TE MANATŪ WAKA
MINISTRY OF TRANSPORT

# Domestic Transport Costs and Charges Study

## Working Paper C7
## Parking

Prepared for Te Manatū Waka Ministry of Transport (NZ)
Veitch Lister Consulting Pty Ltd, in association with Ian Wallis Associates Ltd
June 2023

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## Disclaimer

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## Research, Economics and Evaluation

The Research, Economics and Evaluation team operates within the System Performance and Governance Group of Te Manatū Waka Ministry of Transport. The team supports the Ministry's policy teams by providing the evidence base at each stage of the policy development.

The team is responsible for:

- Providing sector direction on the establishment and use of the Transport Evidence Base (see below) – including the collection, use, and sharing of data, research and analytics across the transport sector and fostering the development of sector research capabilities and ideas.
- Leading and undertaking economic analyses, appraisals and assessment including providing economic input on business cases and funding requests.
- Performing the evaluation function for Te Manatū Waka, including designing monitoring and evaluation frameworks and approaches, developing performance metrics and indicators, and designing, conducting and procuring evaluations.

## The Transport Evidence Base

The Transport Evidence Base Strategy creates an environment to ensure data, information, research and evaluation play a key role in shaping the policy landscape. Good, evidence-based decisions also enhance the delivery of services provided by both the public and private sectors to support the delivery of transport outcomes and improve wellbeing and liveability in New Zealand.

The Domestic Transport Costs and Charges study aims to fill some of the research gaps identified in the 2016 Transport Domain Plan (Recommendation R6.2), which forms part of the Transport Evidence Base.

## Citation

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## For more information

For more information about this project and associated report, please contact: info@transport.govt.nz.

# Glossary of terms and abbreviations

| Term | Description |
|---|---|
| Census | *New Zealand Census 2018* |
| DTCC | *Domestic Transport Costs and Charges(study)* |
| MBCM | *Monetised Benefits and Costs Manual* |
| HTS | *Ministry of Transport Household Travel Survey 2017-18* |
| HUD | *Ministry of Housing and Urban Development* |
| IWA | *Ian Wallis Associates* |
| NPS | *National Policy Statement on Urban Development* |
| Te Manatū Waka | Ministry of Transport |
| Waka Kotahi | New Zealand Transport Agency |
| TOF | Transport Outcomes Framework |
| VLC | Veitch Lister Consulting |
| WP | Working paper |

# Executive summary

## Overview

The Domestic Transport Costs and Charges (DTCC) study was undertaken for Te Manatū Waka Ministry of Transport by a consultant consortium headed by Ian Wallis Associates. The DTCC study aims to identify all the costs imposed by the domestic transport system on the wider New Zealand economy including costs (financial and non-financial) and charges borne by the transport user. Outputs of the DTCC Study will improve our understanding of current economic costs and the extent to which these costs are covered by the charges paid by users. Robust information on transport costs and charges can, in turn, help inform policy settings, such as Te Manatū Waka Transport Outcomes Framework (TOF). This Working Paper (C7) has been prepared by Veitch Lister Consulting (VLC) and focuses on car parking ("parking").

Along with roads and vehicles, parking is a key element of the transport system needed to enable the use of private vehicles. A large and growing body of evidence suggests the availability and price of parking is a major influence on transport and land use outcomes. Parking policy in New Zealand is, moreover, currently in a state of flux: The Government's recent National Policy Statement on Urban Development ("NPS") requires the removal of parking minimums from all urban areas with more than 10,000 residents. Given the key role parking plays in the transport system; the influence of parking on transport and land use outcomes; and recent policy changes, the DTCC study presents a unique opportunity to investigate parking costs and charges in the New Zealand context.

This Working Paper represents one of the first attempts to comprehensively assess the costs and charges of parking in New Zealand. Though we make use of local research and data where it exists, we must turn to international research to inform some of our important assumptions. Perhaps more so than other DTCC Working Papers, our analyses of the costs and charges of car parking are presented as indicative rather than definitive. Within the report, we identify several areas where further research is needed. Finally, our findings are most relevant to other DTCC working papers that consider costs and charges for private vehicles, especially those that consider externalities, such as crashes, congestion, and emissions.

## Questions and Challenges

This working paper responds to the following three research questions:

1. *Economic costs:* What are the total economic costs of parking in New Zealand?
2. *Financial charges:* How do charges for parking vary by location, trip type, and time of day?
3. *Incidence of charges:* How is the burden of charges split between different parties?

In answering these questions, we had to overcome four main challenges. First, there is a lack of consistent and comprehensive data on parking costs and charges in New Zealand. Second, the public and private providers of parking face distinct incentives, which leads to variation in costs and charges. Third, parking charges often vary due to factors that are difficult for researchers like us to observe, such as workplace employment agreements. Finally, the supply of parking is influenced by planning policies, which means user charges may not be a reliable indicator of economic costs.

## Our Approach

We estimate the economic costs of parking in two key steps:

- *Parking unit costs.* In the first step, we estimate parking unit costs. To do so, we adapt and extend earlier research by Nunns (2017), which considers the value of capital, land, and O&M inputs into the provision of parking. Our estimates of parking unit costs vary by parking typologies and geographic locations due to variation in input quantities or prices.
- *Parking supply*. In the second step, we estimate parking supply using a unique approach that multiplies estimates of (1) the number of registered vehicles with (2) the average number of parking spaces per vehicle. In this way, we arrive at estimates of the total on- and off-street parking supply for urban and rural areas in each region of New Zealand.

To estimate user charges, we analyse HTS data for different trip types as well as different time periods, specifically peak vis-à-vis off-peak periods. We also gather data on parking charges in major city centres in Auckland, Wellington, and Christchurch, which we can compare to the predictions of our cost model in these locations. Finally, we consider differences in the incidence of parking costs and fees for employees vis-à-vis workers, that is, the distributional impacts of fees.

## Main Results

First, our mid-point estimate of the economic (resource) costs of parking is $14.7 billion p.a. This equates to approximately $3,739 p.a. per light vehicle, or $3.90 per vehicle trip, or $0.32 per person-km. We find considerable regional variation around these national averages. Approximately 61% of the total costs are associated with land, with 25% and 15% due to O&M and capital, respectively.

**Table ES1: Average economic cost of parking per light vehicle, vehicle trip, and person-kilometre travelled**

| Region | Cost | Vehicles | Demands [mill p.a.] | | Average costs [$ per …] | | |
|---|---|---|---|---|---|---|---|
| | [mill $ p.a.] | [,000s] | Trips | Person-km | Veh p.a. | Trip | Person-km |
| Northland | $242 | 137 | 136 | 2,291 | $1,764 | $1.78 | $0.11 |
| Auckland | $8,437 | 1,268 | 1,213 | 14,385 | $6,653 | $6.96 | $0.59 |
| Waikato | $844 | 371 | 387 | 6,009 | $2,273 | $2.18 | $0.14 |
| Bay of Plenty | $715 | 284 | 235 | 2,991 | $2,517 | $3.05 | $0.24 |
| Gisborne | $59 | 34 | 47 | 371 | $1,751 | $1.27 | $0.16 |
| Hawke's Bay | $288 | 135 | 143 | 1,549 | $2,140 | $2.01 | $0.19 |
| Taranaki | $184 | 94 | 88 | 1,082 | $1,952 | $2.09 | $0.17 |
| Manawatu-Wanganui | $392 | 197 | 192 | 2,615 | $1,988 | $2.05 | $0.15 |
| Wellington | $1,198 | 356 | 346 | 4,102 | $3,368 | $3.46 | $0.29 |
| West Coast | $45 | 27 | 33 | 348 | $1,635 | $1.37 | $0.13 |
| Canterbury | $1,366 | 584 | 545 | 5,862 | $2,339 | $2.51 | $0.23 |
| Otago | $402 | 182 | 173 | 2,187 | $2,208 | $2.33 | $0.18 |
| Southland | $164 | 95 | 83 | 948 | $1,731 | $1.97 | $0.17 |
| Tasman | $108 | 56 | 34 | 460 | $1,928 | $3.21 | $0.23 |
| Nelson | $117 | 49 | 52 | 430 | $2,397 | $2.25 | $0.27 |
| Marlborough | $94 | 50 | 56 | 494 | $1,876 | $1.69 | $0.19 |
| **National totals / average** | **$14,656** | **3,920** | **3,761** | **46,124** | **$3,739** | **$3.90** | **$0.32** |

*Notes:* Author's calculations based on various data sources (c.f. Chapter 3.1). Vehicle trips are defined as the number of annual vehicle trips from A to B that end in each region, where other trip legs—such as return trips—are counted as separate trips.

Second, we consider financial charges for parking and how these vary by location, trip-type, and time of day, as summarised below.

**Table ES2: HTS responses – Type of parking, parking fees, and who paid**

| Regional Council | Trip type | Period | % all trips | Parking type | | Parking fee | | Payer in vehicle | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Off-st. | On-st. | No | Yes | Yes | No |
| Auckland | Commuting and education | Off-peak | 9% | 95% | 5% | 99% | 1% | 87% | 13% |
| | | Peak | 4% | 84% | 16% | 98% | 2% | 26% | 74% |
| | Other | Off-peak | 16% | 86% | 14% | 98% | 2% | 90% | 10% |
| | | Peak | 4% | 73% | 27% | 99% | 1% | 96% | 4% |
| Wellington | Commuting and education | Off-peak | 3% | 94% | 6% | 99% | 1% | 87% | 13% |
| | | Peak | 1% | 84% | 16% | 97% | 3% | 82% | 18% |
| | Other | Off-peak | 5% | 78% | 22% | 98% | 2% | 97% | 3% |
| | | Peak | 1% | 73% | 27% | 98% | 2% | 93% | 7% |
| Canterbury | Commuting and education | Off-peak | 4% | 95% | 5% | 100% | 0% | 74% | 26% |
| | | Peak | 2% | 90% | 10% | 99% | 1% | 87% | 13% |
| | Other | Off-peak | 6% | 83% | 17% | 99% | 1% | 92% | 8% |
| | | Peak | 2% | 80% | 20% | 99% | 1% | 94% | 6% |
| Other | Commuting and education | Off-peak | 12% | 96% | 4% | 99% | 1% | 81% | 19% |
| | | Peak | 5% | 92% | 8% | 98% | 2% | 80% | 20% |
| | Other | Off-peak | 21% | 85% | 15% | 99% | 1% | 94% | 6% |
| | | Peak | 5% | 80% | 20% | 99% | 1% | 89% | 11% |
| **National** | | | **100%** | **86%** | **14%** | **99%** | **1%** | **85%** | **15%** |

*Notes:* Author's calculations based on data sourced from the MOT's HTS (c.f. Chapter 3.2).

We find little systematic variation in parking charges (per hour) by region, trip-type, or time-period. Though peak commuting and education trips in major urban regions are slightly more likely to incur charges, the overall difference is relatively small. On this basis, we conclude parking costs are often not paid directly by the users of vehicles. Instead, parking costs are more often either (1) bundled into the costs of goods and services people purchase, such as housing; (2) paid for indirectly (e.g. through council rates); or (3) subsidised by other people who do not use parking.

Third, we consider the incidence of parking charges for workers vis-à-vis employers. To answer this question, we re-use the data above but focus exclusively on vehicle trips to work. We find 94% of vehicle trips to work do not incur parking charges, which ranges from a low of 86% in Wellington rising to 97% in Canterbury, with Auckland around halfway in between. For the 6% of vehicle trips to work that do incur parking charges, approximately two-thirds of these charges are paid by the workers themselves versus one-third that is paid for by the employer.

