5) examining:

- the sizes and needs of the communities and the establishments they service
- the availability of alternative routes that could be used if the route in question is unavailable
- the likelihood that the alternative routes are also closed

Box 4.13. Reforming regional road project appraisal and funding in Australia (*cont.*)

- historical incidence and duration of events that close or restrict operations on the route
- assessment of responses to previous events, including costs and impacts in the regions serviced.

Going forward, the proposed methodology could be introduced, together with alternatives such as greater weight given to resilience against natural hazards. More effectively linking assessment to overall policy objectives can result in better prioritisation in more peripheral areas, counterbalancing the risk of being excluded from future funding allocations.

Table 4.9. Transport infrastructure gaps and remedies

Theme	Gaps	Recommendations
Last-mile connectivity	• Last-mile connectivity gaps exist at the interface of different modes and limit the efficiency of transport networks as a whole. • Suburban motorways are not always linked to urban roads, and bottlenecks are present along key access routes to large cities. • The lack of high-quality links between ports and the national highway network results in heavy vehicles using inadequate and inappropriate urban streets to access port terminals. • Access to all major airports is exclusively car based, and public transport options are not integrated with urban mobility systems.	• Develop a national multi-modal strategy. The main goal of the strategy is to identify, upgrade and interconnect the assets that contribute to trade competitiveness. • Priorities should cover addressing last-mile connectivity issues and providing better intermodal links to ports, including the nationally significant opportunity to develop a logistics system in central Chile. • Give metropolitan authorities transport infrastructure planning instruments to develop comprehensive strategies and better co-ordinate investment across ports, airports and urban transport assets.
Inequalities in infrastructure provision and quality	• Gaps in surface quality and safety standards of roads exist not just between Chile and OECD comparators but also between Chilean macrozones and within these zones, as seen by large differences in secondary road quality and road crash rates. • Even starker differences are evident across areas of large cities, where poorer neighbourhoods are not only located further away than richer ones from jobs and services but also suffer from lower-quality infrastructure such as the lack of pavements and other infrastructure for pedestrians.	• Provide more equitable access to jobs and services for all citizens by investing in higher-quality public transport and urban spaces, coupled with policies to manage car and truck traffic flows. • Target investment to make the most of the public funds spent to address gaps in remote regions, either with specific allowances in national and regional budgets or by reforming appraisal methodologies. • Roll out road-paving solutions incrementally in more peripheral regions, taking into account connectivity needs, projected traffic growth (by vehicle type), life-cycle costs and safety implications.
Rail transport potential	• Low investment, unclear capacity allocation choices and the lack of a national strategy for rail transport undermine the rail network's ability to accommodate both passenger and freight services. • The quality of rail freight connections to ports is poor, and the logistics network lacks inland ports and distribution centres connected to the ports by trunk rail or road links, leading to low utilisation of existing tracks, particularly in Central and Southern Chile.	• Promote rail transport to meet freight demand by providing reliable infrastructure and dedicated links that support commercial speeds and accommodate higher loads. • Develop a coherent strategy that reduces conflicts in the allocation of capacity between freight and passenger traffic. • Identify opportunities for new rail passenger services, especially at the suburban level.
Collection, dissemination and analysis of data	• The lack of comprehensive datasets for most transport sectors hinders the compilation of transport statistics and the development of performance indicators and related analysis.	• Deploy standardised data-collection methodologies across transport sectors by bridging the knowledge gap between private and public actors, and between different government agencies. • Set-up a Logistics Observatory in charge of compiling and disseminating statistics and Key Performance Indicators to guide policy.

Table 4.9. Transport infrastructure gaps and remedies (*cont.*)

Theme	Gaps	Recommendations
External impacts of transport	• Transport networks are generating high external costs, reflected in the number of deaths caused by road crashes, the exposure of urban residents to pollutants and growing greenhouse gas emissions. • Externalities derive from an over-reliance on road transport for freight and passenger movements, as well as low-quality public transport alternatives.	• Contain the growth of private motorised vehicles in urban areas by promoting modal shift to public transport and active modes. • Develop costal shipping, including by liberalising cabotage, as an alternative to road transport for imports that arrive at deep-sea ports in Central Chile but carry goods going to other regions. • Develop the National Road Safety Strategy to ensure that legislation, education and infrastructure investment efforts towards greater road safety are joined up and adhere to international best practices.
Focus on performance over lifetime of asset	• Maintenance needs are already evident in Chile's rail infrastructure, and given large-scale construction in recent years, needs will grow as road, port and airport assets age. • Extreme weather events linked to climate change and natural disasters will continue to be a challenge for the resilience of transport networks across the country.	• Assign greater priority to maintenance in future infrastructure budgets based on foreseen needs; develop studies to map and quantify the potentially disruptive impacts of natural disasters and climate change. • Introduce asset-management techniques across all modes to better assess what level of investment is best for each category of infrastructure.

Notes

1. Econometric techniques with panel data (over time and across observations) are designed to estimate elasticities while controlling for external factors such as population growth, urbanisation and economic changes.

2. UNECLAC has adopted this approach in the estimation of the investment gap in Latin America and the Caribbean, based on a comparison with the share of GDP invested in a selection of East Asian countries.

3. The Camara Chilena de Construcción (CChC) employs a similar methodology in its studies of infrastructure needs for Chile (2012 and 2016).

4. For instance, rail freight capacity can be increased by improving both track and train utilisation. In turn, track utilisation can be improved through demand management (e.g. access charges and timetabling) and technology (e.g. modern signalling systems and automation).

5. Data on road traffic flows are not regularly collected, and there is no standard processing of the limited available data to develop regular and comprehensive traffic indices in Chile

6. These include different technical solutions such as a thin layer of asphalt (~5 cm) or a compacted granular base. These solutions are cheaper than more advanced paving techniques and are applied to roads with lower utilisation, as measured by average annual daily traffic (AADT).

7. Laws stipulate that cabotage should be carried out by Chilean-flagged ships: Chilean companies with Chilean crew. Foreign companies can apply for a waiver, but transaction costs are high enough to discourage entry.

8. Port Botany Landside Improvement System (PBLIS)

9. For example, truck waiting times are high; trip length for a truck transporting fruit from the Curico zone to ports in the Central macrozone is estimated to be 28 hours (round trip), of which 7 hours is driving and 21 hours is waiting (CAMPORT, 2015, citing a study by KOM).

10. The average is affected by the high share of rail freight traffic in Australia, supported by large mining and related rail operations.

11. Empresa de los Ferrocarriles del Estado, the state-owned national rail company supervised by the MTT

12 The urban metro operates at night with cargoes to the port (11pm until dawn) (Information provided by Direplan, September 2017)

13. Railway laws in force today are the Ley General de Ferrocariles (1931) for private operators and the Ley Organica de la Empresa de los Ferrocariles del Estado (1993) for EFE’s network and concessions.

14. New buses were introduced in February 2007, with routes restructured around hubs with trunk-and-feeder ines. The aim was to formalise, rationalise and improve public transport quality. Transantiago’s fleet is less polluting, less accident prone and more accessible than the previous system. However, the system has also been criticised for its rigidity, leading to higher journey times for some passengers, and for the faulty implementation of some key elements, such as the lack of reserved bus lanes across the city. Plans are now at an advanced stage for addressing these weaknesses, improving safety and adapting routes to the changing pattern of demand in the fast-growing city.

15. Tiznado et al. use a corrected accessibility measure (CAM), taking into account comfort and number of transfers, to compare accessibility to the CBD from the San Miguel district in the south and from the Las Condes district in the north-east. Based on CAM, travel time is 22 minutes faster from Las Condes than San Miguel.

16. Factors such as age, mental and physical disability, and to a different extent travelling with young children or heavy luggage are all barriers to people’s mobility and, in turn, their ability to access jobs, services and other activities (ITF/OECD, forthcoming).

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Annex 4A

Quantitative benchmarking indicators

Table 4A.1. Population density and GDP per capita, 2004 and 2014

		Population density 2014	GDP per capita (current USD)	
		(inhabitants per km²)	2014	2004
OECD countries	Australia	3	61 925	31 472
	Sweden	24	58 887	42 442
	New Zealand	17	44 342	25 104
	Italy	209	34 960	31 190
	Spain	93	29 767	24 920
	Chile	23	14 528	6 324
OECD regions	Western Australia	1	86 262	34 578
	North Norway	4	67 045	30 888
	North Sweden	6	50 068	36 896
	Southern Italy	172	23 296	20 775
Chilean regions	Chile - North	7	20 559	--
	Chile - Central	140	13 979	--
	Chile - Austral	4	9 693	--
	Chile - South	40	7 435	--

Source: Population: World Bank (2016a), Australia Bureau of Statistics (2016a), ISTAT (2016a), Statistics Norway (2016a), Statistics Sweden (2016a), Instituto Nacional de Estadísticas de Chile (2016a). Land area: World Bank (2016b), Australian Bureau of Statistics (2016b), OECD (2016b), Statistics Norway (2016a), Statistics Sweden (2016b), Instituto Nacional de Estadísticas de Chile (2016b). GDP: World Bank (2016c), Australian Bureau of Statistics (2016c), ISTAT (2016b), Statistics Norway (2016b), Statistics Sweden (2016c), Banco Central de Chile (2016).

Table 4A.2. Rail and road infrastructure investment and maintenance spending as a percentage of GDP, 2000-2014

		2000	2005	2010	2014
Australia	Rail investment	0.10%	0.26%	0.40%	0.40%
	Road investment	0.89%	1.19%	1.25%	1.03%
	Total investment	**0.99%**	**1.45%**	**1.65%**	**1.43%**
	Rail maintenance	na	na	na	na
	Road maintenance	na	0.13%	0.15%	0.18%
	Total maintenance	**na**	**0.13%**	**0.15%**	**0.18%**

Table 4A.2. Rail and road infrastructure investment and maintenance spending as a percentage of GDP, 2000-2014 (*cont.*)

		2000	2005	2010	2014
Italy	Rail investment	0.37%	0.68%	0.30%	0.26%
	Road investment	0.56%	0.62%	0.21%	0.18%
	Total investment	**0.93%**	**1.30%**	**0.51%**	**0.43%**
	Rail maintenance	0.43%	0.60%	0.49%	0.45%
	Road maintenance	0.78%	0.84%	0.40%	0.57%
	Total maintenance	**1.22%**	**1.44%**	**0.89%**	**1.02%**
New Zealand	Rail investment	na	na	na	na
	Road investment	0.25%	0.38%	0.67%	0.63%
	Total investment	**0.25%**	**0.38%**	**0.67%**	**0.63%**
	Rail maintenance	na	na	na	na
	Road maintenance	na	0.62%	0.66%	0.64%
	Total maintenance	na	**0.62%**	**0.66%**	**0.64%**
Spain	Rail investment	0.28%	0.62%	0.71%	0.29%
	Road investment	**0.74%**	**0.92%**	**0.73%**	**0.41%**
	Total investment	1.03%	1.54%	1.44%	0.70%
	Rail maintenance	na	na	na	na
	Road maintenance	na	na	na	na
	Total maintenance	na	na	na	na
Sweden	Rail investment	0.21%	0.36%	0.39%	0.28%
	Road investment	0.32%	0.41%	0.45%	0.43%
	Total investment	**0.53%**	**0.77%**	**0.84%**	**0.71%**
	Rail maintenance	0.11%	0.16%	0.20%	0.23%
	Road maintenance	0.27%	0.25%	0.24%	0.24%
	Total maintenance	**0.37%**	**0.41%**	**0.43%**	**0.46%**

Notes: Data include both private and government investment. Australia: road investment includes tarmac at airports. Chile: rail investment does not include metro. Italy: road investment and maintenance do not include urban roads. Sweden: road investment does not include private local roads; rail investment includes trams and metros. New Zealand: data refer to fiscal years ending on June 30.

Source: OECD (2016c), Ministerio de Obras Públicas (2016b) and Grupo EFE (2016).

Table 4A.3. Global Competitiveness Index (1 = worst, 7 = best), 2015-2016 edition

	Quality of overall infrastructure	Quality of roads	Quality of railroad infrastructure	Quality of port infrastructure	Quality of airport infrastructure
Australia	4.86	4.72	3.90	4.99	5.48
Chile	4.57	4.93	2.35	4.91	5.19
Italy	4.11	4.42	3.96	4.32	4.52
New Zealand	4.96	4.68	3.50	5.47	5.84
Spain	5.73	5.80	5.95	5.65	5.89
Sweden	5.56	5.36	4.25	5.62	5.60

Source: World Economic Forum (2016).

Table 4A.4. Quality of infrastructure, percentage of people responding low or very low, GCI 2015-2016

	Chile	OECD
Ports	0%	45%
Airports	17%	22%
Road	0%	25%
Rail	83%	48%
Warehousing	0%	10%
Telecommunications	29%	20%

Source: Chile's Productivity Commission (2016).

Table 4A.5 Logistics Performance Index (1= worst, 5=best), 2016 edition

	Infrastructure	Customs
Australia	3.82	3.54
Chile	2.77	3.19
Italy	3.79	3.45
New Zealand	3.55	3.18
Spain	3.72	3.48
Sweden	4.27	3.92

Source: World Bank (2016d).

Table 4A.6 Rail, road and port (container) freight traffic in Chile, and estimated capacity needs

		Overall national estimate for Chile			Within 50km from ports, large cities	
		Trade-related freight volumes	Capacity	% change	Capacity needs	% change
Rail		MO tonne-km	Track-km	Over 2010	Track-km	Over 2010
	2010	9 084	620	--	93	--
	2030	12 697	1 599	158%	291	211%
Road		MO tonne-km	Track-km	Over 2010	Track-km	Over 2010
	2010	59 653	17 240	--	1 760	--
	2030	84 652	19 066	11%	2 231	27%
Ports		MO TEUs	TEU capacity	Over 2010	TEU capacity	Over 2010
	2010	3.27	5.26	--	--	--
	2030	7.81	7.85	49%	--	--

Source: ITF/OECD (2016f).