**Table ES3: Incidence of commuter parking charges on employers vis-à-vis workers**

| Region | Measure | Outcome | | |
|---|---|---|---|---|
| | | Free parking | Employer pays | Worker pays |
| Auckland | Trips | 89.46 | 3.57 | 2.73 |
| | % trips | 93% | 4% | 3% |
| Wellington | Trips | 18.89 | 0.47 | 2.57 |
| | % trips | 86% | 2% | 12% |
| Canterbury | Trips | 50.19 | 0.33 | 1.30 |
| | % trips | 97% | 1% | 3% |
| Other | Trips | 122.27 | 1.78 | 6.51 |
| | % trips | 94% | 1% | 5% |
| **National** | **Trips** | **280.81** | **6.15** | **13.12** |
| | **% trips** | **94%** | **2%** | **4%** |

*Notes:* Author's calculations based on data sourced from the MOT's HTS (c.f.Chapter 3.3), including all trips by car.

## Limitations and Further Work

Our approach to estimating the economic cost of parking has several limitations, specifically:

- Our estimates of the number of parking spaces per vehicle rely on international studies, even if we adjust for population density when translating them to the New Zealand context.
- We present estimates of average parking costs, rather than marginal costs. In many cases, the latter may be more relevant to policy. That said, we suggest the scalable nature of off-street parking facilities means average costs are likely to be a decent approximation of marginal costs in the long run. This suggestion is somewhat supported by the close alignment between our estimates of economic costs and user charges in Auckland and Christchurch.
- Our analysis of parking charges is limited by data and complicated by the extent and manner to which parking costs are bundled and/or incurred jointly with other costs. We note the current HTS does not ask questions on the level of parking charges that are incurred, which future iterations of the HTS could seek to address.

In terms of future updates and further work, we suggest there may be value in updating this analysis in approximately 5-years' time, when new HTS and Census data will be available. While the effects of changes to parking policy, like the NPS, are expected to materialise relatively slowly, changes in land values—which is a large driver of the economic costs of parking—can be more rapid. Indeed, recent rapid increases in property prices in New Zealand may mean our estimates, which use land value data from 2018-19, are already somewhat dated. For this reason, we recommend updating our analysis more frequently than is suggested by changes in parking supply itself. Finally, we suggest further work is undertaken to explicitly quantify the supply of parking New Zealand cities and towns, with results used to update the meta-analysis model (and associated estimates of average parking spaces per vehicle) that we use to estimate economic costs. The large magnitude of estimated economic costs that we present in this working paper, together with the dearth of previous research on this topic, suggest that further research into parking in New Zealand is indeed warranted.

# Chapter 1 Introduction

## 1.1. Study Scope and Overview

The Domestic Transport Costs and Charges (DTCC) study aims to identify all the costs associated with the domestic transport system on the wider New Zealand economy including costs (financial and non-financial) and charges borne by the transport user.

The Study is an important input to achieving a quality transport system for New Zealand that improves wellbeing and liveability. Its outputs will improve our understanding of the economic, environmental and social costs imposed by different transport modes - including road, rail and coastal shipping - and the extent to which those costs are currently offset by charges paid by transport users.

The DTCC is intended to support the wider policy framework of Te Manatū Waka, especially the Transport Outcomes Framework (TOF). The TOF seeks to make clear what government wants to achieve through the transport system under five outcome areas:

- Inclusive access,
- Economic prosperity,
- Healthy and safe people,
- Environmental sustainability, and
- Resilience and security.

Underpinning outcomes in these areas is the guiding principle of mode neutrality. In general, outputs of the DTCC study will contribute to the TOF by providing consistent methods for (1) estimating and reporting economic costs and financial charges and (2) understanding how these costs and charges vary across dimensions that are relevant to policy, such as location, mode and trip type.

Robust information on transport costs and charges is critical to establishing a sound transport policy framework. The Study itself does not address future transport policy options; but the study outputs will help inform important policy development including areas such as charging and revenue management, internalising externalities, and travel demand management.

The Study has been undertaken for Te Manatū Waka by a consultant consortium headed by Ian Wallis Associates. The Study has been divided into a number of topic areas, some of which relate to different transport modes (including road, rail, urban public transport and coastal shipping), and others to impacts or externalities (including accidents, congestion, public health, emissions, noise, biodiversity and biosecurity).

Working papers are being prepared for each of the topic areas. The topic areas and specialist authors are listed in Appendix 2.

## 1.2. Costing Practices

The focus of DTCC is on NZ transport operations, economic costs, financial costs and charges for the year ending 30 June 2019 (FY 2018/19). Consistent with this focus, all economic and financial cost figures are given in NZ$2018/19 (average for the 12-month period) unless otherwise specified.

All financial costs include any taxes and charges (but exclude GST); while economic costs exclude all taxes and charges.

The DTCC economic and financial analyses comprise essentially single-year assessments of transport sector costs and charges for FY 2018/19. Capital charges have been included in these assessments, with annualised costs based on typical market depreciation rates plus an annualised charge (derived as 4% p.a., in real terms, of the optimised replacement costs of the assets involved).

## 1.3. Paper Overview

This Working Paper (C7) addresses car parking ("parking"). Along with roads and vehicles, parking is a key part of the transport system that supports the use of private vehicles. A large and growing body of evidence finds the availability and price of parking exerts a major influence on transport and land use outcomes (see, for example, Inci, 2015). Parking policy in New Zealand is, moreover, in a state of flux: The Government's recent National Policy Statement on Urban Development ("NPS") requires the removal of parking minimums from all urban areas with more than 10,000 residents. Given the integral role of parking in the transport system; the influence of parking on transport and land use outcomes; and recent parking policy changes, the DTCC study represents a unique and timely opportunity to investigate parking in the New Zealand context. As far as we understand, this working paper represents one of the first attempts to do so on a comprehensive, nationwide basis.

In this working paper, we seek to address the following three research questions:

1. *Economic costs:* What are the total economic costs of parking in NZ?
2. *Financial charges:* How do charges for parking vary by location, trip type, and time of day?
3. *Incidence of charges:* How is the burden of charges split between different parties?

Perhaps more so than other DTCC Working Papers, our analyses are presented as *indicative* rather than *definitive*, simply due to the paucity of independent, local information to which we can compare our results. Within the report, we identify several areas where further research is, in our view, warranted. In terms of relationships to other working papers, our findings are relevant to understanding travel by car and non-car modes. To the extent parking costs and charges result in subsidies for driving, as our finding seem to suggest, then current parking policy settings are likely to exacerbate the negative externalities associated with car travel, such as crashes, congestion, and emissions. This is especially true in urban areas where we find parking costs are the highest.

The following sections of this Working Paper are structured as follows: Chapter 2 summarises our methodology, Chapter 3 presents the results of our analysis, and Chapter 4 discusses limitations and further work. The appendices to this working paper provide additional clarifying information.

# Chapter 2 Methodology

## 2.1 Research Questions

This working paper seeks to address the following three research questions:

1. *Economic costs:* What are the total economic costs of parking?
2. *Financial charges:* How do charges for parking vary by location, trip type, and time of day?
3. *Incidence of charges:* How is the burden of charges split between different parties?

## 2.2 Challenges to our Analysis

In answering these research questions, we strive to overcome the following four challenges:

- First, there exists a paucity of consistent and comprehensive data on the nature of parking supply and demand in NZ, at least compared to other parts of the land transport system.
- Second, parking is supplied by both public and private providers, which face distinct incentives that gives rise to considerable variation in economic costs and financial charges.
- Third, the financial charges incurred by drivers often vary significantly due to factors that are difficult for researchers, like us, to observe, such as workplace employment agreements.
- Fourth, the supply (and, by extension, the price) of parking is in many places not set by market forces but rather planning policies, such as parking minimums and maximums.

The last point is important: By influencing the supply of car parking, land use policies affect both price and demand. Parking minimums, for example, have historically sought to increase the supply of parking above what the market would deliver of its own accord. In doing so, parking minimums seem likely to increase the economic cost of parking. In contrast, parking maximums in some parts of Auckland, Wellington, Christchurch and elsewhere may have increased parking charges above resource costs. Together, the distortionary effects of land use policies mean prevailing charges may not be an accurate reflection of the underlying cost of parking. Instead, we seek to estimate the economic costs of parking by considering the value of the resources that it uses.

## 2.3 Data and General Assumptions

The following three data sources play a key role in our estimates of parking costs:

- *The New Zealand Census 2018 ("Census")*, from which we derive estimates of vehicle ownership, population density, and associated parking demands in each location
- *The Ministry of Housing and Urban Development ("HUD") rateable land values 2018-19*, from which we derive estimates of land values in each location[1]

[1] HUD generously supplied information on rateable land values at the level of SA2s. We are, however, unable to publish values at these levels of granularity. Hence, we present average land values for urban and rural areas in each region. In the three major

- *The Ministry of Transport Household Travel Survey 2017-18 ("HTS")*, from which we derive estimates of travel demands in each location.

Several limitations of these data sets are discussed later in this working paper. We also draw heavily and gratefully on the estimates of construction costs for off-street parking typologies presented in Nunns (2017), which we update and extend to suit our purposes—noting the scope of our analysis here extends to include all off-street and on-street parking.

Unless otherwise noted, the analyses in this paper are based on the following general assumptions:

- *Base price period.* All prices are expressed in NZD 2018/19 (i.e. prices typical of or averaged over the 12 months ending 30 June 19).
- *Pricing in real terms.* All prices are expressed in constant real dollar terms, i.e. excluding any inflationary components.
- *Taxes and duties.* Our estimates of economic costs usually exclude taxes or duties from the prices of goods and services.
- *Cost of capital / discount rate.* Unless otherwise stated, we assume the cost of capital is 4% p.a. (in real terms), as per Waka Kotahi NZ Transport Agency's Monetised Benefits and Costs Manual ("MBCM").
- *Capital depreciation,* we assume land does not depreciate. Other capital inputs into parking construction are assumed to depreciate at 2% p.a. (i.e. have an economic life of 50-years).

## 2.4 Average versus Marginal Costs

We estimate the average economic costs of parking, rather than marginal costs. While the latter are more important to policy, their estimation is more complex—especially given the limited data available for our analysis. Nonetheless, we consider it likely the average and marginal costs of parking are likely to converge in the long-run, due to the relatively scalable nature of off-street parking. Put another way, we are not aware of any evidence that the production of parking experiences large economies of scale. For this reason, we expect average costs provide a reasonable approximation of long-run marginal costs. On-street parking is perhaps the main exception, especially in locations where supply is constrained and the opportunity cost of space within the road corridor is high. In these cases, marginal costs of on-street parking are likely to differ from the average costs we present here.

## 2.5 Segmentation

In terms of segmentation, we note the following key dimensions to our analysis:

- *Geographic.* We estimate the economic costs of parking separately for urban and rural geographies in each region in New Zealand.[2] We find this geographic segmentation is

urban centres, however, we source data on land values directly from the respective local authorities, which is not subject to the same data restrictions. In these urban centres, we can and do provide more detailed breakdowns of land values.

[2] To distinguish between urban and rural areas, we adopt Statistics New Zealand definitions at the SA2 level, where SA2s are designed to "… reflect communities that interact together socially and economically. In populated areas, SA2s generally contain

important for capturing heterogeneity in parking input prices and the level of parking supply.

- *Trip type and time of day.* We consider differences in financial charges based on trip type, specifically for commuting and education-related travel, as well as for travel at peak vis-à-vis off-peak periods. Vehicle trips ending between the hours of 7-9am and 4-6pm on weekdays are defined as peak trips while all other vehicle trips are defined to be off-peak.
- *Employees and employers.* We consider differences in the incidence of parking costs and fees for employees vis-à-vis employers. We discuss differences for other parties.

We sometimes consider interactions between segments when analysing HTS data. The geographic segmentation, for example, can be interacted with the trip type and time of day segments. In this way, we analyse peak commuter trips separately for some regions. In doing so, however, we remain wary of issues with HTS sample sizes: The more segmented our analysis, the more our results will rely on small numbers of households and trips, which increase the risk of bias. This risk is especially relevant when considering parking charges, given the latter are incurred for only a relatively small proportion of vehicle trips. For these reasons, our segmentation seeks to strike a balance between capturing sources of heterogeneity that are relevant to parking charges while guarding against the risk of drawing conclusions from small and unrepresentative samples (that is, “over-fitting”).

similar-sized populations.” http://archive.stats.govt.nz/methods/classifications-and-standards/classification-related-stats-standards/geographic-areas/pg4.aspx#gsc.tab=0.

# Chapter 3 Results

In the following sections, we present the results of our analysis, which are structured as per our three research questions:

1. *Economic costs:* What are the total economic costs of parking?
2. *Financial charges:* How do charges for parking vary by location, trip type, and time of day?
3. *Incidence of charges:* How is the burden of charges split between different parties?

## 3.1 Question 1: Economic Costs

### 3.1.1 Overview

We estimate the economic cost of parking in two steps: First, we estimate parking unit costs (that is, the cost per parking space), and, second, we estimate parking supply (that is, the number of parking spaces). By multiplying parking unit costs with parking supply, we arrive at estimates of the economic cost of parking. Notwithstanding the intuition of this approach, both steps are somewhat complex. In the first step, complexity is introduced by the need to capture variation in parking unit costs between geographic locations and parking typologies. This variation arises largely due to differences in input prices between locations, especially land, as well as differences in input quantities between typologies, for example, off-street surface vis-à-vis structured parking. Ultimately, we estimate individual parking unit costs for 32 locations (that is, urban and rural areas in 16 regions) and 3 typologies (that is, on-street parking, off-street surface parking, and off-street structured parking). In the second step, an additional source of complexity is introduced due to the lack of comprehensive and consistent information on parking supply. For this reason, we synthesize the results of international studies, which we translate to the New Zealand context adjusting for differences in population densities. The following sections summarise our analyses of parking unit costs and parking supply, respectively.

### 3.1.2 Parking Unit Costs

In the first step of our analysis, we estimate parking unit costs based on the value of the resources used to provide parking. We consider three cost components, namely: (1) *capital* costs; (2) *land* costs; and finally (3) o*perating and maintenance (O&M) costs*. Capital and O&M costs are the same in all locations but vary by typology, that is, between on-street parking, off-street surface parking, and off-street structured parking. Land costs, in contrast, vary both by locations and typologies due to variation in prices and quantities, respectively. In the following sub-sections, we estimate these cost components and then calculate parking unit costs for each location and typology.

#### *Capital costs*

We estimate capital costs for on-street parking, off-street surface parking, and off-street structured parking. For the latter two, we draw on capital cost estimates in Nunns (2017), which uses 2013 construction price data. We inflate these costs to 2018/19 NZD using the average of Statistics New Zealand's "construction" and "building construction" producer price indexes, which implies a 21% increase. To estimate capital costs for on-street parking, we pro-rata the costs for off-street surface

parking.[3] Table 1 summarises capital costs per parking space (that is, excluding land and O&M costs). In the final column, we convert capital costs into an annual flow measure per annum, assuming 4% cost of capital plus 2% annual depreciation. This produces an estimated mid-point cost of $147 and $1,423 p.a. for surface and structured parking, respectively, versus $71 p.a. for on-street parking.

**Table 1: Capital costs by parking typology**

| Parking typology | Nunns (2017) | DTCC WP-C7 | |
|---|---|---|---|
| | | Total | p.a. |
| Off-street – surface | $2,020 | $2,444 | $147 |
| Off-street – structure | $19,600 | $23,716 | $1,423 |
| On-street | NA | $1,178 | $71 |

*Source:* Nunns (2017) and Authors' calculations.

We caution these capital costs capture the mid-point of a heterogeneous distribution. In the case of surface parking, our capital costs relate to parking that is sealed but uncovered, which seems typical of ancillary parking in New Zealand. We expect considerable variation in capital costs for residential parking, which range from simple gravel areas through to sophisticated garages. Surveys undertaken by the Automobile Association of New Zealand, for example, finds 58% of vehicles in New Zealand are stored in garages or carports with the remaining 42% stored either on driveways, grass verges, or on-street.[4] Our estimates seem likely to understate the capital cost of garaged residential parking (which may indeed approach that of structured parking) but overstate the capital costs associated with parking on driveways and grass verges. Structured parking is likely to exhibit similar heterogeneity. The estimates in Nunns (2017) pertain to five-storey parking buildings, which are likely to understate capital costs for underground parking while overstating costs for larger developments. In the absence of more detailed data—and in the interests of simplicity—we adopt the estimates in Table 1, although note this as an area of further work.

### *Land costs*

To calculate average land costs, we multiply the average land used for each parking typology with average land prices in each location. Table 2 summarises our results. In terms of average land costs, for each location, $s$, we present three averages, namely: (1) the average cost per sqm, (2) the average cost per SA2, and (3) the "household (HH) weighted" average cost ($c_{h(s)}$), which is our preferred measure.

Formally, $c_{h(s)}$ is calculated as $c_{h(s)} = \frac{\sum_{i \in S} c_i h_i}{\sum_{i \in S} h_i} \; \forall \; s$, where:

- The subscripts $s$ and $i$ denotes location and SA2s, respectively. A one-to-many relationship exists between locations and SA2s.
- $c_i$ denotes the average land cost in each SA2 in 2018/19 (sourced gratefully from data supplied by the Ministry of Housing and Urban Development).
- $h_i$ denotes the number of resident households in each SA2 (sourced from the 2018 census).

[3] We assume the land area of the average on-street parking space is 3.0*4.5 = 13.5 sqm versus 28 sqm for the average off-street surface parking space. Capital costs for on-street spaces are thus 13.5 / 28 = 48% of off-street surface parking.

[4] We are grateful to Barney Irvine of the Automobile Association of New Zealand for supplying this information.

Our preferred measure of land prices, $c_{h(s)}$, typically lies close to the SA2 average.[5] In contrast, we find lower land prices when using the average per sqm, which reflects the influence of large parcels of low-value land. In our view, the latter are not representative of populated areas, where most parking is provided. The three right-hand columns of Table 2 present estimated land costs for each typology in each location. These columns are calculated as follows: First, we multiply land prices (HH average) with the average area per parking space[6] and, second, the assumed cost of capital 4% p.a.[7]

Finally, Table 2 applies an 85% discount to land prices for on-street parking. We make this adjustment to ensure land prices for on-street parking are equivalent to those used for walking and cycling in WP C8. The latter is, in turn, calibrated to align with the land values used in WP C2 (road network). Challenges aligning the price of land for the road network vis-à-vis walking / cycling are discussed in detail in WP C8.

**Table 2: Land costs by location and typology**

| Regional Council | Segment | Per square metre | | | Per car-park p.a. | | |
|---|---|---|---|---|---|---|---|
| | | Average | SA2 av. | Hh av. | Surface | Structured | On-street |
| 01 Northland Region | Rural | $2.04 | $12.50 | $11.18 | $12.53 | $2.50 | $0.67 |
| | Urban | $68.23 | $103.82 | $104.07 | $116.56 | $23.31 | $6.24 |
| 02 Auckland Region | Rural | $11.81 | $29.18 | $27.42 | $30.71 | $6.14 | $1.65 |
| | Urban | $732.74 | $1,542.20 | $1,744.36 | $1,953.69 | $390.74 | $104.66 |
| 03 Waikato Region | Rural | $2.51 | $10.20 | $10.00 | $11.20 | $2.24 | $0.60 |
| | Urban | $121.52 | $273.28 | $296.50 | $332.08 | $66.42 | $17.79 |
| 04 Bay of Plenty Region | Rural | $2.51 | $17.12 | $13.43 | $15.05 | $3.01 | $0.81 |
| | Urban | $127.04 | $279.21 | $343.85 | $385.12 | $77.02 | $20.63 |
| 05 Gisborne Region | Rural | $0.54 | $1.67 | $2.02 | $2.26 | $0.45 | $0.12 |
| | Urban | $77.72 | $95.79 | $91.66 | $102.66 | $20.53 | $5.50 |
| 06 Hawke's Bay Region | Rural | $1.11 | $8.70 | $9.35 | $10.47 | $2.09 | $0.56 |
| | Urban | $85.92 | $214.36 | $210.99 | $236.30 | $47.26 | $12.66 |
| 07 Taranaki Region | Rural | $2.19 | $4.31 | $4.47 | $5.00 | $1.00 | $0.27 |
| | Urban | $93.99 | $150.01 | $154.15 | $172.65 | $34.53 | $9.25 |
| 08 Manawatu-Wanganui Region | Rural | $1.07 | $2.51 | $3.02 | $3.38 | $0.68 | $0.18 |
| | Urban | $72.74 | $148.93 | $169.26 | $189.57 | $37.91 | $10.16 |
| 09 Wellington Region | Rural | $1.19 | $2.90 | $3.00 | $3.36 | $0.67 | $0.18 |
| | Urban | $205.08 | $523.49 | $574.46 | $643.40 | $128.68 | $34.47 |
| 12 West Coast Region | Rural | $0.22 | $0.46 | $0.48 | $0.54 | $0.11 | $0.03 |
| | Urban | $8.69 | $23.24 | $26.39 | $29.56 | $5.91 | $1.58 |
| 13 Canterbury Region | Rural | $1.12 | $7.25 | $6.50 | $7.28 | $1.46 | $0.39 |
| | Urban | $130.00 | $274.75 | $278.27 | $311.67 | $62.33 | $16.70 |
| 14 Otago Region | Rural | $0.83 | $11.81 | $10.47 | $11.72 | $2.35 | $0.63 |
| | Urban | $88.59 | $274.77 | $242.45 | $271.55 | $54.31 | $14.55 |
| 15 Southland Region | Rural | $1.05 | $1.87 | $1.91 | $2.14 | $0.43 | $0.11 |
| | Urban | $40.73 | $66.66 | $73.39 | $82.20 | $16.44 | $4.40 |
| 16 Tasman Region | Rural | $0.68 | $7.86 | $10.31 | $11.55 | $2.31 | $0.62 |
| | Urban | $67.62 | $144.16 | $165.71 | $185.60 | $37.12 | $9.94 |
| 17 Nelson Region | Rural | $1.18 | $1.18 | $1.18 | $1.32 | $0.26 | $0.07 |
| | Urban | $155.66 | $252.02 | $257.87 | $288.81 | $57.76 | $15.47 |
| 18 Marlborough Region | Rural | $0.83 | $8.06 | $5.17 | $5.79 | $1.16 | $0.31 |
| | Urban | $80.23 | $155.84 | $150.24 | $168.27 | $33.65 | $9.01 |

[5] As Statistics New Zealand designs SA2s to have broadly similar populations, this alignment is to be expected.

[6] For off-street parking, we follow Nunns (2017) and assume 28 and 5.6 sqm per surface and structured parking space, respectively. For on-street parking, we assume 3.0*4.5 = 13.5 sqm, as per Footnote 3 in Chapter 3.1.2 'Capital costs'.

[7] We assume land does not depreciate, which is consistent with other DTCC working papers.

*Source:* Own calculations based on data from HUD (land values), Census 2018 (number of households), and Nunns (2017).

### *Operating and maintenance costs*

For operating and maintenance (O&M) costs, Australian Transport Council (2006) recommends AUD $1,000 per space for structured parking (pg. 56, Section 6.5). To convert this 2006 AUD cost to 2018-19 NZD, we assume an exchange rate of 1.162, which was the average NZD:AUD daily exchange rate in 2006. We then use consumer price inflation indexes from the Reserve Bank of New Zealand to calculate a price inflator of 1.26. On this basis, we estimate O&M costs of $\$1{,}000 \times 1.162 \times 1.26 = \$1{,}464$ in 2018-19 NZD. Australian Transport Council (2006) also recommends maintenance costs of 2006 AUD $100 p.a. per space for surface parking, which converts to $146 p.a. 2018-19 NZD.

Unfortunately, Australian Transport Council (2006) does not report operating costs for surface parking, noting instead—and reasonably, in our view—that these costs are likely to vary substantially depending on the facility. Nunns (2017) assumes operating costs for surface parking of $400 per parking space p.a. in 2013 NZD, which seems reasonable for actively managed surface parking facilities. In our case, however, we need to consider average operating costs for *all* surface parking, much of which is provided in residential locations and other destinations where it will not need to be actively managed. For this reason, we assume lower average operating costs of $100 p.a. for surface parking, yielding total O&M costs per space of $246 p.a. For on-street parking, we have less information to work with. For simplicity, we assume on-street parking incurs 50% of the O&M costs of off-street surface parking. Table 3 summarises our estimated O&M costs. As well as being based on limited information, we again caution our estimates denote the mid-point of heterogeneous distribution, especially for surface parking.