Table 4A.7 Road, rail and port freight transport intensity of the economy, 2004 and 2013

	Road tonne-km per current US$ GDP			Rail tonne-km per current US$ GDP			TEUs at ports per current 1000US$ GDP		
	2004	2013	Growth rate	2004	2013	Growth rate	2004	2013	Growth rate
Australia	0.25	0.14	-44%	0.27	0.24	-11%	1.00	0.85	-14%
Chile	--	0.21	--	--	0.02	--	0.89	0.56	-37%
Italy	0.09	0.06	-36%	0.01	0.01	-31%	0.23	0.21	-10%
New Zealand	0.19	0.11	-39%	0.06	0.03	-43%	0.39	0.30	-24%
Spain	0.21	0.14	-32%	0.01	0.01	-52%	0.32	0.31	-2%
Sweden	0.09	0.07	-22%	0.05	0.04	-34%	0.36	0.29	-20%

Source: Road and rail ton-km: OECD (2016d), data elaborated by the ITF/OECD based on data from Western Australia rail operators' reports and Grupo EFE, Ministerio de Transporte y Telecomunicaciones (2015). Metric tonnes at ports: data elaborated by the ITF/OECD based on data from Lloyds Intelligence Unit. GDP: World Bank (2016c).

Table 4A.8 Road and rail passenger transport volumes per inhabitant

	Road passenger transport (thousand passenger-km per inhabitant)		Rail passenger transport (thousand passenger-km per inhabitant)	
	2004	2013	2004	2013
Australia	13.87	12.53	0.59	0.66
Chile	--	--	0.05	0.05
Italy	14.14	12.00	0.85	0.81
Spain	8.94	7.90	0.47	0.51
Sweden	12.95	12.17	0.96	1.24

Source: Passenger transport: OECD (2016e), Ministerio de Transporte y Telecomunicaciones (2015). Population: World Bank (2016a).

Table 4A.9 Stock of road motor vehicles per 100 inhabitants, 2004 and 2014

		Passenger cars		Goods road motor vehicles	
		2004	2014	2004	2014
OECD countries	Australia	52.81	56.61	11.80	14.40
	Chile	8.19	15.71	1.52	2.13
	Italy	58.89	60.32	6.67	7.77
	New Zealand	--	60.94	--	11.32
	Spain	45.53	47.47	10.73	10.83
	Sweden	45.31	47.33	4.69	6.01
OECD regions	Southern Italy	54.13	59.05	5.97	7.38
	North Norway	39.94	49.34	24%	8.89

Note: goods road motor vehicles include vans, trucks, road and agricultural tractors.

Source: Stock of passenger cars: ITF (2016a), ISTAT (2016c), Statistics Norway (2016c), Instituto Nacional de Estadísticas de Chile (2016d). Population: World Bank (2016a), ISTAT (2016a), Statistics Norway (2016a).

Table 4A.10 Density of road network by area and population, latest available year

		Km of road network per km²		Km of road network per 1000 inhabitants	
		Total	Paved	Total	Paved
OECD countries	Australia	0.12	0.05	38.32	15.17
	Chile	0.10	0.04	4.38	1.74
	New Zealand	0.36	0.24	20.95	13.92
	Spain	0.33	--	3.58	--
	Sweden	0.53	0.29	22.33	12.37
OECD regions	Western Australia	0.07	0.02	72.61	21.94
	North Norway	0.03	0.03	7.41	6.27
	North Sweden	0.06	0.04	10.50	6.55
Chilean regions	North	0.08	0.04	10.32	5.10
	Central	0.21	0.12	1.51	0.87
	South	0.28	0.07	6.99	1.81
	Austral	0.05	0.01	12.37	3.28

Source: Road network: BITRE (2013), MOP (2016b), ITF (2016b), Ministerio de Fomento (2016), Statistics Sweden (2016d), Mainroads Western Australia (2015), Roadex (2000), CIA (2016). Land area: World Bank (2016b), Australian Bureau of Statistics (2016b), Statistics Norway (2016a), Statistics Sweden (2016b), Instituto Nacional de Estadísticas de Chile (2016b). Population: World Bank (2016a), Australia Bureau of Statistics (2016a), Statistics Norway (2016a), Statistics Sweden (2016a), Instituto Nacional de Estadísticas de Chile (2016a).

Table 4A.11 Share of paved roads, latest available year

OECD countries	Australia	43%
	Chile	40%
	Italy	78%
	New Zealand	66%
	Spain	86%
	Sweden	30%
OECD regions	Western Australia	79%
	Southern Italy	85%
	North Norway	62%
	North Sweden	49%
Chilean regions	North	57%
	Central	26%
	South	26%
	Austral	43%

Notes: Data exclude privately owned roads. In Chile, paved roads include "*soluciones básicas*".

Source: CIA (2016), Ministerio de Obras Públicas (2016c), SITEB (2012), Trafikverket (2016), Mainroads Western Australia (2015), Roadex (2000).

Table 4A.12. Roads rated three stars or better for vehicle occupants (iRAP model V2)

Carriageway	Divided		Undivided		Total
AADT	<5 000	>=5 000	<5 000	>=5 000	
Chile	49%	62%	30%	47%	34%
Chile - Austral	0%	0%	19%	0%	16%
Chile - Centre	63%	68%	40%	61%	46%
Chile - South	22%	0%	15%	0%	14%

Notes: V2 and V3 stars are not directly comparable. AADT = average annual daily traffic.

Source: IRAP (2016).

Table 4A.13. Roads rated three stars or better for vehicle occupants (iRAP model V3)

Carriageway	Divided		Undivided		Total
AADT	<5 000	>=5 000	<5 000	>=5 000	
Catalonia	100%	99%	35%	41%	75%
Chile - Centre	N/A	100%	24%	N/A	26%
Chile - North	78%	100%	70%	26%	82%
Western Australia	72%	57%	55%	3%	54%
New Zealand	94%	96%	6%	6%	10%

Notes: V2 and V3 stars are not directly comparable. AADT = average annual daily traffic.

Source: IRAP (2016).

Table 4A.14. Curves on rural roads where traffic flows at >80 km/h that have hazardous roadsides

Carriageway	Divided		Undivided	
AADT	<5 000	>=5 000	<5 000	>=5 000
Catalonia	N/A	7%	31%	22%
Chile - Centre	81%	50%	80%	83%
Chile - North	N/A	15%	18%	12%
Chile - South	N/A	N/A	90%	90%
Chile - Austral	N/A	42%	74%	82%
Western Australia	30%	14%	27%	43%
New Zealand	17%	4%	21%	18%

Note: AADT = average annual daily traffic.

Source: IRAP (2016).

Table 4A.15 Number of road fatalities per 100 000 inhabitants, 2004, 2010 and 2014

		2004	2010	2014	% change
OECD countries	Australia	7.86	6.14	4.92	-37%
	Chile	14.35	12.19	11.93	-17%
	Italy	10.61	6.94	5.51	-48%
	New Zealand	10.67	8.62	6.54	-39%
	Spain	11.05	5.32	3.64	-67%
	Sweden	5.34	2.84	2.79	-48%
OECD regions	Western Australia	8.96	8.37	7.13	-20%
	Southern Italy	8.63	5.94	4.86	-44%
	North Norway	9.94	7.30	3.35	-66%
	North Sweden	--	6.28	5.54	--
Chilean regions	North	--	--	15.86	--
	Central	--	--	9.48	--
	South	--	--	15.98	--
	Austral	--	--	14.74	--

Note: fatalities correspond to death within 30 days after the accident.

Source: Road fatalities - ITF (2016c), Instituto Nacional de Estadísticas de Chile (2016e), BITRE (2016a), ISTAT (2016d), Statistics Norway (2016d), Transportstyrelsen (2016). Population: World Bank (2016a), Australia Bureau of Statistics (2016a), ISTAT (2016a), Statistics Norway (2016a), Statistics Sweden (2016a), Instituto Nacional de Estadísticas de Chile (2016a).

Table 4A.16 Average ship and container ship turnaround time (days), 2013

		Ship	Container ship
OECD countries	Australia	2.99	1.28
	Chile	3.20	1.61
	Italy	1.82	1.13
	New Zealand	1.55	0.76
	Spain	1.53	0.86
	Sweden	0.91	0.65
OECD regions	Western Australia	3.25	1.37
	Southern Italy	1.78	1.09
	North Norway	1.61	1.86
	North Sweden	0.97	0.83
Chilean regions	North	3.85	1.93
	Central	2.52	1.29
	South	5.69	2.53
	Austral	3.78	1.58

Note: global average is one day.

Source: data elaborated by the ITF/OECD based on data from Lloyds Intelligence Unit.

Table 4A.17 Modal share of rail at ports, latest available year

Port	Country/macrozone	Road	Rail
Naples	Italy	92%	8%
Barcelona	Spain	90%	10%
Fremantle	Australia	86%	14%
Livorno	Italy	76%	24%
Tauranga*	New Zealand	60%	40%
Goteborg*	Sweden	50%	50%
Port Hedland*	Australia	14%	86%
Antofagasta	North	68%	32%
Arica	North	87%	13%
Ventanas	Centre	75%	25%
San Antonio	Centre	88%	12%
Valparaiso	Centre	96%	4%
Coronel	South	48%	52%
San Vicente	South	81%	19%

Note: * indicates the presence of dedicated port-hinterland rail shuttle services.

Source: European Parliament (2015), data elaborated by the ITF/OECD based on data from port authorities, BITRE (2014b), Ministerio de Transporte y Telecomunicaciones (2011).

Table 4A.18 Land transport – modal share of rail, 2013

	Freight rail modal share	Passenger rail modal share
Western Australia	63%	<1%
Chile North	17%	<1%
New Zealand	23%	<1%
Sweden	35%	9%
Chile – Central/South	6%	<1%

Source: data elaborated by the ITF/OECD based on data from Western Australia rail operators' reports and data from Grupo EFE, Ministerio de Transporte y Telecomunicaciones (2015), OECD (2016d), OECD (2016e).

Table 4A.19 Density of rail network by area and population, latest available year

	Km of rail network per 10 km2	Km of rail network per 1 000 inhabitants
Australia	0.53	1.75
Chile	0.43	0.18
Italy	5.79	0.28
New Zealand	1.52	0.89
Spain	3.37	0.36
Sweden	2.38	1.00
Western Australia	0.29	2.88
Chile – North	0.37	0.50
Chile – Central/South	2.73	0.19

Source: Rail network: World Bank (2016f), BITRE (2015), Ministerio de Transporte y Telecomunicaciones (2015), data elaborated by the ITF/OECD based on data from Western Australia rail operators' reports. Population: World Bank (2016a), Australia Bureau of Statistics (2016a), Instituto Nacional de Estadísticas de Chile (2016a). Land area: World Bank (2016b), Australian Bureau of Statistics (2016b), Instituto Nacional de Estadísticas de Chile (2016b).

Table 4A.20 Rail freight performance indicators, 2013

	Mo tonne-km per track km	1 000 tonnes per track km
Western Australia	22.7	16.2
Chile North	1.8	14.7
New Zealand	2.6	6.4
Sweden	2.2	6.4
Chile – Central/South	1.8	5.4

Source: Rail freight: data elaborated by the ITF/OECD based on data from Western Australia rail operators' reports and Grupo EFE, Ministerio de Transporte y Telecomunicaciones (2015), OECD (2016d). Rail network: World Bank (2016f), Ministerio de Transporte y Telecomunicaciones (2015), data elaborated by the ITF/OECD based on data from Western Australia rail operators' reports.

Table 4A.21 Modal share in cities, latest available year

	Private car	Public transport	Other
Santiago	26%	24%	39%
Madrid	29%	42%	29%
Stockholm	47%	35%	18%
Rome	57%	27%	16%
Sydney	68%	23%	6%
Auckland	79%	4%	16%
Coquimbo - La Serena	32%	30%	37%
Valparaiso	33%	39%	27%
Barcelona	35%	18%	47%
Temuco	35%	36%	26%
Milan	47%	27%	26%
Naples	51%	18%	31%
Iquique	36%	30%	34%
Antofagasta	37%	34%	29%
Arica	38%	23%	38%
Copiapo	39%	29%	31%
Fremantle	70%	15%	15%
Perth	79%	13%	4%
Osorno	46%	31%	21%
Valdivia	49%	30%	20%
Tromso	52%	17%	31%
Umeå	57%	8%	35%

Note: Modal share calculations may differ on survey methodology adopted.

Source: SECTRA (2016), Ministero dell'Economia e delle Finanze (2016), data elaborated by the ITF/OECD based on data from national travel surveys.

Table 4A.22 Modal share in cities, latest available year

	Daily passengers per km	Network length
Santiago	17 759	103
Rome	12 740	60
Milan	11 386	101
Barcelona	7 833	144.3
Stockholm	8 502	105.7
Madrid	5 236	293

Source: data elaborated by the ITF/OECD based on data from cities' annual reports.

Table 4.A.23 Mean population exposure to PM2.5 (micrograms per cubic metre), 2005 and 2013

		2005	2013	% change
OECD countries	Australia	7.8	6.0	-22%
	Chile	19.6	18.0	-8%
	Italy	22.0	18.4	-16%
	New Zealand	8.5	8.6	1%
	Spain	15.2	11.7	-24%
	Sweden	8.8	7.5	-16%
OECD regions	Western Australia	6.2	6.1	0%
	South Italy	15.8	13.5	-15%
	North Norway	3.7	3.5	-5%
	North Sweden	6.0	5.1	-16%
Chile regions	North	9.3	7.9	-16%
	Central	26.5	24.2	-9%
	South	6.2	6.1	-1%
	Austral	5.1	5.3	4%

Source: OECD (2016f).

Table 4.A.24 NO_2 Emissions (10^n molecules/cm^2) in urban, intermediate and rural areas, 2012

	Predominantly urban areas	Intermediate areas	Predominantly rural areas
Chile	2.7	1.6	0.8
Italy	5.1	4.9	2
New Zealand	0.7	0.4	--
Norway	2.2	2.6	2.4
Spain	1.8	1.6	2.1
Sweden	2	2.1	1.9

Source: OECD (2016g).

Table 4.A.25 Transport-related greenhouse gas emissions (CO2 equivalent tonnes) per inhabitant, 1994, 2004 and 2013

	1994	2004	2013	% change 2013-2004
Australia	3.63	3.93	3.93	0%
Chile	0.88	1.06	1.39	31%
Italy	1.84	2.15	1.67	-22%
New Zealand	2.79	3.29	3.08	-6%
Spain	1.80	2.46	1.76	-28%
Sweden	2.29	2.45	2.05	-16%

Source: CO2 emissions: IEA (2016). Population: World Bank (2016a).

Table 4.A.26 Propensity to fly, 2004 and 2014

		2004	2014	% change
OECD countries	Australia	2.82	3.91	39%
	Chile	0.42	0.90	116%
	Italy	1.42	1.98	39%
	New Zealand	2.77	3.34	21%
	Spain	3.02	3.85	27%
	Sweden	2.61	3.55	36%
OECD regions	Western Australia	2.21	3.53	59%
	Southern Italy	0.70	1.16	64%
	North Norway	--	7.81	--
	North Sweden	--	0.95	--
Chilean regions	North	--	0.89	--
	Central	--	1.07	--
	South	--	0.23	--
	Austral	--	1.20	--

Note: propensity to fly is the ratio of the number of national and international passengers in the country/region divided by the population.

Source: Number of passenger: BITRE (2016b), Junta de Aeronáutica Civil (2016), ISTAT (2016e), World Bank (2016g), AENA (2016), Statistics Sweden (2016e) Population: World Bank (2016a), Australia Bureau of Statistics (2016a), ISTAT (2016a), Statistics Sweden (2016a), Instituto Nacional de Estadísticas de Chile (2016a).

Table 4A.27 Surface access to airports, passenger modal share and travel time

	Share of public transport (rail and bus)	Average travel time by car (mins)	Average travel time by rail (mins)	Average travel time by bus (mins)
Düsseldorf	22%	13	15	29
Zurich	47%	14	12	27
Geneva	28%	14	7	20
Copenhagen	37%	18	14	43
Frankfurt	33%	18	11	11
Vienna	41%	23	16	48
Brussels	26%	29	21	60
Santiago	--	29	--	45
Amsterdam	37%	30	6	6
Munich	36%	38	42	55
Stockholm	34%	38	18	45
Oslo	64%	40	30	49
London (LHR)	36%	42	15	68
Paris (CDG)	40%	45	34	67

Source: Share of public transport: ACRP (2008), data elaborated by ITF/OECD based on data from Google Maps.

Annex 4B

Overview of transport infrastructure investment and policies in selected comparator OECD regions

4B.1 Western Australia

4B.1.1 Economic and demographic profile

Western Australia is the largest of Australia's States and Territories, covering 2.5 million km^2 or 33% of Australia's land mass (Australian Bureau of Statistics, 2014: 3). At that size, Wetern Australian has over three times more territory than Chile. However, like Chile, Western Australia's north-south coverage leads to substantial diversity in its climate, landscape and vegetation. Western Australia has a monsoonal tropical climate in the north, arid northern coastal and inland areas, and a temperate and Mediterranean climate in the south west. Unlike Chile, most of Western Australia is a flat, low plateau (Australian Bureau of Statistics, 1998: 16).

Almost 80% of WA's 2.5 million residents live in the capital city Perth (Australian Bureau of Statistics, 2014: 3). Therefore, the majority of the state is sparsely populated. Greater Perth has a population density of 315 people per km^2, while the rest of Western Australia has 0.2 people per km^2. On average, across the state, Western Australia has an average population density of 1 person per km^2 (Australian Bureau of Statistics, 2013-14).

Western Australia is a high-income state. In 2012-13, its Gross State Product (GSP) per capita was USD 93 825, which was 1.5 times greater than Australia's GDP per capita (Australian Bureau of Statistics, 2014-15). Arguably, Western Australia's high income is mainly related to the boom in recent years in the state's key exports – minerals and petroleum products. In 2012-13, Western Australia's exports totalled USD 104 166 million, which represented 47% of Australia's total exports. Of these exports, 46% were iron ore, 13% were gold products and 10% were natural gas (ibid).

Western Australia's key iron ore and natural gas production is located in the Pilbara region in the north and its surrounding waters. The Pilbara region constitutes 20% of WA's land mass, roughly equivalent in size to Spain. The main town in the Pilbara is Port Hedland, which is located on the coast 1 312 km north of Perth (1 638 km by road) (Main Roads Western Australia, 2013: 12). Iron ore mines are located inland, up to 425 km from Port Hedland (Bureau of Transport, Infrastructure and Economics, 2013: 23).

These characteristics make Western Australia a good comparator for the North of Chile. (Australian Bureau of Statistics, 2013-14)

Table 4B.1 Characteristics of Western Australia

	Year	Western Australia	Australia	Northern Chile
GDP per capita (current USD)	2004	34 578	31 472	
	2014	93 825	60 806	20 559
Population density (inhabitants per km²)	2004	0.79	2.62	
	2014	1.02	3.06	7.46
Main exports (by value, latest available)	1.	Iron	Wholesale and retail trade hotels and restaurants	Copper and iron
	2.	Gold	Transport and storage, post and telecommunication	
	3.	Natural gas	Food products, beverages and tobacco	

Source: Population: World Bank (2016a), Australian Bureau of Statistics (2016a), Instituto Nacional de Estadísticas de Chile (2016a). Land area: World Bank (2016b), Australian Bureau of Statistics (2016b), Instituto Nacional de Estadísticas de Chile (2016b). GDP: World Bank (2016c), Australian Bureau of Statistics (2016c), Banco Central de Chile (2016). Exports: OECD (2016), Direccion Nacional de Adunas (2016).

4B.1.2 Overview of transport infrastructure and key issues

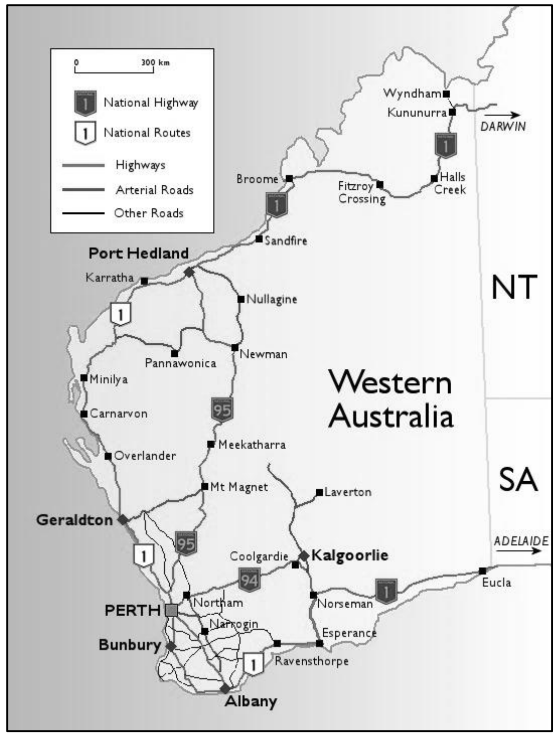
Western Australia has extensive transport infrastructure, both near the main population centre in Perth and throughout the state. The following is an overview of the transport infrastructure in Western Australia.

Road

Western Australia's size and sparse population density affects the make-up of its road infrastructure. Of its 186 308 km of roads, only 10% are urban roads (Bureau of Infrastructure, Transport and Regional Economics, 2015: 44). Many of the roads link regional centres with Perth and each other. Unsurprisingly, most of the road network is in the state's south west (Department of Transport Western Australia, 2014: 23), which also has most of the state's population.

Only 30% Western Australia's main roads are paved (Main Roads Western Australia, 2015: 147). These include only some of the substantial freight routes carrying heavy vehicles. For example, the Goldfields Highway that links Kalgoorlie to a port at Esperance is unpaved. There are only medium-term plans to pave this road. However, those plans include paving the road to the full standard. There are also similar medium-term plans for the Marble Bar Road in the Pilbara region to assist with the development of new iron ore mines (Department of Transport Western Australia, 2014: 51-52).

Figure 4B.1 Map of Western Australia's road network



Source: Australian1.com.

Rail

Western Australia has 7 391 route-km of railway (Bureau of Infrastructure, Transport and Regional Economics, 2015: 96). The railways can be considered in two sections.

The first section covers the southern half of the state. It includes:

- the urban public transport rail network in Perth
- a freight network linking regional centres to Perth, each other and various ports
- a link to the rest of the Australian mainland (Economic Regulatory Authority of Western Australia, 2017).

This network undertakes a range of tasks, including transporting general freight and limited passenger services (Brookfield Rail). However, its main transport tasks involve transporting export commodities such as minerals and grain to ports (Department of Transport Western Australia, 2014).

Most of this network is government owned and privately operated by Brookfield Rail under a lease that is in force until 2049. Brookfield provides open access to its part of the network for above rail operators and is responsible for providing track infrastructure and train control services (*ibid*). The link to the rest of the Australian mainland is also an open-access multi-user network. The Perth public transport rail network is government owned and operated (Economic Regulatory Authority of Western Australia, 2017).

The second section is the Pilbara railways. These are heavy-haulage rail lines that transport iron ore from mines up to 425 km inland to export ports on Western Australia's coast (Bureau of Infrastructure, Transport and Regional Economics, 2013:23).

The Pilbara railways are privately owned and operated by iron ore mining companies and their joint venture partners as an integrated part of the iron ore supply chain. There is a more detailed discussion on the Pilbara railways and their integration with port infrastructure below.

Ports

With a mainland coastline of 12 889 km (Geoscience Australia), WA has the largest network of ports of any Australian state or territory. There are 17 government-owned ports. However, nine of these are privately operated, and many of the government-operated ports have substantial privately owned and operated infrastructure within them (Department of Transport Western Australia, 2014a: 23).

Western Australia is also home to the world's biggest iron ore port at Port Hedland (Department of Transport Western Australia, 2015: 28). Most of Western Australia's port activities are commodity export oriented.

The state's biggest general cargo port is at Fremantle near Perth, which handles almost all of Western Australia's container trade. As with many ports in urban areas, the Port of Freemantle has suffered from congestion and issues arising from trucks using local roads. The Western Australian government has sought to alleviate these issues by providing a rail subsidy for freight moved by rail between the Port of Freemantle and an intermodal hub in Forrestfield, an industrial suburb of Perth. From 2002 to 2013, the share of containers entering/exiting the Port of Freemantle by rail increased from 2% to 14%, equating to an estimated 100 000 fewer truck movements annually on roads linking with the port (Buswell, 2013). The Western Australian government has extended the subsidy to 2021-22 (Freemantle Ports, 2016) and has a target of 30% of containers reaching the port by rail in the long term (Buswell, 2013).

Airports

WA's size and low population density can result in aviation being the only practical way to transport people around the state (Department of Transport Western Australia, 2015: 4). Thus, Western Australia has one major international airport at Perth and 12 regional airports. Perth International Airport is also the main airport for domestic connections to other Australian states and territories (Department of Transport Western Australia, 2014: 51).

To ensure the viability of some regional air services, the Western Australian government holds tender processes and grants exclusive rights to operate certain air routes from Perth to particular regional towns. The Western Australian government does not provide subsidies for this policy (Department of Transport Western Australia, 2015: 5).

Box 4B.1 Port Hedland and Newcastle – two approaches to an integrated supply chain

Port Hedland – separately owned and operated supply chains

The Port of Port Hedland is the world's largest bulk port. While the port dates back to 1896, large-scale development only began in 1965 with the commencement of iron ore exports (Bureau of Transport, Infrastructure and Economics, 2013:20). There is strong integration across the iron ore export supply chain. The railways that service the port are the world's highest-capacity bulk railways. The newest railway involves trains of up to 33 000 tonnes, with 234 wagons operating under a 40-tonne axle load limit (ibid: 27). Railways come all the way to the port, unloading iron ore at large stockpiling facilities located close to berths. The railways at the port have balloon loops to maximise efficiency in turnaround times. The iron ore is blended at the port and moved to loading facilities by relatively short conveyer belts. While there are shared facilities available, BHP Biliton and Fortescue Metal Group each own and operate separate supply chain infrastructure from mine to ship. Vertical integration facilitates planning and day-to-day logistics maximise efficiency (ibid: 23). Port Hedland is a relatively remote location, which had little major development prior to iron ore exports commencing. Arguably, this provided substantial land away from a large population centre in which to build infrastructure to optimise the integration of supply chains.