**Table 3: O&M costs by typology**

| Parking typology | $ p.a. |
|---|---|
| Off-street surface | $246 |
| Off-street structure | $1,464 |
| On-street | $123 |

*Source:* Own calculations based on Australian Transport Council (2006), Reserve Bank of New Zealand (2020), and Nunns (2017).

### *Parking unit costs*

Table 4 reports our estimated total parking unit costs for each of the locations and typologies. Our approach assumes capital and O&M costs do not vary by location but do vary by typology. In contrast, land costs vary by both location and typology. Hence, variation in costs across rows in Table 4 is driven by differences in land prices. For all locations, we find on-street parking has the lowest unit cost. When we calculate the household-weighted average cost, for example, we find on-street parking has an average unit cost approximately one fifth of that for off-street surface parking. And the average unit cost of the latter is, in turn, approximately one third of that for off-street structured parking.[8]

[8] We note, however, that this result is based on average land values, which are not always a useful representation of the cost structures that prevail in city centre locations. We return to this issue in more detail in Chapter 3.2.2.

**Table 4: Total parking unit costs by location and typology**

| Location | | Off-street surface | | | | Off-street structure | | | | On-street | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cap. | Land | O&M | Total | Cap. | Land | O&M | Total | Cap. | Land | O&M | Total |
| 01 Northland Region | Rural | $147 | $13 | $246 | *$405* | $1,423 | $3 | $1,464 | *$2,889* | $71 | $1 | $123 | *$194* |
| | Urban | $147 | $117 | $246 | *$509* | $1,423 | $23 | $1,464 | *$2,910* | $71 | $6 | $123 | *$200* |
| 02 Auckland Region | Rural | $147 | $31 | $246 | *$423* | $1,423 | $6 | $1,464 | *$2,893* | $71 | $2 | $123 | *$195* |
| | Urban | $147 | $1,954 | $246 | *$2,346* | $1,423 | $391 | $1,464 | *$3,278* | $71 | $105 | $123 | *$298* |
| 03 Waikato Region | Rural | $147 | $11 | $246 | *$404* | $1,423 | $2 | $1,464 | *$2,889* | $71 | $1 | $123 | *$194* |
| | Urban | $147 | $332 | $246 | *$725* | $1,423 | $66 | $1,464 | *$2,953* | $71 | $18 | $123 | *$211* |
| 04 Bay of Plenty Region | Rural | $147 | $15 | $246 | *$408* | $1,423 | $3 | $1,464 | *$2,890* | $71 | $1 | $123 | *$195* |
| | Urban | $147 | $385 | $246 | *$778* | $1,423 | $77 | $1,464 | *$2,964* | $71 | $21 | $123 | *$214* |
| 05 Gisborne Region | Rural | $147 | $2 | $246 | *$395* | $1,423 | $0 | $1,464 | *$2,887* | $71 | $0 | $123 | *$194* |
| | Urban | $147 | $103 | $246 | *$495* | $1,423 | $21 | $1,464 | *$2,907* | $71 | $5 | $123 | *$199* |
| 06 Hawke's Bay Region | Rural | $147 | $10 | $246 | *$403* | $1,423 | $2 | $1,464 | *$2,889* | $71 | $1 | $123 | *$194* |
| | Urban | $147 | $236 | $246 | *$629* | $1,423 | $47 | $1,464 | *$2,934* | $71 | $13 | $123 | *$206* |
| 07 Taranaki Region | Rural | $147 | $5 | $246 | *$398* | $1,423 | $1 | $1,464 | *$2,888* | $71 | $0 | $123 | *$194* |
| | Urban | $147 | $173 | $246 | *$565* | $1,423 | $35 | $1,464 | *$2,921* | $71 | $9 | $123 | *$203* |
| 08 Manawatu-Wanganui Region | Rural | $147 | $3 | $246 | *$396* | $1,423 | $1 | $1,464 | *$2,888* | $71 | $0 | $123 | *$194* |
| | Urban | $147 | $190 | $246 | *$582* | $1,423 | $38 | $1,464 | *$2,925* | $71 | $10 | $123 | *$204* |
| 09 Wellington Region | Rural | $147 | $3 | $246 | *$396* | $1,423 | $1 | $1,464 | *$2,888* | $71 | $0 | $123 | *$194* |
| | Urban | $147 | $643 | $246 | *$1,036* | $1,423 | $129 | $1,464 | *$3,016* | $71 | $34 | $123 | *$228* |
| 12 West Coast Region | Rural | $147 | $1 | $246 | *$393* | $1,423 | $0 | $1,464 | *$2,887* | $71 | $0 | $123 | *$194* |
| | Urban | $147 | $30 | $246 | *$422* | $1,423 | $6 | $1,464 | *$2,893* | $71 | $2 | $123 | *$195* |
| 13 Canterbury Region | Rural | $147 | $7 | $246 | *$400* | $1,423 | $1 | $1,464 | *$2,888* | $71 | $0 | $123 | *$194* |
| | Urban | $147 | $312 | $246 | *$704* | $1,423 | $62 | $1,464 | *$2,949* | $71 | $17 | $123 | *$210* |
| 14 Otago Region | Rural | $147 | $12 | $246 | *$404* | $1,423 | $2 | $1,464 | *$2,889* | $71 | $1 | $123 | *$194* |
| | Urban | $147 | $272 | $246 | *$664* | $1,423 | $54 | $1,464 | *$2,941* | $71 | $15 | $123 | *$208* |
| 15 Southland Region | Rural | $147 | $2 | $246 | *$395* | $1,423 | $0 | $1,464 | *$2,887* | $71 | $0 | $123 | *$194* |
| | Urban | $147 | $82 | $246 | *$475* | $1,423 | $16 | $1,464 | *$2,903* | $71 | $4 | $123 | *$198* |
| 16 Tasman Region | Rural | $147 | $12 | $246 | *$404* | $1,423 | $2 | $1,464 | *$2,889* | $71 | $1 | $123 | *$194* |
| | Urban | $147 | $186 | $246 | *$578* | $1,423 | $37 | $1,464 | *$2,924* | $71 | $10 | $123 | *$204* |
| 17 Nelson Region | Rural | $147 | $1 | $246 | *$394* | $1,423 | $0 | $1,464 | *$2,887* | $71 | $0 | $123 | *$194* |
| | Urban | $147 | $289 | $246 | *$681* | $1,423 | $58 | $1,464 | *$2,945* | $71 | $15 | $123 | *$209* |
| 18 Marlborough Region | Rural | $147 | $6 | $246 | *$398* | $1,423 | $1 | $1,464 | *$2,888* | $71 | $0 | $123 | *$194* |
| | Urban | $147 | $168 | $246 | *$561* | $1,423 | $34 | $1,464 | *$2,921* | $71 | $9 | $123 | *$203* |

*Source:* Authors' calculations drawing on Table 1, Table 2, and Table 3.

Finally, we note that the estimated unit cost for off-street surface parking is lower than that for off-street structured parking in every location that we analyse. The cost-effectiveness of off-street surface parking likely explains its prevalence relative to structured parking in most parts of New Zealand.

### 3.1.3 Parking Supply

In the second step of our analysis, we estimate the parking supply in each location. First, we estimate the number of registered vehicles in each location. To do this, we draw on information on personal vehicles from the 2018 Census, which we adjust upwards to account for other registered vehicles that are not captured in the Census. Second, we estimate the average number of parking spaces per vehicle by translating the results of international studies to the New Zealand context, adjusting for differences in population density. By multiplying the number of registered vehicles with average parking spaces per vehicle, we arrive at our estimates of the total parking supply in each location.

### *Number of registered vehicles*

To estimate the number of registered vehicles in each region , we draw on two data sets. The first is the 2018 Census, which provides estimates of the number of vehicles owned by households in each location. Crucially, Census data is available at detailed levels of spatial disaggregation, which align with the locations used in Chapter 3.1.2. The main disadvantages of the Census, however, are (1) household vehicle ownership is top-coded (e.g. “five or more vehicles …”) and (2) large numbers of light vehicles, such as commercial vehicles, are not counted. For these reasons, estimates of vehicle numbers derived from the Census will be lower than the total number of light vehicles in the New Zealand fleet. To address these problems, we draw on a second data supplied by Te Manatū Waka, which provides information on the total number of registered vehicles for each region in New Zealand. Using this data, we adjust upwards the estimates of household vehicle ownership that we derive from the Census, such that it matches the total number of light vehicles registered in each region (that is, excluding heavy vehicles and motorcycles). The two left-most columns of Table 5 presents our estimates of registered vehicles.

### *Average number of spaces per vehicle*

To estimate the average number of spaces per vehicle, we synthesise a range of estimates for cities overseas. The studies and methods that underpin this synthesis is discussed in detail in Appendix 3. In general, we find variation in the average number of parking spaces per vehicle for our sample of cities is strongly associated with population density. Figure 1 illustrates this strong negative relationship, where the dashed vertical line denotes average population density in urban parts of Auckland.

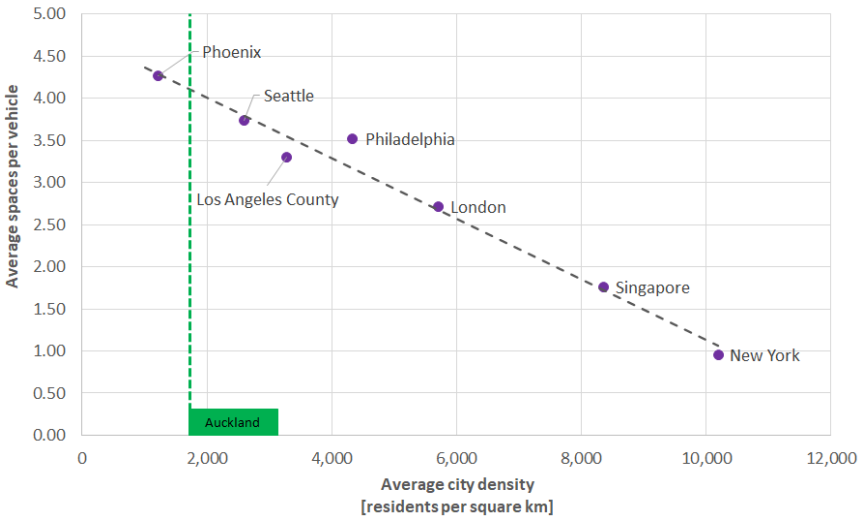


**Figure 1: Average number of spaces per vehicle versus population density (Source: c.f. Appendix 3)**

We also derive a similar, albeit weaker, negative relationship between population density and the average number of on-street spaces. Using these relationships, we can then estimate the average number of parking spaces for different locations in New Zealand, adjusting for differences in population density. We use our statistical models to generate high and low supply scenarios around this central scenario, specifically we use the 90% probability intervals. Table 5 summarises our predictions for the average spaces per vehicle for each location under each of these three scenarios. We find the average number of spaces per vehicle ranges from a low of 4.1 in urban Auckland to 4.8 in the rural parts of several regions. Of these averages, we estimate on-street

parking spaces typically make up around 1.2-1.4 spaces per vehicle, or approximately one-third. By extension, the average number of off-street spaces per vehicle ranges from 2.2-2.7. To arrive at estimates of the total parking supply, one can simply multiple the (adjusted) number of vehicles with the average number of parking spaces for the relevant scenario.