Newcastle – shared infrastructure and central supply chain co-ordination

The Port of Newcastle (on Australia's east coast in the State of New South Wales) is the world's largest coal export port (ibid: 39). Supply integration at the Port of Newcastle takes a different approach from that of Port Hedland. While railways come all the way to the port, the rail network linking coal mines to the port is operated by a single infrastructure company with access arrangements to provide for above rail competition. The presence of the city of Newcastle limits the port's ability to expand. In the past, there was no central planning or co-ordination for moving coal through the supply chain. This resulted in substantial delays and inefficiency. Over the course of several years, all stakeholders, including coal producers, above and below rail operators, coal terminals, and the port developed a co-ordination system. The Hunter Valley Coal Chain Coordinator (HVCCC) was established to plan and co-ordinate the daily operation of the coal logistics chain. It co-ordinates vessel berthing, stockpile layouts and train sequencing to fulfil customers' orders efficiently. It also models future developments to predict future constraints in the supply chain and work with other stakeholders to keep them from occurring (Hunter Valley Coal Chain Coordinator, 2013: 1, 3).

4B.1.3 A co-ordinated approach to port hinterland transport – Port Botany, Sydney, Australia

The Australian and New South Wales (NSW) Governments have collaborated over several years to improve land transport connections to Port Botany in Sydney. The collaboration involves:

- expansion of the port itself (funded on a commercial basis) and subsequent privatisation of the port (in 2013)
- introduction of a third stevedore (commenced operations in July 2014)
- funding of extensions and upgrades to an existing dedicated rail freight line between the port and parts of western Sydney (primarily by the Australian Government)
- facilitating development of intermodal freight terminals
- joint funding of upgrades of the motorway network between the port and key freight hubs in western Sydney.

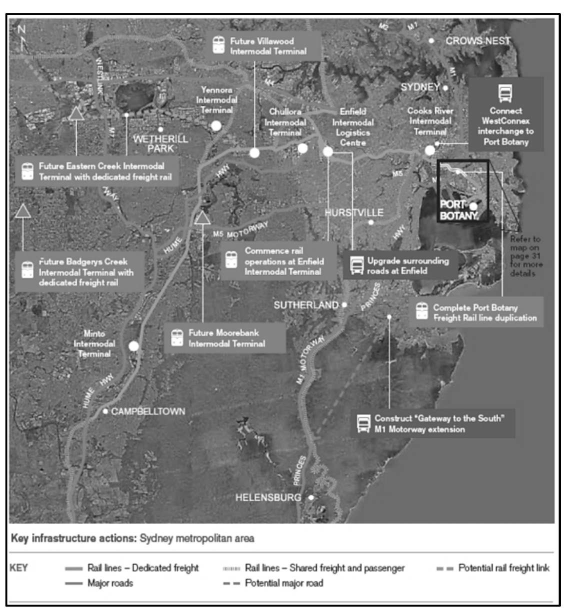
Port Botany is the largest container port in NSW, and it serves Sydney (-population 5.0 million in mid-2016) and regional NSW. In 2014-15, the port handled approximately 2.28 million TEUs, including 0.14 million TEUs in transhipments (NSW Ports, 2015). The port's private-sector operator forecasts that this volume will grow to between 7.5 million and 8.4 million TEUs by 2045 (NSW Ports, 2015a).

Approximately 85% of containers originate from or are bound for a destination within 40 kilometres of Port Botany. The rail mode share of container movements to and from Port Botany declined from 25.0% in 2001-02 to 14.1% in 2012 (NSW Government, 2013). The NSW Government has set a target of doubling the rail mode share by 2020.

To improve landside access to the port, several actions have been pursued over the past five to seven years, and they continue to be developed. These are shown on Figure B.2. The most significant developments are:

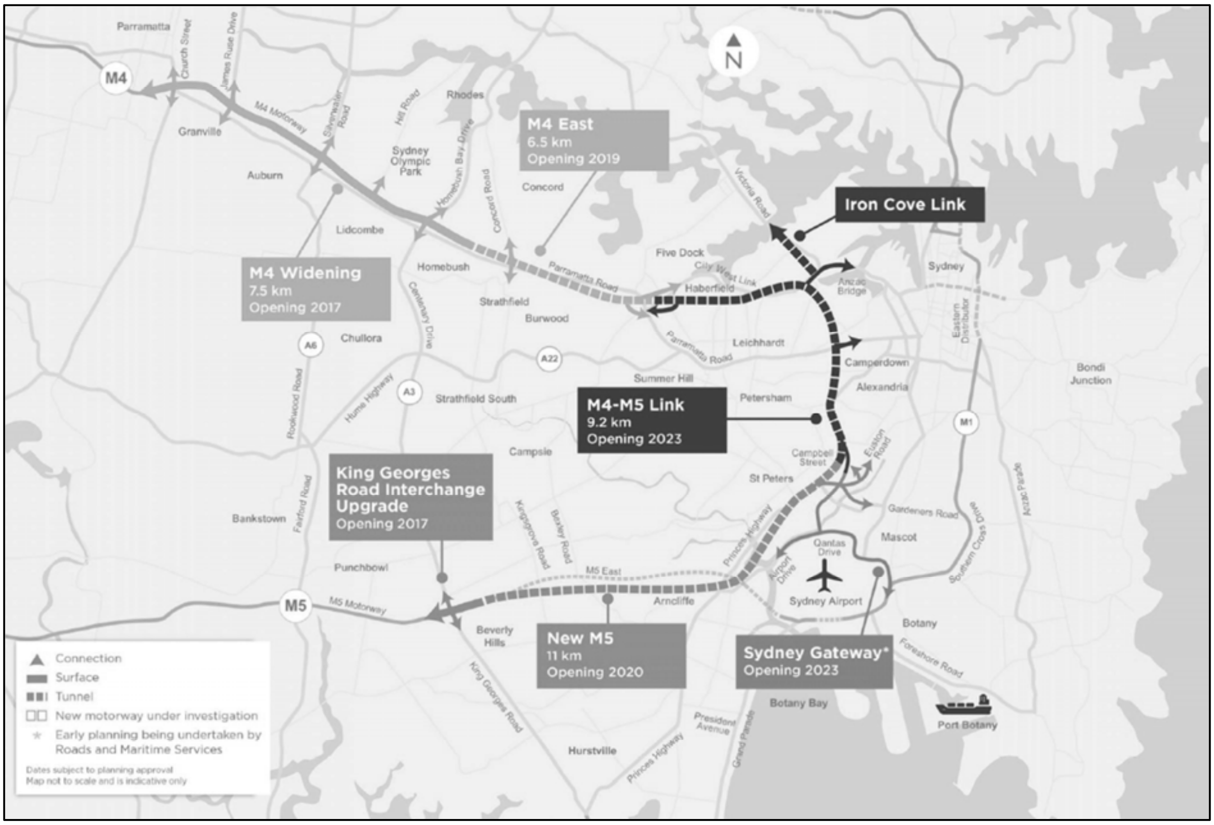
1. Development of the Southern Sydney Freight Line (at a cost of approximately AUD 1 billion) to provide a dedicated freight rail line, which achieved the following:
   - improved access for interstate and intrastate freight trains passing through the southern part of the Sydney rail network (the network carries large passenger loads on weekdays; there were curfews on freight trains entering the network before the SSFL; there are still are curfews on parts of the network that do not have a dedicated freight line)
   - extended an existing dedicated rail freight connection (between Port Botany and Enfield) to a new intermodal terminal to be developed on a 241-ha. site at Moorebank in south-western Sydney (about 35 km from the port).
2. Progressive upgrades of the motorway network, notably the development of the WestConnex project, which will be developed over three stages between 2015 and 2023 (at a nominal cost of AUD 16.8 billion).[1] The project will be funded with a mixture of:
   a. distance-based tolls on all vehicles, including trucks
   b. an availability charge from the NSW Government
   c. AUD 1.5 billion grant from the Australian Government.

Figure 4B.2. Map of existing and potential future infrastructure supporting Port Botany



Source: NSW Ports (2015a), p. 37.

Figure 4B.3. Map of WestConnex



Source: Sydney Motorway Corporation (2016)

3. Development of intermodal terminals:

   a. on an existing rail marshalling site at Enfield (approximately 15 km inland from the port). The terminal is being operated by the rail operator, Aurizon, in partnership with the port corporation; the port corporation presently has environmental planning approval to handle 300 000 TEUs per year through the terminal

   b. a new terminal for port-related containers and interstate rail traffic at Moorebank, on the site of a former military training facility; the terminal will operate as an open-access facility with capacity for up to 1.05 million import-export and 500 000 interstate freight containers per year by 2030; the site adjoins the dedicated freight rail network and the motorway network; the terminal is to be developed by Qube Holdings, a private operator, which is investing approximately AUD 1.5 billion in the project (Australian Department of Infrastructure and Regional Development, 2015); the Australian Government is contributing a further AUD 370 million (principally for a rail connection to the SSFL) and leasing the land for the terminal; the terminal is expected to commence operations by the end of 2017.

In addition to the infrastructure upgrades, the NSW Government has established a range of measures to improve the operational efficiency of the supply chain through the port (the Port Botany Landside Improvement System – PBLIS). These include the following:

4. Most notably, since February 2011, a range of Operational Performance Measurement standards have been applied to truck movements at the port. The standards are applied by NSW Government regulation. Stevedores and truck carriers incur reciprocal financial penalties for poor performance against the standards. The system provides:

- an independent data source
- truck tracking
- information to assist with traffic and congestion management
- transparency and visibility for carriers and stevedores
- user capable reporting (Penalty Trend, Truck Trip Arrival Performance, Truck Spread)
- online training.

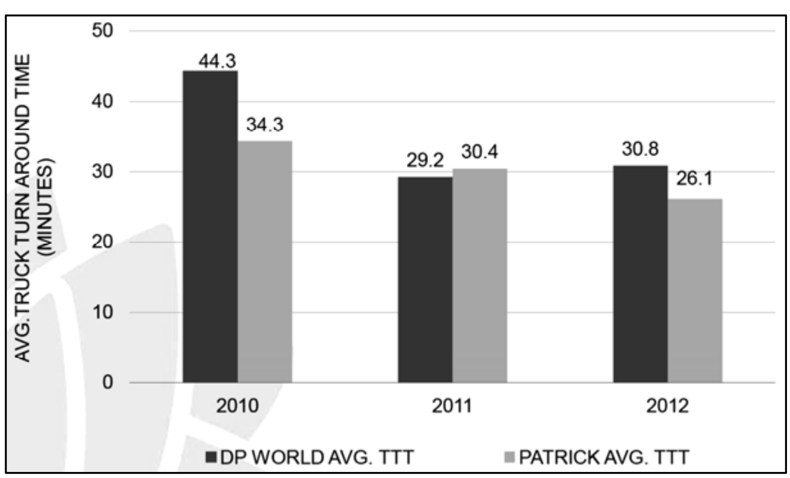
5. Consideration has been given to applying a similar regime to rail operations at the port:

- establishment of a Cargo Movement Co-ordination Centre and establishment of teams of industry and government stakeholders in the road and rail sectors, working to improve operations along the supply chain and at the port (Transport for NSW, 2015)

- use of "TruckCams" at selected locations around the port to provide timely information on traffic movements to assist port users in better managing their business.

Figure 4B.4 below shows the improvement in truck turnaround times at the two stevedores – DP World and Patrick – following the introduction of the PBLIS system. The on-time performance of trucks arriving at Port Botany increased from 72% before PBLIS to 93% in March 2013 (Transport for NSW, (2013).

Figure 4B.4 Turnaround times comparison by stevedore



Source: Transport for NSW, 2013.

4B.1.4 Overview of framework conditions (policy, planning, co-ordination)

Western Australia has a detailed hierarchy for developing long-term planning strategies across all sectors of its economy, including for the development of transport infrastructure. The Western Australian Planning Commission works in consultation with a range of government and non-government stakeholders to produce long-term planning strategies. Western Australia has been issuing these since 1997 (Western Australian Planning Commission, 2014: 7).

The most recent strategy was issued in 2014 and seeks to develop strategies until 2050. The State Planning Strategy is the highest-order planning instrument in the Western Australian planning system (ibid: 8). While the document does not bind government agencies to specific actions, it is used to guide, shape and inform a hierarchy of state, regional and local planning tools, instruments and decisions within the Western Australian planning system (ibid: 7). All other planning documents seek to be consistent with the planning strategy.

In the transport space, Western Australia has also developed other long-term planning documents. These include:

- the Western Australian Regional Freight Transport Network Plan 2031
- the Perth Transport Plan for 3.5 million people and beyond
- the Western Australian State Aviation Strategy 2015.

In addition, the Western Australian Government has quarantined revenue from the iron ore mining boom to plan and fund regional development, including transport infrastructure, as part of the *Royalties for Regions* programme (see Box 4B.2).

Box 4B.2. Royalties for regions

Since December 2008, the Western Australian Government has allocated a set proportion of revenue from mining royalties to regional development, as an addition to funding provided out of the ordinary state budget. The Royalties for Regions programme is a fund, enshrined in legislation, which ensures that 25% of forecast royalty income for each year (up to a cap of AUD 1 billion per annum) is allocated to development of Western Australia's regional areas (Royalties for Regions Act, 2009, (WA) ss. 3, 6(2) and 8). The fund consists of three subaccounts relating to local government, regional community services and regional infrastructure (ibid s. 5(11)). Funds from the Royalties for Regions programme may be used for the following purposes:

- to provide infrastructure and services in regional Western Australia
- to develop and broaden the economic base of regional Western Australia
- to maximise job creation and improve career opportunities in regional Western Australia (ibid s. 9(11).

The Royalties for Regions programme has a regional grants scheme, which allows the nine regional development commissions to administer and allocate some funds directly within their regions (Department of Regional Development, n.d.). Much of the funding under the scheme is allocated by the Minister for Regional Development. An independent advisory board, The Regional Development Trust, provides recommendations and advice to the minister on how to allocate funding and operate the programme (Royalties for Regions Act, 2009 (WA) s. 12).

Since its commencement in December 2008, the Western Australian Government has allocated AUD 6.1 billion to the Royalties for Regions programme and used on more than 3 600 projects (Department of Regional Development, 2015: 6).

One project being funded through Royalties for Regions is the Infrastructure Audit and Investment Fund. The Department of Regional Development has commissioned an infrastructure audit to improve supply chains and the opportunity for Western Australian producers to export premium quality food and fibre products from regional Western Australia. Once the audit it complete, it will be used to identify and fund necessary transport, freight, storage, packaging and processing infrastructure and to alleviate other supply chain constraints (Department of Regional Development, n.d.).

Note

1. The overall project is very large. By the time it is finished, there will around 25 km of motorway standard tunnel, as well as approximately 8 km of surface motorway. The expected cost of the project has increased since it was first announced, and there is speculation that, by the time the project is finished, the costs will increase further.

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4B.2 Southern Italy – Il Mezzogiorno

4B.2.1 Economic and demographic profile

The Italian Mezzogiorno is a macrozone comprising an area of 121 364 km^2 in the South of Italy. Around 20.5 million people live in the area, and the population density is 172 inhabitants per km^2. Incomes in Sothern Italy are lower than the national average, with GDP per capita of USD 23 304 in 2014. GDP growth has been stagnant after a sharp decline in the 2008-09 recession. Unemployment is high at 18% (2015), compared to 12% nationally.

The economy relies heavily on public services, agriculture and specialised industries such as food processing and the extraction of raw materials. Only 12% of Italy's exports are produced in the South, and export composition reflects the industry mix. However, the Mezzogiorno plays a key role in Italy's logistics chains, including by handling a large share of imports through its ports. The population is concentrated in and around main cities. More than 3 million people live in Napoli's metropolitan area.

These characteristics make the Italian Mezzogiorno a good comparator for Central Chile. However, it is worth noting that the income trajectory of Central Chile is on an upward trend, compared to a stagnant economy in Southern Italy. Therefore, the key challenge for infrastructure in Southern Italy is not to cope with growth but rather to cater for changing economic needs and to boost competitiveness against the threat of continued decline.

Table 4B.2 Characteristics of Southern Italy

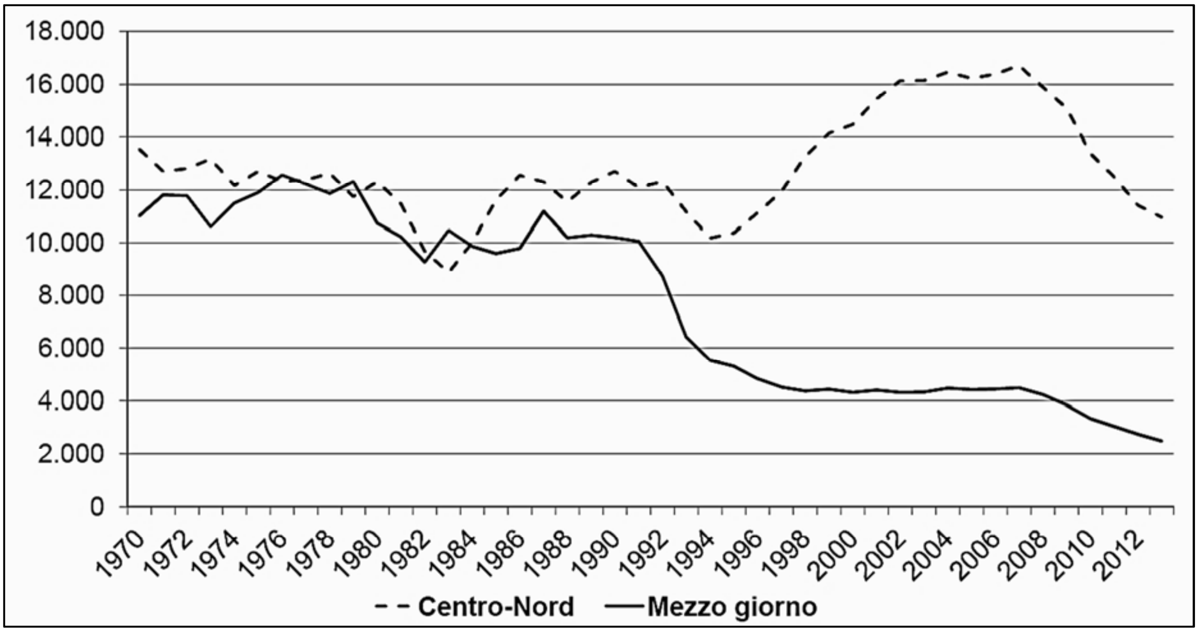
	Year	Southern Italy	Italy	Central Chile
GDP per capita (current USD)	2004	20 775	31 190	
	2014	23 004	34 909	13 979
Population density (inhabitants per km^2)	2004	169	196	
	2014	172	208	139
Main exports (by value, latest available)	1.	Extractive minerals	Chemicals and non-metallic mineral products	Copper and iron
	2.	Food and beverage	Wholesale and retail trade, hotels and restaurants	Fruits
	3.	Transport machinery	Machinery and equipment	Food

Source: Population: World Bank (2016a), ISTAT (2016a), Instituto Nacional de Estadísticas de Chile (2016a). Land area: World Bank (2016b), OECD (2016a), Instituto Nacional de Estadísticas de Chile (2016b). GDP: World Bank (2016c), ISTAT (2016b), Banco Central de Chile (2016b). Exports: OECD (2016), Direccion Nacional de Adunas (2016).

4B.2.2 Overview of transport infrastructure and key issues

Historically, transport connectivity has been a challenge for the Mezzogiorno given its complex geography – a peninsula with mountainous areas and two large islands. Following a period of high public investment over the 1970s and 1980s, the backbone of transport infrastructure has been provided across all transport modes. However, the decoupling of investment between the Centre and North and the South of Italy (Figure 4B.5) that has existed since the early 1990s is often blamed for the lack of progress in the coverage and quality of infrastructure in Southern Italy compared to the Centre and North.

Figure 4B.5. Investment in public infrastructure, constant million EUR 2005



Note: it includes transport, water and energy networks and reconstruction following natural disasters.

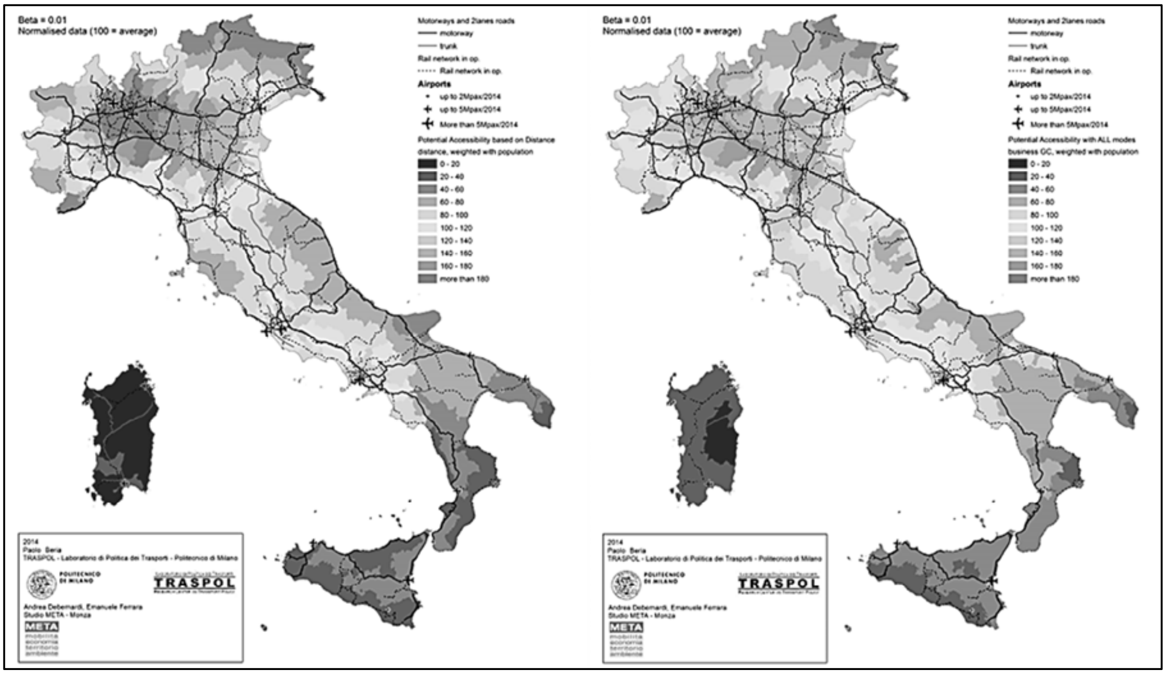
Source: SVIMEZ (2015b).

As a result, passenger transport infrastructure in the South of Italy is perceived as being worse than the rest of the country, and it is often blamed for holding back the economic potential of the area (SVIMEZ, 2015). However, large variations exist within the Mezzogiorno; for instance, the A1 motorway and the High-Speed Rail lines have been extended to the city-region of Naples (which is therefore well connected to the rest of Italy) but not further South. Figure 4B.6 shows that passenger connectivity to population centres and jobs is worse for most areas in the South than the rest of the country when considering all modes of transport.

Similarly, freight transport infrastructure coverage and quality is uneven across the Mezzogiorno. Some large port systems have been developed, sometimes integrated with intermodal services via hinterland ports. Overall, Southern ports handle around half of Italy's maritime traffic. Nonetheless, the development of freight transport in the South is hampered by the under-provision of some critical infrastructure links, such as the A3 motorway between Salerno and Reggio Calabria, and rail/road connections for the ports of Sicily and Apulia.

Despite a general trend of decline in investment, some improvements in passenger infrastructure have been made in recent decades, especially by strengthening rail services in and around cities and to and from transport hubs. Some of the sector-specific issues for transport infrastructure in Southern Italy are discussed next. We also present case studies on the A3 motorway, Naples' hinterland port and Bari's airport rail link.

Figure 4B.6 Accessibility to population and jobs – indicators for Italy, based on 2014 data



Notes: Medium light-grey areas in northern Italy and areas around Rome and Naples indicate good connectivity; dark grey to black indicates poor connectivity. Left: distance-based indicator weighted by population. Right: generalised cost-based indicator (business travel) weighted by population. All modes are included.

Source: Beria et al. (2016).

Road

The road network of Southern Italy comprises 357 686 km of roads, of which around 1% are motorways and 79% are paved. The stock of roads per 10 000 inhabitants is 37 km, above the Italy average of 30 km (Uniontrasporti, 2011).* While road network length has been stable over the past 15 years, two key challenges have emerged with respect to road infrastructure: completing the A3 motorway and maintaining the existing network.

Some view the A3 motorway as a missed opportunity for the economic development of Southern Italy. The motorway may finally be completed in 2016-17 after 20 years of works that were necessary to upgrade it. When the motorway is completed, the north-south backbone infrastructure of Southern Italy will still need to be strengthened to improve the connectivity of Sicily with the rest of the country. Infrastructure needs include the Palermo-Messina connections and potentially a suspension bridge between Messina and Reggio Calabria, for which only preparatory work has been carried out.

The need for road maintenance emerges over time and tends to be directly proportionate to the size of infrastructure stocks, and inversely proportionate to the quality of those stocks. Against a large stock of roads, maintenance budgets have been repeatedly cut under budgetary pressures in Italy; between 2008 and 2012, annual maintenance spending by ANAS decreased from EUR 1.65 billion to EUR 1.15 billion (European Parliament, 2014). Adequate funding for road surfaces is a key pledge of the 2016 Ministry of Transport Plan (Ministero dei Trasporti, 2016), responding to pressures by users and stakeholders on the declining quality of roads.

* Figures exclude urban and other municipal roads

Box 4B.3. The importance of getting investment right
The A3 motorway's EUR 10 billion makeover

The A3 motorway connects Naples to the southernmost city of the Italian peninsula, Reggio Calabria. The A3 was initially planned in the 1950s as the continuation of the A1 motorway (Milan-Naples), which was built and operated (with toll payments) by private investors in partnership with the Italian State. Unlike the A1, however, the A3 was viewed as a public interest project to connect the poorer regions of the South to the Centre-North of Italy. As such, it was wholly financed and built by the State, through its wholly controlled company ANAS, free of charge for users.

The A3 motorway was designed to be single carriageway, with no emergency lanes, and have a length of 440 km, 30% of which was tunnelled given the local morphology. Following the car ownership boom of the 1970s and 1980s, the infrastructure standards of the A3 were revealed to be insufficient, with constant congestion and safety problems. New projects were thus devised to widen the road by adding extra lanes and to improve safety by building new emergency lanes, overhead bridges and tunnels. Works began again in 1997, and after years of delays, they are expected to be finished by 2016-2017.

The case of the A3 motorway illustrates the risks in under-funding infrastructure built to promote regional development. The estimated investment for 1997-2015 is around EUR 10 billion. The makeover of the A3 motorway has damaged the competitiveness of Southern Italy in two ways: first, by reducing connectivity for a prolonged period, with associated high journey times and low safety standards on a key north-south axis; and second, by diverting financial resources away from other infrastructure projects in the area to fill this gap.

Source: "La storia siamo noi" RAI, 2015; Floris, 2010.