**Table 5: Number of vehicles and average spaces per vehicle – low, central, and high scenarios**

| Location | | Light vehicles | | Density [pop. per km$^2$] | Average parking spaces per vehicle | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Low | | | Central | | | High | | |
| | | Census | Adjusted | | On | Off | Tot. | On | Off | Tot. | On | Off | Tot. |
| 01 Northland Region | Rural | 58,047 | 76,538 | 7 | 1.3 | 2.7 | *4.0* | 1.3 | 3.4 | *4.8* | 1.3 | 4.2 | *5.5* |
| | Urban | 45,993 | 60,644 | 581 | 1.3 | 2.5 | *3.8* | 1.3 | 3.2 | *4.6* | 1.3 | 4.0 | *5.3* |
| 02 Auckland Region | Rural | 71,211 | 104,922 | 24 | 1.3 | 2.6 | *4.0* | 1.3 | 3.4 | *4.7* | 1.3 | 4.1 | *5.5* |
| | Urban | 789,474 | 1,163,206 | 1891 | 1.2 | 2.2 | *3.4* | 1.2 | 2.9 | *4.1* | 1.2 | 3.6 | *4.7* |
| 03 Waikato Region | Rural | 91,539 | 121,952 | 6 | 1.3 | 2.7 | *4.0* | 1.3 | 3.4 | *4.8* | 1.3 | 4.2 | *5.5* |
| | Urban | 187,158 | 249,340 | 835 | 1.3 | 2.5 | *3.8* | 1.3 | 3.2 | *4.5* | 1.3 | 4.0 | *5.2* |
| 04 Bay of Plenty Region | Rural | 39,378 | 61,198 | 5 | 1.4 | 2.6 | *4.0* | 1.4 | 3.4 | *4.8* | 1.4 | 4.2 | *5.5* |
| | Urban | 143,445 | 222,930 | 829 | 1.3 | 2.5 | *3.8* | 1.3 | 3.2 | *4.5* | 1.3 | 4.0 | *5.2* |
| 05 Gisborne Region | Rural | 7,371 | 10,372 | 2 | 1.3 | 2.7 | *4.0* | 1.3 | 3.4 | *4.8* | 1.3 | 4.2 | *5.5* |
| | Urban | 16,764 | 23,589 | 955 | 1.3 | 2.4 | *3.7* | 1.3 | 3.2 | *4.4* | 1.3 | 3.9 | *5.2* |
| 06 Hawke's Bay Region | Rural | 21,309 | 29,339 | 2 | 1.4 | 2.6 | *4.0* | 1.4 | 3.4 | *4.8* | 1.4 | 4.1 | *5.5* |
| | Urban | 76,446 | 105,255 | 713 | 1.3 | 2.5 | *3.8* | 1.3 | 3.2 | *4.5* | 1.3 | 3.9 | *5.2* |
| 07 Taranaki Region | Rural | 22,152 | 28,058 | 4 | 1.3 | 2.7 | *4.0* | 1.3 | 3.4 | *4.8* | 1.3 | 4.2 | *5.5* |
| | Urban | 52,296 | 66,239 | 648 | 1.3 | 2.5 | *3.8* | 1.3 | 3.2 | *4.5* | 1.3 | 4.0 | *5.3* |
| 08 Manawatu-Wanganui Region | Rural | 39,111 | 53,720 | 2 | 1.3 | 2.7 | *4.0* | 1.3 | 3.4 | *4.8* | 1.3 | 4.2 | *5.5* |
| | Urban | 104,367 | 143,352 | 742 | 1.3 | 2.5 | *3.8* | 1.3 | 3.2 | *4.5* | 1.3 | 3.9 | *5.2* |
| 09 Wellington Region | Rural | 18,531 | 24,087 | 3 | 1.3 | 2.7 | *4.0* | 1.3 | 3.4 | *4.8* | 1.3 | 4.2 | *5.5* |
| | Urban | 255,147 | 331,643 | 1153 | 1.2 | 2.4 | *3.6* | 1.2 | 3.1 | *4.3* | 1.2 | 3.8 | *5.1* |
| 12 West Coast Region | Rural | 9,339 | 12,812 | 1 | 1.3 | 2.7 | *4.0* | 1.3 | 3.4 | *4.8* | 1.3 | 4.2 | *5.5* |
| | Urban | 10,629 | 14,582 | 347 | 1.3 | 2.6 | *3.9* | 1.3 | 3.3 | *4.6* | 1.3 | 4.1 | *5.4* |
| 13 Canterbury Region | Rural | 73,827 | 109,042 | 2 | 1.3 | 2.7 | *4.0* | 1.3 | 3.4 | *4.8* | 1.3 | 4.2 | *5.6* |
| | Urban | 321,708 | 475,163 | 899 | 1.3 | 2.5 | *3.7* | 1.3 | 3.2 | *4.4* | 1.3 | 3.9 | *5.1* |
| 14 Otago Region | Rural | 36,114 | 45,526 | 2 | 1.3 | 2.7 | *4.0* | 1.3 | 3.4 | *4.8* | 1.3 | 4.2 | *5.5* |
| | Urban | 108,522 | 136,804 | 703 | 1.3 | 2.5 | *3.8* | 1.3 | 3.2 | *4.5* | 1.3 | 4.0 | *5.3* |
| 15 Southland Region | Rural | 24,570 | 34,710 | 1 | 1.3 | 2.7 | *4.0* | 1.3 | 3.4 | *4.8* | 1.3 | 4.2 | *5.5* |
| | Urban | 42,621 | 60,210 | 610 | 1.3 | 2.5 | *3.8* | 1.3 | 3.3 | *4.5* | 1.3 | 4.0 | *5.3* |
| 16 Tasman Region | Rural | 16,581 | 25,847 | 2 | 1.3 | 2.7 | *4.0* | 1.3 | 3.4 | *4.8* | 1.3 | 4.2 | *5.6* |
| | Urban | 19,371 | 30,196 | 456 | 1.3 | 2.6 | *3.9* | 1.3 | 3.3 | *4.6* | 1.3 | 4.0 | *5.3* |
| 17 Nelson Region | Rural | 1,353 | 2,109 | 5 | 1.3 | 2.7 | *4.0* | 1.3 | 3.4 | *4.8* | 1.3 | 4.2 | *5.6* |
| | Urban | 29,865 | 46,554 | 877 | 1.3 | 2.5 | *3.8* | 1.3 | 3.2 | *4.4* | 1.3 | 3.9 | *5.2* |
| 18 Marlborough Region | Rural | 9,948 | 15,507 | 1 | 1.4 | 2.7 | *4.0* | 1.4 | 3.4 | *4.8* | 1.4 | 4.2 | *5.5* |
| | Urban | 22,245 | 34,676 | 1177 | 1.2 | 2.4 | *3.6* | 1.2 | 3.1 | *4.3* | 1.2 | 3.9 | *5.1* |

*Source:* Authors' calculations as described in the text.

To finish this section, we note these numbers on the average number of parking spaces per vehicle is unlikely to be equivalent to the marginal number of parking spaces per vehicle. Specifically, we note the marginal vehicle is unlikely to be accompanied by a proportional increase in parking. This is especially likely in the New Zealand context, where recent changes to planning policies under the NPS-UD have sought to remove minimum parking requirements from urban areas. As such, we expect the marginal number of carparks per vehicle will be lower than the average numbers presented in Table 5 above.

### 3.1.4 Economic Cost Estimates

Table 6 summarises our total cost estimates, drawing on relevant results in Table 4 and Table 5. That is, for each typology and location, we multiply unit costs, vehicle numbers, and average spaces per vehicle.[9]

**Table 6: Economic cost estimates – Low, Central, and High scenarios ($ million, 2018/19 NZD)**

| Location | | Low | | | Central | | | High | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | On | Off | Tot. | On | Off | Tot. | On | Off | Tot. |
| 01 Northland Region | Rural | $20 | $83 | $103 | $20 | $106 | $126 | $20 | $130 | $150 |
| | Urban | $16 | $78 | $94 | $16 | $100 | $116 | $16 | $124 | $140 |
| 02 Auckland Region | Rural | $28 | $117 | $144 | $28 | $151 | $178 | $28 | $184 | $211 |
| | Urban | $415 | $5,959 | $6,374 | $415 | $7,844 | $8,258 | $415 | $9,689 | $10,104 |
| 03 Waikato Region | Rural | $32 | $131 | $163 | $32 | $168 | $200 | $32 | $207 | $239 |
| | Urban | $67 | $447 | $515 | $67 | $576 | $644 | $67 | $715 | $782 |
| 04 Bay of Plenty Region | Rural | $16 | $66 | $82 | $16 | $85 | $101 | $16 | $104 | $120 |
| | Urban | $61 | $430 | $491 | $61 | $553 | $614 | $61 | $687 | $748 |
| 05 Gisborne Region | Rural | $3 | $11 | $14 | $3 | $14 | $17 | $3 | $17 | $20 |
| | Urban | $6 | $28 | $34 | $6 | $37 | $43 | $6 | $46 | $52 |
| 06 Hawke's Bay Region | Rural | $8 | $31 | $39 | $8 | $40 | $48 | $8 | $49 | $57 |
| | Urban | $28 | $164 | $192 | $28 | $212 | $240 | $28 | $261 | $289 |
| 07 Taranaki Region | Rural | $7 | $30 | $37 | $7 | $38 | $45 | $7 | $47 | $54 |
| | Urban | $17 | $95 | $112 | $17 | $121 | $139 | $17 | $150 | $167 |
| 08 Manawatu-Wanganui Region | Rural | $14 | $57 | $71 | $14 | $73 | $87 | $14 | $90 | $103 |
| | Urban | $38 | $208 | $245 | $38 | $267 | $305 | $38 | $327 | $365 |
| 09 Wellington Region | Rural | $6 | $25 | $32 | $6 | $33 | $39 | $6 | $40 | $46 |
| | Urban | $94 | $825 | $919 | $94 | $1,065 | $1,159 | $94 | $1,317 | $1,411 |
| 12 West Coast Region | Rural | $3 | $14 | $17 | $3 | $17 | $21 | $3 | $21 | $25 |
| | Urban | $4 | $16 | $20 | $4 | $20 | $24 | $4 | $25 | $29 |
| 13 Canterbury Region | Rural | $28 | $116 | $145 | $28 | $149 | $178 | $28 | $184 | $212 |
| | Urban | $127 | $825 | $952 | $127 | $1,062 | $1,188 | $127 | $1,298 | $1,424 |
| 14 Otago Region | Rural | $12 | $50 | $62 | $12 | $63 | $75 | $12 | $77 | $89 |
| | Urban | $37 | $223 | $260 | $37 | $290 | $327 | $37 | $361 | $398 |
| 15 Southland Region | Rural | $9 | $37 | $46 | $9 | $47 | $56 | $9 | $57 | $66 |
| | Urban | $15 | $72 | $87 | $15 | $93 | $108 | $15 | $114 | $130 |
| 16 Tasman Region | Rural | $7 | $28 | $35 | $7 | $36 | $43 | $7 | $44 | $51 |
| | Urban | $8 | $45 | $53 | $8 | $57 | $65 | $8 | $70 | $78 |
| 17 Nelson Region | Rural | $1 | $2 | $3 | $1 | $3 | $3 | $1 | $4 | $4 |
| | Urban | $12 | $79 | $91 | $12 | $101 | $113 | $12 | $124 | $137 |
| 18 Marlborough Region | Rural | $4 | $17 | $21 | $4 | $21 | $25 | $4 | $26 | $30 |
| | Urban | $9 | $46 | $55 | $9 | $60 | $69 | $9 | $75 | $84 |
| **Totals** | | **$1,152** | **$10,355** | ***$11,507*** | **$1,152** | **$13,504** | ***$14,656*** | **$1,152** | **$16,664** | ***$17,816*** |

*Source:* Authors' calculations as described in the text.

Our central estimate of the economic costs of parking is $14.7 billion p.a., with a range from $11.5 billion to $17.8 billion p.a. [10] Table 7 then relates our estimates to travel demands from the HTS.[11] Table 7 underscores that the economic costs of parking exhibit high levels of spatial heterogeneity, with large differences between Auckland and most other regions. We estimate national average

[9] We assume all off-street parking is surface for two reasons. First, Table 4 reveals off-street surface parking is, on average, cheaper than structured parking in all locations we analyse. Second, though important in larger city centres, structured parking makes up a relatively small proportion of overall supply. This assumption is likely to impart a downwards bias to our estimates.