Rail

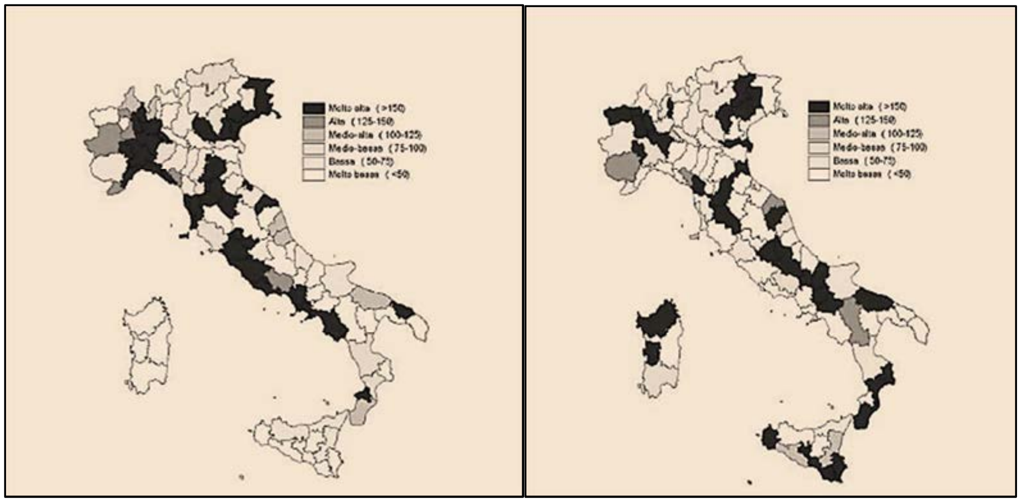
The coverage and quality of rail infrastructure in the Mezzogiorno is below national standards. In addition to the lack of High-Speed Rail connections south of Naples, regional and suburban lines have a low share of electrification (40% in the South compared with 70% nationally) and a high share of single-track lines (RFI, n.d.).

Therefore, passenger services are slower in the South (Uniontrasporti, 2011) than in the rest of the country, and efficiency is held back by the over-reliance on diesel trains. The average age of rolling stock in the South was 20.4 years as opposed to 16.6 years in the North, and more than 50% of trains running in the Mezzogiorno are more than 20 years old (Legambiente, 2015).

Rail freight has historically been marginal in the movement of goods in Southern Italy; however, new investment has been directed to freight in recent years (see Box 4B.3*)*.

Airports in the Mezzogiorno lacked dedicated rail links until recently, when services were opened in the Palermo (2001), Reggio Calabria (2013) and Bari airports (see Box 4B.4). As with roads, Naples is well connected to the Centre and North. As well as the high-speed passenger line, there is an important freight link to the logistics hubs of the north between Bologna and Verona, connecting on to the rail networks of Austria and northern Europe. Customs facilities have been established in Bologna's Hinterport to operate dry port services for Naples for bonded containers, bypassing delays at the Naples port, although labour interests in the customs and inspection services have hampered the use of these facilities.

Figure 4B.7 Density of double-track, electrified lines (left) and single-track, non-electrified lines right)



Notes: dark grey = high density, white = low density.

Source: ISTAT (2006).

Box 4B.4. Integrating Bari Airport with the regional rail network

Airports in the Mezzogiorno carry around 24 million passengers annually. While most airports are served by public transport to and from the nearest city, Bari Airport was the first Southern airport to open a rail link in 2013. Located in Apulia, Bari Airport handles 4 million passengers per year, travelling to both national and international destinations. Over the summer months, it is one of the main points of entry for tourists arriving to the region.

The rail ink was built over 2009-2012 as a spur of the existing regional rail network. The rail link is 8 km long and fully electrified, and it adopts an automatic train control system. Trains can reach maximum speeds of 110 km/hr but on average travel at 60 km/hr. The overall cost of the link was just over EUR 80 million, co-financed by the Region Apulia and the European Commission.

The new infrastructure connects Bari Airport to the city of Bari in 15 minutes, as well as to other regional cities and towns with direct services. A notable feature of the new line at the planning stage was the creation of a stop between Bari and the airport in correspondence with the newly created headquarters for tax authorities (*Cittadella della Finanza*), encouraging land-use and transport integration.

Source: "All'aeroporto di Bari in treno", Ferrovie.it, 2013; FerrovieNordBarese website; Bari Airport website

Ports

Around half of all national maritime traffic is handled at ports in the South of Italy, equivalent to 5 million TEUs per year. The majority of container traffic goes through the port of Gioia Tauro in Calabria, which is the largest transhipment port in Italy. The second and third largest ports by volumes are Taranto and Naples. Naples is the largest import port, specialising in containers and liquid bulk.

Inward connectivity by road and rail to the main ports is one of the national priorities for the ports (Ministero dei Trasporti 2016). Implementing this plan will require close cooperation between public companies (such as port authorities and the rail network manager – RFI), private actors (including intermodal terminal owners) and transport users. The Italian Ministry also stresses the importance of linking all core ports by rail, ultimately to the European freight corridors, to maximise the potential for long-distance Ro-Ro traffic from Southern Italian ports (Ministero dei Trasporti 2014).

Box 4B.5. Intermodal infrastructure – Naples' extended port

The Port of Naples is one of the largest ports in Southern Italy, with a capacity of just over 500 000 TEUs. More than 430 000 TEUs, mainly container traffic for import goods, have been handled annually at the port (traffic has remained fairly constant since the early 2000s), which therefore operates close to capacity. Only 8% of all goods were moved by rail to and from the port. In this context, plans for an "extended Port of Naples" were developed over the past decade, focusing on two key objectives: increasing the modal share of rail and decongesting the port by moving some key functions inland.

The plan has taken shape with the creation of a large hinterland site for port logistics around the existing rail freight depot of Nola, about 30 km inland from Naples. Owned by a private company and known as "*Interporto Campano*", the logistics site occupies an area of 3 million m^2, hosting a large intermodal terminal and parking areas that can cater for up to 3 000 trucks. However, road transport makes up only 18% of traffic at the site. The site is linked to the national rail freight network by a short stretch of electrified railway lines; this in turn is linked to the European TEN-T Corridor 1. Between 10 and 12 weekly rail shuttles have been introduced to move containers arriving on different ships from the Port of Naples to the *Interporto Campano* under a single load, achieving the densities needed to make rail the preferred mode of transport.

Evidence from other OECD countries suggests that Naples' extended port could become a success story for the Mezzogiorno. The hinterland port can reduce capacity constraints at the Port of Naples and road congestion in and around the city. The site will be strengthened through new rail services planned by national freight operators and the expansion of border control facilities. The *Interporto Campano*, however, would not have been possible without the close co-operation between public actors and the private sector, both with respect to co-ordinated planning across modes and to financing. For instance, state contributions amounted to around 30% of the start-up costs of new rail services.

Source: Interporto Campano website, Port of Naples website, European Commission C(2009) 4508

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4B.3 New Zealand

4B.3.1 Economic and demographic profile

New Zealand is an island nation in the south-western Pacific Ocean, covering 263 310 km^2. It is similar in size to the United Kingdom (UK), with no part of New Zealand being greater than 130 km from the sea. New Zealand's main populated territories are its North and South Island, which sit on the Pacific rim. This location gives those islands volcanoes and makes them prone to earthquakes. It has a largely temperate climate (Statistics New Zealand, 2015: 2).

In 2014, New Zealand's population was 4 509 700, with most of the population living on the North Island. Its only large city by international standards is Auckland. The city is home to one-third of the New Zealand population (1.4 million), hosts the country's major commercial and manufacturing centres, and serves as the logistical trade node. Auckland hosts New Zealand's largest two largest export platforms by value (Port of Auckland and Auckland International Airport).

New Zealand has two other regional cities. The capital, Wellington, has less than one-third of Auckland's population at 398 200, and the only other city with a population of about 300 000 is Christchurch at 381 800 (Statistics NZ, 2015a). New Zealand's average population density is 17.13 people per km^2.

New Zealand is a high-income country. In 2014, its Gross Domestic Product (GDP) per capita was USD44 342. Of New Zealand's GDP, 28% is derived from exports. New Zealand's main exports by value include agricultural goods and services.[1] It also has a substantial forestry export industry.

These characteristics make New Zealand a good comparator for the Southern Chile.

Table 4B.3 Characteristics of New Zealand

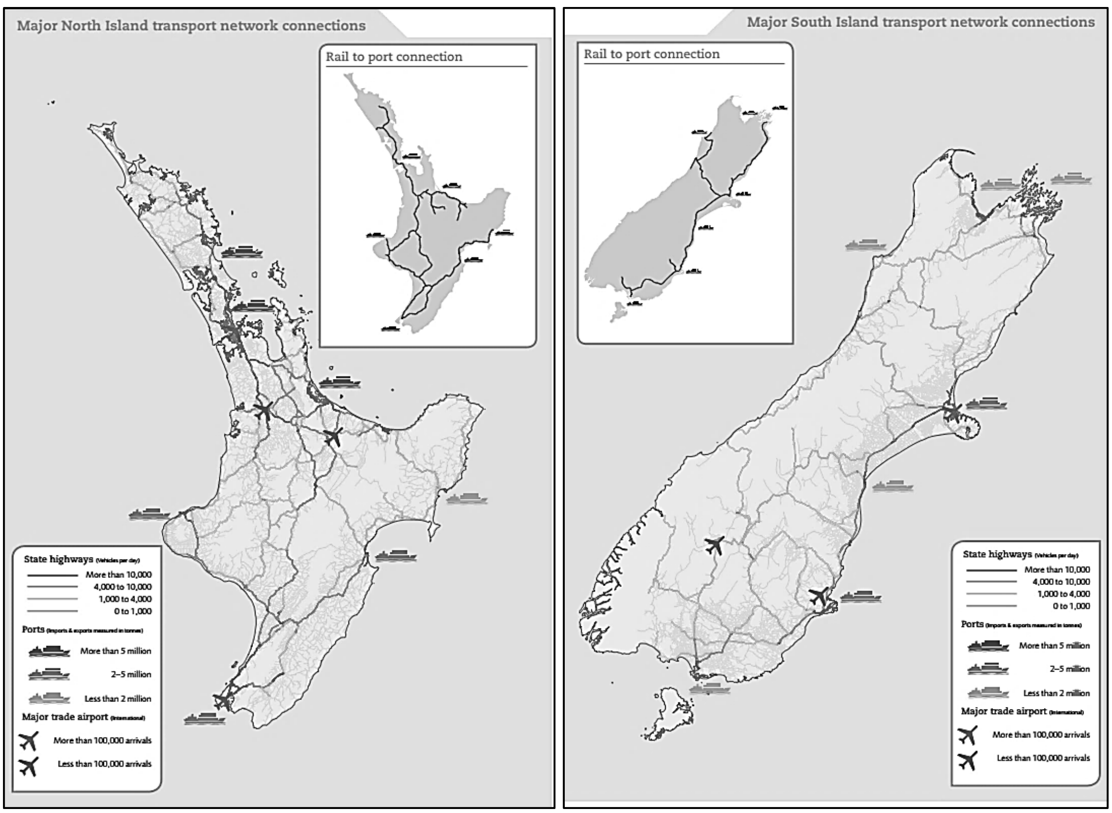
	Year	New Zealand	Central Chile
GDP per capita (current USD)	2004	25 104	
	2014	44 342	7 435
Population density (inhabitants per km^2)	2004	15.52	
	2014	17.13	39.91
Main exports (by value, latest available)	1.	Food products, beverages and tobacco	Paper, paper products
	2.	Wholesale and retail trade, hotels and restaurants	Forestry
	3.	Transport and storage, post and telecommunication	Food

Source: Population: World Bank (2016a), Instituto Nacional de Estadísticas de Chile (2016a). Land area: World Bank (2016b), Instituto Nacional de Estadísticas de Chile (2016b). GDP: World Bank (2016c), Banco Central de Chile (2016). Exports: OECD (2016), Direccion Nacional de Adunas (2016).

4B.3.2 Overview of transport infrastructure and key issues

New Zealand has extensive transport infrastructure and substantial plans to improve its transport infrastructure for the next 30 years. At present, the New Zealand Government subsidises the road and rail networks. It requires ports and airports to have a commercial focus, and a similar focus increasingly applies to rail (National Infrastructure Unit, 2015: 20).

Figure 4B.8 Map of transport networks in New Zealand



Source: NZ Ministry of Transport.

The following provides an overview of the transport infrastructure in New Zealand.

Road

New Zealand has approximately 95 000 km roads, two-thirds of which are paved (ibid: 3). New Zealand's roads can be considered in two categories. The State Highway network is made up of 11 000 km of highways that link cities and towns and provide access to transport hubs, such as ports. Despite being only 11.6% of roads, the State Highway network carries almost half of all road travel kilometres in New Zealand. The State Highway network is funded and operated by the national government through the New Zealand Transport Authority. Approximately 27.5 km of the network is tolled (New Zealand Transport Agency, n.d.).

All other roads are the responsibility of local and regional governments. However, much of this is subsidised by the national government.

Box 4B.6 Small but congested cities

The drive for greater asset utilisation has created larger volumes at some ports, such as Auckland. However, the Port of Auckland is adjacent to the city's central business district. Therefore, land near the port is limited, and an increased number of trucks travelling to the port is exacerbating congestion in the area.

Road carries the majority of traffic in New Zealand, especially in and around cities. There is heavy reliance on private motorised vehicles for urban transport. Public transport accounts for only 2.8% of all trips. Private vehicles account for almost 80%. There are several factors that appear to encourage private vehicle use in New Zealand cities. These include:

- spread-out, low-density cities (hindering cost effectiveness of public transport)
- historically low levels of public investment in infrastructure for public transport
- administrative boundaries not matching the real boundaries of built-up areas (hindering planning co-ordination).

Together with economic and population growth, as well as New Zealand's geography, the factors encouraging private vehicle use have resulted in substantial congestion in New Zealand's main cities. In fact, congestion in New Zealand's main cities is higher than that in most Australian cities that have higher populations.