[10] Uncertainty is introduced via our estimates of average spaces per vehicle, c.f. Table 5. As we treat parking unit costs and registered vehicles as deterministic variables, our scenarios understate the level of uncertainty in our estimates of costs.

[11] Average cost per vehicle trip is independent of vehicle occupancy, whereas the average cost per person-km is not. We aggregate to the regional level, which helps to avoid issues with small HTS sample sizes.

costs of parking at $3,739 per vehicle p.a., or $3.90 per vehicle trip, or $0.32 per person-kilometre. We note Auckland is the only region with economic costs that are above the national average. Outside of Auckland, average costs range from $1,635—$3,368 per vehicle p.a., or $1.27—$3.46 per vehicle trip, or $0.11—$0.29 per person-kilometre. Our preferred cost metric is the cost per vehicle p.a., which does not require additional assumptions on travel demands. Approximately 61% of the total costs are associated with land, with 25% and 15% due to O&M and capital, respectively. These numbers represent weighted averages for New Zealand, where weights are based on the number of registered lights vehicles in the urban / rural parts of each region as well as the split between on- and off-street supply.

**Table 7: Average costs of parking per vehicle, vehicle trip, and person-kilometre travelled**

| Region | Cost | Vehicles | Demands [mill p.a.] | | Average costs [$ per …] | | |
|---|---|---|---|---|---|---|---|
| | [mill $ p.a.] | [,000s] | Trips | Person-km | Veh p.a. | Trip | Person-km |
| Northland | $242 | 137 | 136 | 2,291 | $1,764 | $1.78 | $0.11 |
| Auckland | $8,437 | 1,268 | 1,213 | 14,385 | $6,653 | $6.96 | $0.59 |
| Waikato | $844 | 371 | 387 | 6,009 | $2,273 | $2.18 | $0.14 |
| Bay of Plenty | $715 | 284 | 235 | 2,991 | $2,517 | $3.05 | $0.24 |
| Gisborne | $59 | 34 | 47 | 371 | $1,751 | $1.27 | $0.16 |
| Hawke's Bay | $288 | 135 | 143 | 1,549 | $2,140 | $2.01 | $0.19 |
| Taranaki | $184 | 94 | 88 | 1,082 | $1,952 | $2.09 | $0.17 |
| Manawatu-Wanganui | $392 | 197 | 192 | 2,615 | $1,988 | $2.05 | $0.15 |
| Wellington | $1,198 | 356 | 346 | 4,102 | $3,368 | $3.46 | $0.29 |
| West Coast | $45 | 27 | 33 | 348 | $1,635 | $1.37 | $0.13 |
| Canterbury | $1,366 | 584 | 545 | 5,862 | $2,339 | $2.51 | $0.23 |
| Otago | $402 | 182 | 173 | 2,187 | $2,208 | $2.33 | $0.18 |
| Southland | $164 | 95 | 83 | 948 | $1,731 | $1.97 | $0.17 |
| Tasman | $108 | 56 | 34 | 460 | $1,928 | $3.21 | $0.23 |
| Nelson | $117 | 49 | 52 | 430 | $2,397 | $2.25 | $0.27 |
| Marlborough | $94 | 50 | 56 | 494 | $1,876 | $1.69 | $0.19 |
| **National totals / average** | **$14,656** | **3,920** | **3,761** | **46,124** | **$3,739** | **$3.90** | **$0.32** |

*Source:* Authors' calculations, with travel demands sourced from HTS.

## 3.2 Question 2: Financial Charges

### 3.2.1 Payment of charges

To understand the financial charges attached to parking and how they vary by location, trip type, and time of day, we draw on HTS data.[12] To maintain consistency with the analysis in Section 3.1 and to ensure a sufficiently large sample, we analyse HTS responses separately by region for Auckland, Wellington, and Canterbury while grouping together responses for other regions. Though this smooths over differences between smaller regions, the larger sample size (and robustness) means it is a worthwhile compromise.

Table 8 summarises our analysis of HTS responses. Specifically, we consider responses for the type of parking used (*trwpark*), the proportion of trips for which a parking fee was paid (*trparkfee*), and the person or entity that paid the parking fee, e.g. driver, employer, or other (*trwhopaid*). For the "parking type" and "parking fee" columns, we calculate percentages relative to the total number

[12] The primary downside of using the HTS is it records only whether a fee was paid, not the level of the fee that was paid. We recommend future iterations of the HTS collect information on the level of parking fees.

of vehicle trips for each combination of region, trip type and time-period. For the "payer in vehicle" columns, however, the percentages relate only to those vehicle trips for which a parking fee was paid.

The results of our analysis in Table 8 reveal relatively similar outcomes in financial charges between regions in New Zealand.[13] At a national level we find 86% of trips use off-street parking at their destination, 99% of trips do not end in parking charges, and 85% of parking charges are paid by people in the vehicle. These results suggest parking costs are not usually charged directly to drivers, which in turn implies the costs are either (1) bundled in the costs of goods and services; (2) paid for indirectly by drivers in other ways, e.g. through rates, or (3) subsidised by wider society. We expect, for example, the costs of parking at destinations are often subsidised whereas the costs of parking at people's homes is likely to be bundled (e.g. into housing costs, for those who park off-street) or partly subsidised (e.g. via rates, for those who park on-street). Where parking charges are applied and/or costs are bundled into the costs of goods and services that are purchased by divers, the total subsidy for parking will be somewhat lower than the total economic costs we estimate in Chapter 3.1.4.

**Table 8: HTS responses – Type of parking, parking fees, and who paid**

| Region | Trip type | Period | % all trips | Parking type | | Parking fee | | Payer in vehicle | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Off-st. | On-st. | No | Yes | Yes | No |
| Auckland | Commuting and education | Off-peak | 9% | 95% | 5% | 99% | 1% | 87% | 13% |
| | | Peak | 4% | 84% | 16% | 98% | 2% | 26% | 74% |
| | Other | Off-peak | 16% | 86% | 14% | 98% | 2% | 90% | 10% |
| | | Peak | 4% | 73% | 27% | 99% | 1% | 96% | 4% |
| Wellington | Commuting and education | Off-peak | 3% | 94% | 6% | 99% | 1% | 87% | 13% |
| | | Peak | 1% | 84% | 16% | 97% | 3% | 82% | 18% |
| | Other | Off-peak | 5% | 78% | 22% | 98% | 2% | 97% | 3% |
| | | Peak | 1% | 73% | 27% | 98% | 2% | 93% | 7% |
| Canterbury | Commuting and education | Off-peak | 4% | 95% | 5% | 100% | 0% | 74% | 26% |
| | | Peak | 2% | 90% | 10% | 99% | 1% | 87% | 13% |
| | Other | Off-peak | 6% | 83% | 17% | 99% | 1% | 92% | 8% |
| | | Peak | 2% | 80% | 20% | 99% | 1% | 94% | 6% |
| Other | Commuting and education | Off-peak | 12% | 96% | 4% | 99% | 1% | 81% | 19% |
| | | Peak | 5% | 92% | 8% | 98% | 2% | 80% | 20% |
| | Other | Off-peak | 21% | 85% | 15% | 99% | 1% | 94% | 6% |
| | | Peak | 5% | 80% | 20% | 99% | 1% | 89% | 11% |
| **National** | | | **100%** | **86%** | **14%** | **99%** | **1%** | **85%** | **15%** |

*Source:* Authors' calculations, with travel demands sourced from HTS.

To finish, we consider off-street parking charges faced by commuters to the city centres in Auckland, Wellington, and Christchurch. Figure 2, Figure 3, and Figure 4 compare (ex GST) daily and earlybird parking charges for these cities, which is sourced from the website Parkopedia.[14]

[13] With one exception: In Auckland, only 26% of fees are paid by people in the vehicle. This may hint at issues with sample sizes.

[14] Lower earlybird rates may reflect the higher elasticity of this market segment. See, for example, Kelly, J. A., & Clinch, J. P. (2009). Temporal variance of revealed preference on-street parking price elasticity. Transport Policy, 16(4), 193-199.

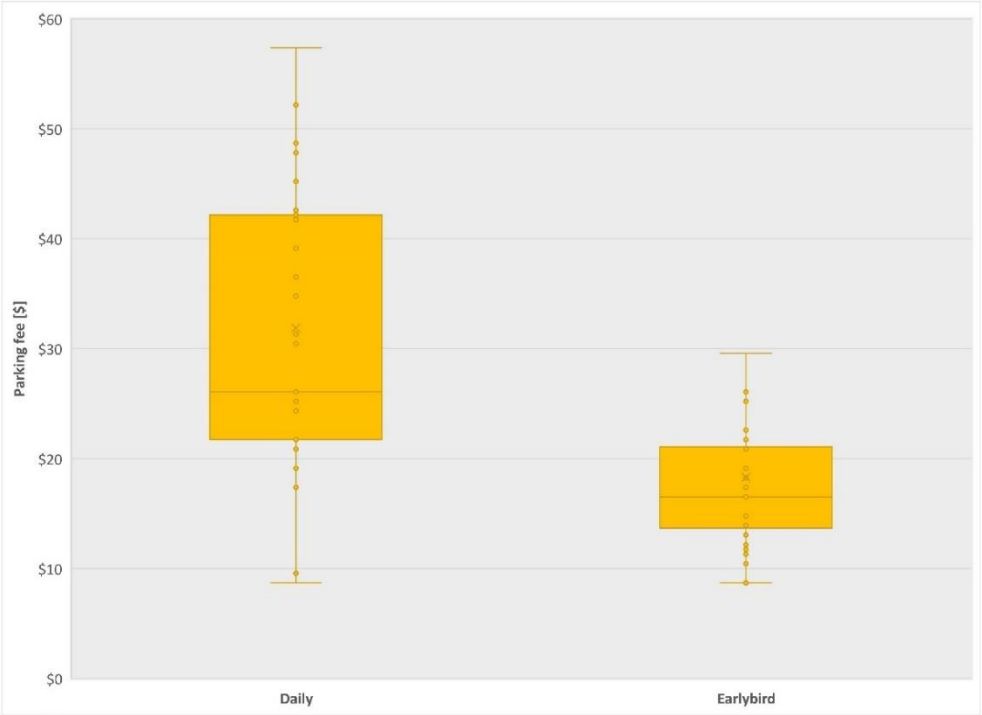


**Figure 2: Casual daily and early-bird parking fees in Auckland (NB: The "whiskers" shows the range in observed parking charges, while the "box" shows the interquartile range and median price)**

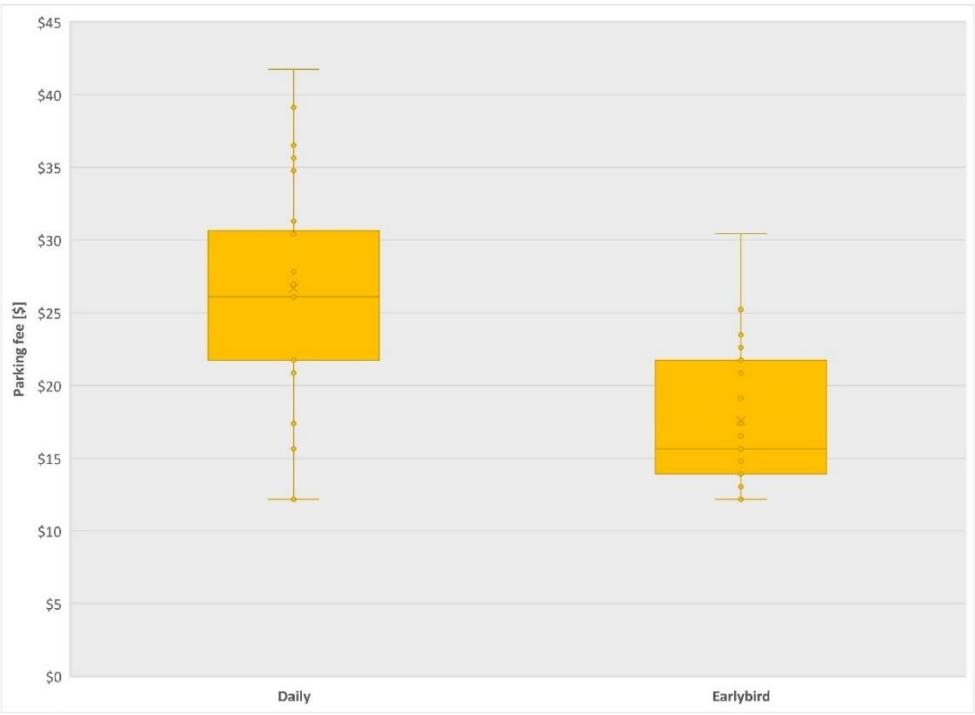


**Figure 3: Casual daily and early-bird parking fees in Wellington (NB: The "whiskers" shows the range in observed parking charges, while the "box" shows the interquartile range and median price)**

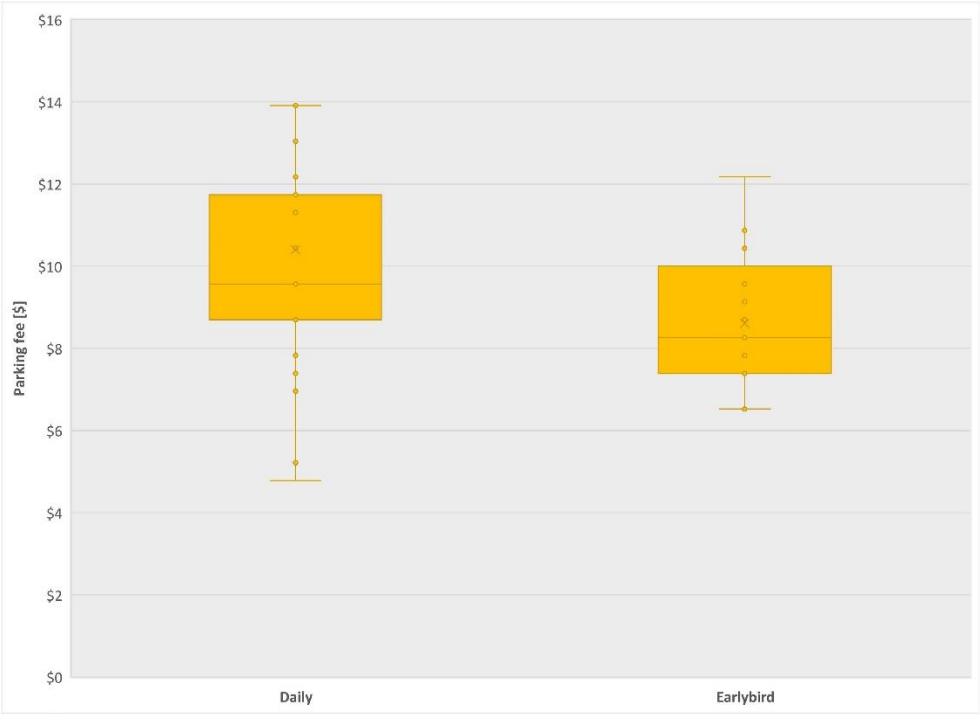


**Figure 4: Casual daily and early-bird parking fees in Christchurch (NB: The "whiskers" shows the range in observed parking charges, while the "box" shows the interquartile range and median price)**

### 3.2.2 Comparing costs and charges

We now draw on our results from Chapters 3.1.2 and 3.2.1 to compare costs and charges in the city centres of Auckland, Wellington, and Christchurch. This comparison is intended to provide insight into the alignment between our parking unit costs and the financial charges paid by users (ex GST). Though the latter are not a perfect indicator of economic costs—for reasons we expand on below—we suggest they are a useful proxy that can help to informally validate our estimates of parking unit costs.

To proceed, we first use Council ratings data to calculate average land prices in each city centre. Figure 5 illustrates the SA1s we use to define each of the three city centres for the purposes of calculating average land prices. We use these prices to estimate the cost of land per surface and structured parking spaces.

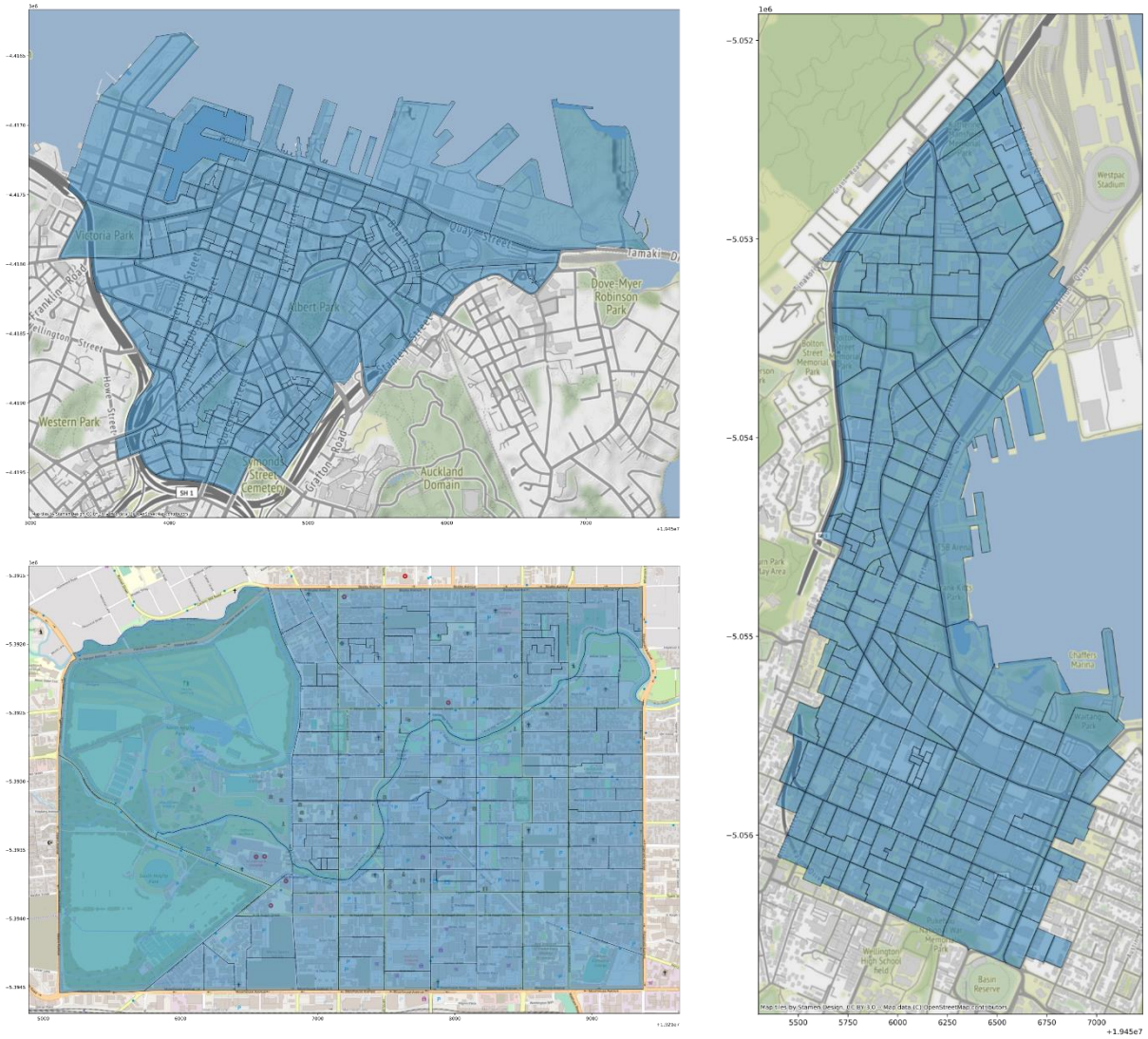


**Figure 5: Definition of City Centres in Auckland, Wellington, and Christchurch**

Second, we add to the land costs the relevant capital and O&M costs to arrive at a total unit cost p.a. Third, we divide this total cost per car park p.a. by 250 days p.a. to arrive at an estimated cost per day. Finally, we calculate daily parking charges (ex GST) in each city centre using the Parkopedia data previously illustrated in Figure 2, Figure 3, and Figure 4.[15] Table 9 summarises results.

[15] While user charges vary with duration, we suggest the casual daily rate is a decent indication of the average long-run daily parking revenue (NB: Noting the average hourly rates for earlybird and casual parking will be lower and higher, respectively).

**Table 9: Comparing costs and charges ($/parking space/day)**

| City centre | Typology | Land | | Capital | O&M | Total | Cost $ per day | Charges | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | $ / sqm | $ / space | | | | | Low | Mean | High |
| Auckland | Surface | $9,846 | $11,028 | $147 | $246 | $11,420 | $46 | $21.74 | $31.87 | $42.17 |
| | Structure | $9,846 | $2,206 | $1,423 | $1,464 | $5,092 | $20 | | | |
| Wellington | Surface | $4,479 | $5,017 | $147 | $246 | $5,409 | $22 | $21.74 | $26.68 | $30.65 |
| | Structure | $4,479 | $1,003 | $1,423 | $1,464 | $3,890 | $16 | | | |
| Christchurch | Surface | $1,849 | $2,070 | $147 | $246 | $2,463 | $10 | $8.70 | $10.40 | $11.74 |
| | Structure | $1,849 | $414 | $1,423 | $1,464 | $3,301 | $13 | | | |

*Source:* Authors' calculations and Parkopedia data.

In the case of Auckland and Christchurch, our estimated costs for surface and structured parking seem to quite align closely with the user charges derived from Parkopedia data. In Wellington, however, our estimated costs are somewhat lower than actual user charges. We suggest our estimated economic costs may diverge from observed user charges for several reasons, including but not limited to:

- *Regulatory constraints.* In all three city centres the removal of parking minimums was accompanied by the imposition of parking maximums, which serves to constrain the parking supply and may cause charges to exceed costs. It may be that the maximums imposed in Wellington bind more tightly or are enforced more stringently than those in, say, Auckland.
- *Revenue estimates.* In all three city centres, we approximate average parking revenues per space based on the quoted daily rates for casual parking. This cost will be significantly higher than the earlybird and long-term leases typically paid by regular commuters but significantly lower than the hourly rates for short-stay casual parking. The accuracy of our revenue estimates depends on the extent to which casual daily rates approximate the average revenue per day.
- *Short-run shocks*. Recent earthquakes in Wellington and Christchurch may have affected prices in the short term, perhaps even in different directions. Specifically, the Wellington earthquake seems to have reduced supply (due to the closure of several parking buildings) whereas the Christchurch earthquake seems to have increased supply (due to increased surface parking) as well as reducing demand for parking in the city centre (e.g. due to the relocation of many offices and retail outlets to suburban areas).
- *Compositional bias*. Our sample of public parking sites may be biased towards larger, more formal, and more expensive commercial parking facilities compared to the overall parking supply, which might also comprise of many smaller, less formal commercial and residential providers.
- *Market power*. Providers of off-street parking may have market power that allows them to set charges that exceed their costs. This is especially true in constrained locations where alternative off-street parking facilities act as imperfect (spatial) substitutes.

A combination of these factors, as well as others we do not identify, may explain why our estimated economic costs are somewhat below prevailing user charges in Wellington.

## 3.3 Question 3: Incidence of charges

The incidence of parking fees and charges—and how this incidence varies over space and time—is relevant to policy. For this reason, we analyse how the incidence, or "burden", of parking charges falls on workers vis-à-vis employers. To understand this issue, we again use the HTS,

specifically car trips (*trmode* = 0 or 1 for driver and passengers, respectively) to work (*tractiv = 3).*[16] Of this subset of trips, we then identify three outcomes that are most relevant to the incidence of parking charges:

- *Free parking:* Trips ending with employer-provided free parking (*trwpark* = 2 and *trparkfee* = 1)
- *Employer pays:* Trips ending with parking fees that are paid by the employer (*trparkfee* = 2, 3, or 4 and *trwhopaid* = 2).
- *Worker pays:* Trips ending with parking fees that are paid by the worker (*trparkfee* = 2, 3, or 4 and *trwhopaid* = 1).