Starting to address congestion in Auckland

Just over 90% of Aucklanders commute to work by car, and the number of kilometres travelled by car has increased by 30% since 2000.

The New Zealand government has sought to address congestion and other issues in Auckland through a range of mechanisms including:

- increased investment in transport infrastructure, including public transport infrastructure; motorways, busways and electrified urban rail have been introduced or expanded in recent years
- reforming governance and planning systems, such as merging the eight previous bodies governing the Auckland metropolitan area into a single body, the new Auckland Council
- requiring the Auckland Council to develop the Auckland Plan, which, among other things, sets out strategies for building infrastructure to improve Auckland's congestion over the next 30 years.

While there are signs of improvement, the Auckland Plan acknowledges that forecast population growth means that congestion will deteriorate over the next 30 years, even with very substantial investments in transport infrastructure.

Rail

New Zealand has approximately 3 500 route-km of railway (KiwiRail, Annual Integrated Report, 2016: 6), down from a peak of 5 695km in 1952 (Asia-Pacific Economic Co-operation, 2011:231). At present, the railways focus on linking New Zealand's main industrial and agricultural centres and ports. There has been an increased focus on freight activities, and several segments of the passenger network have been closed in recent years (National Infrastructure Unit, 2015: 4, 8).

Following the privatisation of railways for a relatively short period (1993-2008), the New Zealand government bought back the national railway operator, currently branded KiwiRail (Kiwi Rail, n.d.). The operator is vertically integrated, operating and maintaining rolling stock and rail infrastructure services. Local governments own the rolling stock that provides urban public transport and contract with KiwiRail for those services (ibid: 4). KiwiRail's above rail operations are cash positive. However, the New Zealand government provides a subsidy (NZD 210 million in 2016) to fund the rail infrastructure (KiwiRail, 2016: 21).

While the government is addressing road congestion through improved rail public transport, land-use limitations at the Port of Auckland incentivise moving more freight by rail to inland ports. Passenger and freight services share rail infrastructure in Auckland. Thus, congestion on Auckland's railways is increasing, undermining reliability for both passenger and freight services. In turn, this undermines government attempts to move passenger and freight transport from road to rail. In November 2016, KiwiRail proposed that the New Zealand government fund construction of separate freight rail lines in central Auckland to ease congestion for both passenger and freight trains (KiwiRail, 2016: 41). So far, the New Zealand government has not made any decisions on the proposal.

Box 4B.7 Governance structures and policy objectives changed; underlying economics did not

Over the past 40 years, New Zealand's rail industry has experienced several reforms. Originally, the New Zealand Railways Department built infrastructure and operated services. Rail was viewed as a public service to link sparsely populated communities and industries to population centres and ports. It was protected from competition by restrictions on road haulage. However, protection did not prevent competition from trucking and domestic shipping. In turn, from the 1920s onwards, rail in New Zealand required increasing government funding as operating profits declined and turned negative.

In 1982, New Zealand corporatised rail into a vertically integrated government business enterprise – the New Zealand Rail Corporation (NZRC). This improved efficiency, reducing staffing by 54%, closing some uneconomic lines and steadying rail's decline. However, this was not enough to stop the downward trend, especially after protections were removed in 1986. In 1990, the NZRC transferred operations to NZ Rail to prepare for privatisation.

In 1993, a new government privatised rail, and NZ Rail became Tranz Rail. The government sought to maximise access of the new company to private funding and avoid further government investment by selling an integrated monopoly with no access regime. This provided incentives for investment, which improved productivity.

Tranz Rail was unable to sell any land under the rail network, and in 2002, another new government prevented it from closing any of the 41% of rail lines that Tranz Rail considered to be uneconomic. In 2002, this resulted in Tranz Rail on-selling the railway at a discount to Toll Rail.

In 2004, Toll Rail returned the unprofitable rail infrastructure to the government (NZRC) and began paying an access charge for rail operations. Tension over the access charge followed. The government sought increases to fund infrastructure enhancements. Toll Rail sought decreases to keep rail freight competitive with road. Toll Rail's ability to withdraw operations gave it greater bargaining power, reducing access charges and, in turn, increasing subsidies.

In 2005, New Zealand enacted a limited access regime for freight lines that Toll was underutilising.

The government was prepared to subsidise rail to provide the extensive national rail network that it considered necessary to meet its goals relating to regional development, primary industry exports and the environment. However, it considered it preferable to provide subsidies to a government entity rather than a foreign, private company. Thus, in 2008, the government bought back the operations for NZD 690 million.

A month later, the government changed again. This government expected a commercial rate of return and that any subsidies would be transparent. Further efficiencies followed, including substantial line closures. Network length has been reduced from 4 000 km in 2008 to 3 500 km in 2016. Above rail operations are cash positive, while below rail operations continue to require substantial subsidies (NZD 210 million in financial year 2016).

The various reforms to the New Zealand rail sector demonstrate how structural changes cannot remedy fundamental economic issues. New Zealand's low population density, together with its legacy network's layout and narrow gauge, make government subsidies a necessity if there is to be an extensive national passenger and freight rail network. It is advisable to identify the underlying circumstances driving challenges in a country's rail network and addressing those directly and transparently, rather than assume that corporatisation, privatisation or open access will cure all issues.

Furthermore, New Zealand's experience indicates the importance of setting and holding true-to-policy objectives over the long term. New Zealand's rail reforms may have been more successful if the original efficiency objectives were maintained throughout the period. This would have allowed the railways to focus on areas such as bulk freight on a limited number of profitable lines where they provide greatest benefit to the community, rather than needing to provide a broader range of services. Coincidentally, these are often also the areas providing commercial returns and operating on an environmentally sustainable basis.

Source: APEC, 2011 (pp. 230-253); KiwiRail, 2016 (pp. 6, 21).

Ports

As an island nation, New Zealand's international trade relies heavily on port infrastructure. Of New Zealand's international trade, 99% is shipped through sea ports (National Infrastructure Unit, 2015: 10). It has 16 ports that service domestic and international ship movements. More than two-thirds of throughput volume at New Zealand ports is bulk, rather than containerised freight. However, containerised freight is 80% of the value of exports (ibid: 4-5).

New Zealand's biggest container freight and passenger port is adjacent to the Auckland central business district (Ports of Auckland, 2015: 3). Approximately 200 km away, the Port of Tuaranga has expanded from its previous focus on forestry exports to compete with the Port of Auckland for container transport.

Most ports are owned by local governments (there is also some private ownership), with each port serving a local hinterland. However, over time, international ships have called at fewer ports to obtain greater asset utilisation.

Box 4B.8 Inland port competition

The drive for greater asset utilisation has created larger volumes at some ports, such as Auckland. However, the Port of Auckland is adjacent to the city's central business district. Therefore, land near the port is limited, and an increased number of trucks travelling to the port was exacerbating congestion in the area.

The Port of Auckland responded to these challenges by creating an inland port, located in the south of Auckland close to its manufacturing and industrial activities. Containers are moved by rail from the Port of Auckland to the Wiri Inland Port, reducing truck traffic in central Auckland, while helping to address congestion and difficulties with limited space at the port.

The Port of Tuaranga, 200 km by road from Auckland on the east coast, has sought to compete with the Port of Auckland. It has also built an inland port, MetroPort, in southern Auckland, which has a rail link to the Port of Tuaranga (Port of Tuaranga, 2015: 2).

A third inland port, valued at NZD 3.3 billion, will shortly be built at Ruakura, east of Hamilton, 125 km south of Auckland. Ruakura will have rail links to both the ports of Auckland and Tuaranga. Unlike the ports of Auckland and Tuaranga, which have substantial local government ownership, the Ruakura inland port is being funded by Tainui Group Holdings (TNH), which is the investment arm of a local Maori organisation, Waikato-Tainui. Since 1995, TNH has grown an initial settlement payment of NZD 170 million under the Treaty of Waitangi into over NZD 1.1 billion of assets (National Infrastructure Unit, 2015:17). Profits from the Ruakura inland port will form part of TNH's dividends, which are used to support the community through a range of activities including funding for employment and scholarships (Waikato-Tainui, 2016: 4).

Airports

New Zealand has five airports receiving international flights and 26 receiving domestic flights (National Infrastructure Unit, 2015: 4). Auckland International Airport has the largest passenger and cargo operations. It is the second largest cargo port by value in New Zealand (ibid: 25). New Zealand's other key international passenger airports are in Wellington and Christchurch. Most airports in New Zealand are owned by local governments. There is also some central government or private ownership of airports. The three key international airports are subject to light-handed economic regulation.

Surface access to Auckland International Airport has been a growing concern, given the increasing difficulty that passengers, staff and businesses have experienced in accessing the airport. Airport managers commissioned a surface access study in 2005, and the study confirmed the presence of severe travel-time delays to and from the airport as a result of bottlenecks on the regional road network. It also highlighted the weaknesses in public transport services. A number of planning and feasibility studies are under way, paving the way for the construction of a dedicated public transport link, possibly by rail, to better serve the airport and reduce congestion.

4B.3.3 Overview of framework conditions (policy, planning, co-ordination)

New Zealand has detailed mechanisms to undertake transport infrastructure planning. The National Infrastructure Unit within the New Zealand Treasury works with a range of stakeholders to develop, monitor and update the National Infrastructure Plan (NIP) and the supporting evidence base, which cover infrastructure across all sectors of the economy. The most recent 30-year plan and supporting evidence were released in 2015. They include a vision for infrastructure over the life of the plan and more detailed objectives that explain the vision. In addition, the plan sets out the strategic context, current state of infrastructure and the responses that the plan proposes.

In addition to the NIP, the **2003 Land Transport Management Act** (LTMA) sets out the requirements for the operation, development and funding of the land transport system. Through the Government Policy Statement on Land Transport (GPS), the central government sets the overall objectives and long-term results sought over a ten-year period, as well as expenditure ranges for each class of transport activity. The New Zealand Transport Agency (NZTA) then develops a three-year National Land Transport Programme, which outlines the activities that will receive funding from the National Land Transport Fund. These activities are selected from proposals prepared by regional land transport committees. Activities proposed for funding must form part of a ten-year Regional Land Transport Plan (RLTP). All RLTPs must be consistent with the GPS. There are also requirements to consult Maori affected by these plans.[2]

Notes

1. New Zealand includes travel, commercial and transportation services under the service category. Commercial services include financial and insurance services, telecommunication and computer services, and other business services. Government services are also included; see Statistics New Zealand, New Zealand in profile, 2015, p. 2.
2. Land Transport Management Act 2003 ss. 18F and 18G.

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4B.4 Northern Sweden – The Sub-Arctic

4B.4.1 Economic and demographic profile

This area of Sweden stretches from the north-eastern border with Finland to the inland mountainous areas marking the border with Norway on the West. To the east, the coastal region along the Baltic Sea is relatively flat, with several island archipelagos. The area has a sub-arctic climate, with cold winters and mild summers. The inland territories receive abundant precipitation.

Northern Sweden had a population of 1 714 342 inhabitants in 2014 and a population density of just under 6 inhabitants per km^2. The largest county is Norrbotten, representing one-quarter of Sweden's total land area. Three-quarters of the population is concentrated along the coast, and Umeå, the biggest city, has 100 000 inhabitants. The inland regions are very sparsely populated.

The area is rich in mineral resources, notably iron ore, and forests, with a large production of timber. Almost 90% of the entire European supply of iron ore is extracted in Norrbotten. Forests cover almost 60% of the area of Västerbotten County area and 35% of Norrbotten County. The forests provide raw materials for the sawmill, carpentry, cellulose and energy industries, and they are also significant for biodiversity, ecosystem-related services and experiencing nature. Other business activities include industries such as gold and hydropower. Tourism is on the rise. Between 2004 and 2014, GDP per capita grew by more than one-third in Northern Sweden; average incomes are slightly below the national average.

These characteristics make Northern Sweden an appropriate comparator for Chile's Austral marcozone. Although the southernmost regions of Chile have an even more irregular territory and lower population density, the geographic and climatic conditions of Northern Sweden are not too dissimilar. These, coupled with economic activities such as forestry, result in similar demands for local transport networks. A notable difference is that Northern Sweden has a highly developed mineral extraction industry.

Table 4B.4 Characteristics of Northern Sweden

	Year	Northern Sweden	Sweden	Chile Austral
GDP per capita (current USD)	2004	36 896	42 442	
	2014	50 068	58 939	9 693
Population density (inhabitants per km^2)	2004	5.97	22.08	
	2014	5.99	23.79	3.82
Main exports (by value, latest available)	1.	Forestry	Chemicals and mineral products	Food products
	2.	Chemicals and mineral products	Wholesale and retail trade, hotels and restaurants	Forestry
	3.		Real estate	

Source: Population: World Bank (2016a), Statistics Sweden (2016a), Instituto Nacional de Estadísticas de Chile (2016a). Land area: World Bank (2016b), Statistics Sweden (2016b), Instituto Nacional de Estadísticas de Chile (2016b). GDP: World Bank (2016c), Statistics Sweden (2016c), Banco Central de Chile (2016). Exports: OECD (2016), Direccion Nacional de Adunas (2016).

4B.4.2 Overview of transport infrastructure and key issues

Transport infrastructure in Northern Sweden is designed to meet the needs of extractive industries such as iron ore extraction and forestry, as well as for passenger connectivity within the region and with the rest of Sweden. Road and rail networks need to be resilient enough to accommodate both freight and passenger flows throughout the year considering very low temperatures and heavy snowfalls.

Road

The road network is Northern Sweden covers 18 000 km of publicly owned roads, characterised by a large share of roads with low traffic volumes (<1 000 AADT) and high seasonal fluctuations (ROADEX, n.d.). Fluctuations correspond to production peaks for extractive industries and to periods of high tourist activity. In mountainous areas, for instance, spring time is when passenger car traffic is the highest, corresponding to the peak season for frost-related road damage. Road deformations and restrictions can have high economic impacts on local industries. Northern Sweden has reduced the number of road fatalities in recent years to low levels, but the rate is still double that for Sweden as a whole.

Around two-thirds of all roads in Northern Sweden are paved, and around one-third are gravel roads. Meeting the requirements of heavy haulage on secondary roads (that are often not paved) is a specific challenge of this area. Design standards are based on traffic flow, as well as stress and strain calculations; layer thickness is dependent on the chosen construction type, the number of equivalent standard axles,[*] and the type of material in the subgrade and the climatic zone. The highest road standards are set for roads with >2,000 AADT and prescribe a rock-bitumen pavement. For roads to be considered as suitable for paving, traffic must be higher than 250 AADT.

In Sweden during the 1980s, most low-traffic-volume roads were paved with thinner and weaker structures, mainly using “Y1G” (surface dressing with one layer, 0-18 mm – a layer of stone is stuck with bitumen emulsion on the underlying gravel layer). The Y1G method was aimed at gravel roads to make the surface more even and reduce dust.

Although cheaper, the Y1G method revealed its limitations over time. The gravel road beds on which the solution was applied were not built to appropriate standards, and new surfaces were already subject to heavy damage after only a few years, especially in frost-sensitive areas. It was then necessary to impose bearing capacity restrictions (12-ton maximum weight), particularly during the spring thaw. This negatively affected heavy vehicles relying on these roads.

Thin-layer paving solutions were almost entirely abandoned in Sweden as a result of this experience, which highlighted the risks of using thin layers directly on gravel roads. Thin layers are only used today when the road has good bearing capacity, a base course and good drainage. Importantly, thin layers are only applied on roads with very low AADT and almost no heavy traffic.

* This number is calculated from AADT, the percentage of heavy vehicles, the number of standard axles per vehicle and the assumed changes in traffic during the intended lifetime of the road.

Rail

The rail network is approximately 1 670 km long in Northern Sweden. One of the main railway lines is the Ore Railway, between Luleå (Sweden) and Narvik (Norway), which carries iron ore products from the extraction sites to areas of industrial refinement in Sweden to export ports in Norway. Norwegian fish products are also carried into Sweden on the line. Half of Sweden's tonnage of railway freight is transported from Kiruna to Riksgränsen and on to Narvik.

Other important freight links run east-west, for instance carrying ore from the interior to the coast where steel factories are located, and north-south, carrying those metal products to Southern Sweden for value-added manufacturing. Thus, the share of rail freight transport is high in Northern Sweden (38% of all tonne-km are moved by rail.).

Passenger services are provided along the north-south axis running inland because of strategic, historical decisions not to build rail lines along the coast. Services subsidised by the State include two overnight trains per day linking the North to Stockholm and Goteborg. One of the largest infrastructure projects in Northern Sweden is linked to the construction of the North Bothnian Line, which will complete the coastal railway line, connecting the major population centres in the region and reducing journey times between them and to the rest of the country (see Box 4B.9*)*.

Box 4B.9 The North Bothnian Line

The Bothnian Corridor extends along the Swedish and Finnish sides of the Gulf of Bothnia. The northern part of the corridor, which will extend between Umeå and Luleå, is recognised as a "missing link" in Sweden's strategic infrastructure.

Original plans envisaged the construction of the North Bothnian Line as a key freight link, connecting to the existing Bothnian Line in the south for onwards transport towards Europe, the Iron Ore Line in the west leading to Norway and the sea routes, and to the east via the Haparanda Line to the Finnish and Russian rail networks. Upon completion, the Bothnian Corridor would bring together several rail networks and enable transport to the east-west interchange between the east coast of the US and the Far East.

However, a number of studies during the 2000s showed that there would be considerable benefits for passengers travelling between Northern Swedish cities and towns as well. Currently, around 300 000 people live along the rail route, and all passenger movements take place by road. New rail services would significantly reduce journey times for different categories of users, including commuting trips for professionals, workers in key service sectors and students. For instance, travelling between Luleå and Umeå would be 20 minutes faster.

After years of delays linked to changes in political circumstances and budget availability, the presence of these large benefits for both freight and passenger services resulted in the project being reintroduced as a priority project by the Swedish government in 2014 and consequently marked as part of the part of the European Core Network, to be completed by 2030.

Construction of the 270-km North Bothnian Line is planned to commence in 2018 for a total estimated cost of around EUR 3 billion. The project will be co-funded by the European Union and some of the municipalities located along the Line, which have pledged to contribute with direct funding as well as investment in related infrastructure such as railway stations.

Source: European Railway Review (2013); Trafikverket (2016).

Ports

The largest commercial port is located in Luleå. Luleå is Sweden's leading bulk goods terminal. Iron ore constitutes more than half of the volumes traded. An effective icebreaker service enables the ports of Piteå and Luleå to remain open all year round for the intensive shipping. The harbour in Kalix also has year-round shipping, although on a smaller scale than Luleå and Piteå. Shipping is crucial for export competitiveness: for example, 95% of all the overseas exports from Västerbotten County (measured in tonnes of goods) are moved by ships.

Passenger ferry services are also important to connect isolated communities. Where it is not possible to build bridges, the Swedish government provides ferry services free of charge for the local population. With respect to international connectivity, the Kvarken route, a ferry line between Umeå and Vaasa, provides an important year-round link with Finland.

Airports

There are 11 airports in Northern Sweden, three of which are part of the primary network operated by Swedavia and eight of which are owned by local municipalities. Sweden's Transport Agency is responsible for procuring non-commercially viable services at these airports. These services are directly subsidised by the government. Luleå Airport is the sixth largest airport in Sweden, and the air route to Stockholm/Arlanda is the busiest domestic route in Sweden. The next largest airports are in Umeå and Kiruna.

4B.4.3 Overview of framework conditions (policy, planning, co-ordination)

The Ministry of Enterprise, Energy and Communications has responsibility over transport matters in Sweden. The ministry, together with the Swedish Parliament (Riksdag), sets the overall direction for transport policies through the Direction Plan, within the framework of Policy Goals and Policy Principles (see Box. 4B.10).

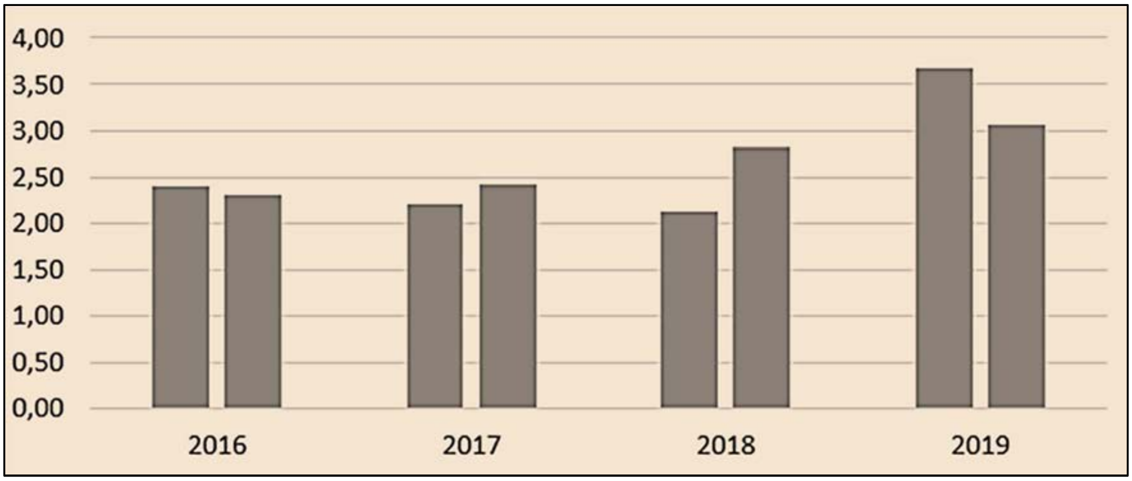
The Swedish Transport Administration (Trafikverket) operates under the authority of the ministry and has overseen all modes of transport since 2010. Based on the Direction Plan, it is tasked with preparing an Infrastructure Proposal to cover how Swedish roads, railways and infrastructure for shipping and aviation should develop and be managed over a period of 12 years. The Proposal, with its associated budget, is sent to Parliament by the government. This offers Parliament the opportunity to modify the proposal, balancing the interests of stakeholders with different political and regional goals.

Once the Proposal is approved, the government tasks Trafikverket with preparing a National Transport Plan to implement the projects and measures developed. Over a period of approximately one year, the Administration develops concrete investment and maintenance plans, and it ensures that regional inputs from Sweden's 21 counties are included. These inputs are the result of analysis on specific local issues and often give rise to the definition of smaller schemes, always within the framework of national priorities.

The latest National Transport Plan 2014-2025 was released in April 2014. It is associated with a budget envelope of around SEK 58 billion (EUR 5.8 billion). Approximately SEK 9.5 billion is for operation and maintenance of the railways, with SEK 17 billion for operation and maintenance of the roads and SEK 31 billion for infrastructure development in line with regional plans.

The allocation of funds is not based on any territorial criteria, nor on per capita spending rules. Nonetheless, the process gives rise to a fairly balanced distribution of investment across Swedish regions, as shown in Figure 4B.9 This is the result of the ability of local project sponsors to identify investment proposals that meet the national strategic objectives and that are supported by a wide range of stakeholders, including local municipalities and private businesses. One such project is investment in increasing the load-bearing capacity of roads ahead of the introduction of 74-tonne trucks in Northern Sweden.

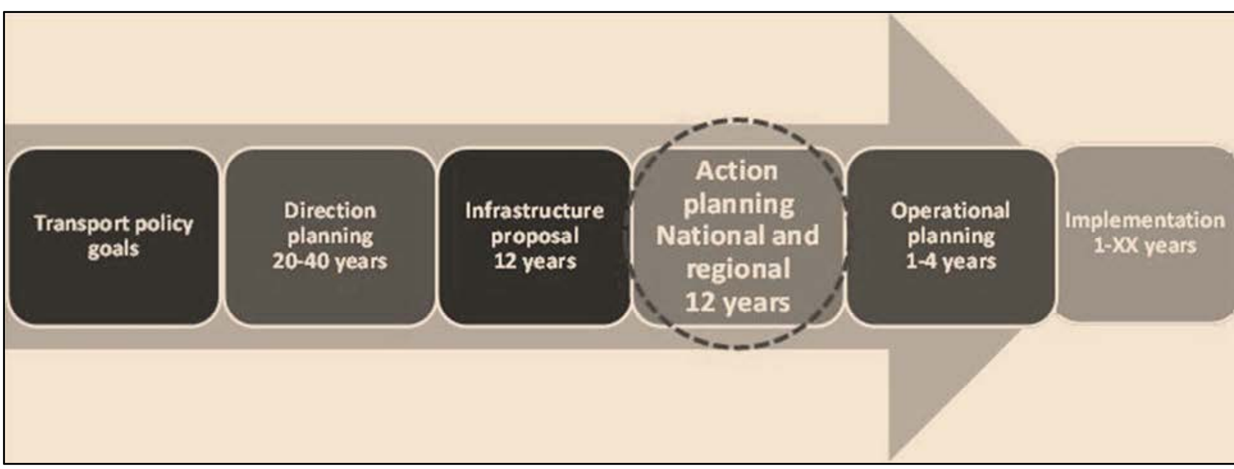
Figure 4B.9 Transport investment per capita (thousands of SEK) in Northern Sweden and Sweden



Note: Left bars = Northern Sweden; Right bars = all Sweden.

Source: Trafikverket (2016).

Figure 4B.10 From transport policy goals to implementation



Source: Trafikverket (2016).

Box 4B.10 Sweden's transport policy vision, goals and principles

The national vision for transport infrastructure in Sweden establishes that "everyone shall arrive in a smooth, green and secure way". The vision is further explained as follows:

Smooth: Our transport system is efficient and available for all

Both citizens and the business community, regardless of individual preconditions and where they live or work, have access to good connectivity. We have a comprehensive attitude to travel and transportation. It is both smooth and convenient to be able to choose and combine different modes of transport for door-to-door movements.

Green: Our transport system takes the environment and health into consideration

When we are developing the transport system, we always consider health aspects and give due consideration to people and the countryside/nature. The transport system shall be clean, quiet, energy-efficient and have a limited impact on the climate.

Secure: Our traffic environments feel secure and safe for everyone

The whole journey, irrespective of how we travel or are transported in traffic, is safe, and our traffic environments are perceived as being secure. Together with other players in society, we are working for unambiguous safety goals with a Vision Zero as our guiding star.

Within the context of this vision, Sweden's overall transport policy goal is set to guarantee an economically efficient and effective transport supply system for citizens and the business community, which is sustainable in the long term throughout the whole country. The current functional goal of transport policy is **availability**. This goal needs to be balanced by transport policy considerations around **safety, the environment and health**.The following guiding principles complement the vision and goals:

- Customers should be given freedom to decide how they want to travel.
- Decisions on transport production should take place in a decentralised manner.
- Co-operation within and between modes of transport will be promoted.
- Competition between railway undertakings and transport options will be promoted.
- Transport costs to society should be the main consideration when designing transport policy regulatory instruments.

Source: Trafikverket, 2016.

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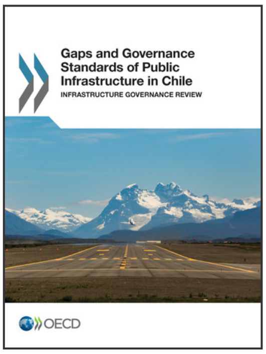

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