For the first two outcomes, the burden of parking charges is indirectly or directly borne by the employer. In contrast, for the third outcome, the burden of parking charges is borne by the employee. Results are summarised in Table 10 for Auckland, Wellington, Canterbury, and Other regions.

**Table 10: Incidence of parking charges on workers and employers (commuter trips)**

| Region | Measure | Outcome | | |
|---|---|---|---|---|
| | | Free parking | Employer pays | Worker pays |
| Auckland | Trips | 89.46 | 3.57 | 2.73 |
| | % trips | 93% | 4% | 3% |
| Wellington | Trips | 18.89 | 0.47 | 2.57 |
| | % trips | 86% | 2% | 12% |
| Canterbury | Trips | 50.19 | 0.33 | 1.30 |
| | % trips | 97% | 1% | 3% |
| Other | Trips | 122.27 | 1.78 | 6.51 |
| | % trips | 94% | 1% | 5% |
| **National** | **Trips** | **280.81** | **6.15** | **13.12** |
| | **% trips** | **94%** | **2%** | **4%** |

*Source:* Authors' calculations using HTS data

We find only 4% of car trips to work in New Zealand ends with parking charges being paid by vehicle occupants, that is, the workers. Instead, most people park for free at the place of work (94%) or have charges paid for by their employer (2%). When parking charges are incurred for commuting trips, car users cover these costs in approximately two-thirds (68%) of occasions. These national averages belie some regional variations: specifically, the proportion of trips to work that incur parking fees is higher in Wellington than other parts of the country (14% vis-à-vis 6%, respectively). Moreover, the proportion of workers that bear these costs themselves is higher in Wellington (85% versus 68% nationally).

A lack of data hinders our analysis of the extent to which the economic costs of parking are charged to users, either directly or indirectly. More specifically, we cannot see a straightforward way to use existing data to quantify direct user charges, largely because the HTS asks only whether a trip ends in parking charges, rather than the amount paid for parking (NB: We suggest future iterations of the HTS consider asking questions on the level of parking charges). We also cannot see a straightforward way to quantify indirect user charges paid via housing; goods and

[16] Relevant HTS filters indicated in *italics*.

services; or council rates.[17] The recent policy decision to remove minimum parking requirements under the NPS-UD provides an opportunity to study the supply of parking that results from the choices of market participants. Presumably, these choices lead to less parking being provided that has historically been the case. Experience with removing MPRs in London, for example, finds the supply of parking with new developments fell by approximately 40%, although we are unsure of the associated effects on the level and incidence of parking fees for car users.[18]

Given the lack of detailed and reliable data on parking fees, we are unable to robustly quantify total user charges and the extent to which parking costs are subsidised by wider society and recommend further research into these questions. Our prior expectations are that users are likely to pay directly for approximately 5% of costs with their indirect contribution potentially ranging anywhere between 25-75%, yielding a total user contribution to the costs of parking of approximately 30-80%. This range, in turn, implies that the annual subsidy for parking could range from $2.93-$10.32b p.a. in our central scenario. Limitations and future updates

[17] One might presume some of the economic costs of off-street parking are included in housing costs and/or the price of goods and services. One might be tempted to assume the latter costs are passed on equally to all consumers irrespective of how they travel, although we know of no research into this question. One can imagine a scenario where users of non-car transport modes are less price-sensitive because, for example, they are less willing or able to shop around compared to vehicle users. In this case, profit-maximising businesses might seek to bundle the costs of parking in such a way that they are effectively sheeted home to non-car users more so than drivers. As for council rates, detailed analysis would have to answer complex questions around the allocation of joint costs and funding sources. Specifically, investment in on-street parking is often incurred jointly with larger investments, such as the development of new streets. Moreover, splitting out the extent to which historical investment in parking was covered by rates vis-à-vis other sources of funding strikes us as extremely challenging.

[18] Li, F., & Guo, Z. (2014). Do parking standards matter? Evaluating the London parking reform with a matched-pair approach. Transportation Research Part A: Policy and Practice, 67, 352-365.

# Chapter 4 Limitations and future updates

## 4.1 Limitations

Our approach to estimating the economic cost of parking has several limitations. Perhaps the most notable is our estimates for the average number of spaces per vehicles rely solely on international studies, albeit adjusted for population density when translating them to the New Zealand context. Appendix 3 documents the research and analysis that underpins our estimates. We also present estimates of average parking costs, rather than marginal costs. In many cases, the latter may be more relevant to policy. That said, the scalable nature of off-street parking facilities suggests average costs are likely, in our view, to provide a reasonable approximation of marginal costs, at least in the long run. This seems to be confirmed by the general alignment between the predictions of our economic cost model and prevailing user charges in Auckland and Christchurch. Finally, our analysis of parking charges is limited by data and complicated by the extent and manner to which parking costs are bundled and/or incurred jointly with other costs. We note the current HTS does not ask questions on the level of parking charges that are incurred, which future iterations of the HTS could seek to address.

## 4.2 Guidance for Updating

In terms of future updates, we suggest there may be value in updating this analysis in approximately 5-years' time, when new HTS and Census data will be available. While the effects of changes to parking policy like the NPS are expected to materialise only slowly, changes in land values—which is a large driver of the economic costs of parking—may be more rapid. Indeed, recent rapid increases in property prices in New Zealand may mean our estimates, which use land value data from 2018-19, are already somewhat dated. For this reason, we suggest there may be merit in updating these estimates more regularly than is might be suggested by changes in the level of parking supply itself.

## 4.3 Further Work

We suggest further work seek to quantify the supply of parking in a selection of New Zealand cities and towns, possibly by adopting the methodologies of the studies we review in Appendix 3 (NB: Our meta-analysis methodology, which is also presented in Appendix 3, can be readily extended to incorporate the results of local studies). More estimates of average parking spaces per vehicle might also enable the meta-analysis model to be extended to include other locational attributes in addition to density, such as mode share. Incorporating the latter would serve to strengthen the link between our analysis of parking costs and the transport policy levers available to policy makers. Finally, further work could seek to analyse issues of bundling and joint costs to enable the quantification of parking charges (direct and indirect) and, by extension, the extent to which parking costs are subsidised by wider society.

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# Appendix 2 : Listing of DTCC Working Papers

The table below lists the Working Papers prepared as part of the DTCC Study, together with the consultants responsible for their preparation.

| Ref | Topic/Working Paper title | Principal Consultants | Affiliation |
|---|---|---|---|
| **MODAL TOPICS** | | | |
| **C1.1** | Road Infrastructure – Marginal Costs | David Lupton | David Lupton & Associates |
| **C1.2** | Road Infrastructure – Total & Average Costs | | |
| **C2** | Valuation of the Road Network | Richard Paling | Richard Paling Consulting |
| **C3** | Road Expenditure & Funding Overview | | |
| **C4** | Road Vehicle Ownership & Use Charges | | |
| **C5** | Motor Vehicle Operating Costs | | |
| **C6** | Long-distance Coaches | David Lupton | David Lupton & Associates |
| **C7** | Car Parking | Stuart Donovan | Veitch Lister Consulting |
| **C8** | Walking & Cycling | | |
| **C9** | Taxis & Ride-hailing | | |
| **C10** | Micro-mobility | | |
| **C11.2** | Rail Regulation | Murray King | Murray King & Francis Small Consultancy |
| **C11.3** | Rail Investment | | |
| **C11.4** | Rail Funding | | |
| **C11.5** | Rail Operating Costs | | |
| **C11.6** | Rail Safety | | |
| **C12** | Urban Public Transport | Ian Wallis & Adam Lawrence | Ian Wallis Associates |
| **C14** | Coastal Shipping | Chris Stone | Rockpoint Corporate Finance |
| **C15** | Cook Strait Ferries | | |
| **SOCIAL AND ENVIRONMENTAL IMPACT TOPICS** | | | |
| **D1** | Costs of Road Transport Accidents | Glen Koorey | ViaStrada |
| **D2** | Road Congestion Costs | David Lupton | David Lupton & Associates |
| **D3** | Health Impacts of Active Transport | Anja Misdrak & Ed Randal | University of Otago (Wellington) |
| **D4** | Air Quality & Greenhouse Gas Emissions | Gerda Kuschel | Emission Impossible |
| **D5** | Noise | Michael Smith | Altissimo Consulting |
| **D6** | Biodiversity & Biosecurity | Stephen Fuller | Boffa Miskell |

Note:

The above listing incorporates a number of variations from the initial listing and scope of the DTCC Working Papers as set out in the DTCC Scoping Report (May 2020).

# Appendix 3 : Average Parking Spaces per Vehicle

To estimate the average number of car parks per vehicle, we undertook a simple meta-analysis of the literature. Table 11 summarises the studies identified in our review and their main findings.

**Table 11: Summary of research into average number of car-parks per vehicle**

| Study | Main findings |
|---|---|
| Pijanowski, B. (2007). Parking Spaces Outnumber Drivers 3-to-1, Drive Pollution and Warming. Purdue University News. | Indiana: Approximately 3.0 non-residential off-street parking spaces per vehicle. |
| Davis, A. Y., Pijanowski, B. C., Robinson, K. D., & Kidwell, P. B. (2010). Estimating parking lot footprints in the Upper Great Lakes Region of the USA. Landscape and Urban Planning, 96(2), 68-77. | Illinois: 2.81 spaces per vehicle<br>Indiana: 2.49 spaces per vehicle<br>Michigan: 2.95 spaces per vehicle<br>Wisconsin: 2.53 spaces per vehicle |
| Ben-Joseph, E. (2012). ReThinking a lot: the design and culture of parking (Vol. 7). Cambridge, MA: MIT press. | Average of 3.2 spaces per vehicle in the United States |
| Chester, M., Fraser, A., Matute, J., Flower, C., & Pendyala, R. (2015). Parking infrastructure: A constraint on or opportunity for urban redevelopment? A study of Los Angeles County parking supply and growth. Journal of the American Planning Association, 81(4), 268-286. | 3.3 spaces per vehicle, which is broken down 1.0 residential off-street, 1.7 non-residential off-street, and 0.6 residential on-street. |
| Scharnhorst, E. (2018). Quantified Parking: Comprehensive Parking Inventories for Five US Cities. Research Institute for Housing America. | New York: 0.6 spaces per household<br>Philadelphia: 3.7 spaces per household<br>Seattle: 5.2 spaces per household<br>Des Moines: 19.4 spaces per household |
| Hoehne, C. G., Chester, M. V., Fraser, A. M., & King, D. A. (2019). Valley of the sun-drenched parking space: The growth, extent, and implications of parking infrastructure in Phoenix. Cities, 89, 186-198. | Metro Phoenix: 4.27 spaces per vehicle, which is split approximately equally between residential off-street, non-residential off-street, and on-street. |
| Kondor, D., Santi, P., Le, D. T., Zhang, X., Millard-Ball, A., & Ratti, C. (2020). Addressing the “minimum parking” problem for on-demand mobility. Scientific reports, 10(1), 1-10. | Estimates total parking supply at approximately 1.2 million spaces for approximately 680,000 vehicles |

Table 12 syntheses these estimates of parking spaces per vehicle, where we separately record estimates for off-street (residential and other) and on-street parking. Table 12 also includes our own estimates for London, which are derived from Bates et al (2012).

**Table 12: Synthesizing estimates of parking spaces per vehicle**

| Geography | Off-street | | | On-street | Total | Source |
|---|---|---|---|---|---|---|
| | Res. | Other | Sub-total | | | |
| New York, New York | | | 0.33 | 0.62 | 0.95 | Scharnhorst (2018) |
| Philadelphia, Pennsylvania | | | 2.80 | 0.72 | 3.52 | |
| Seattle, Washington | | | 2.54 | 1.20 | 3.74 | |
| Des Moines, Iowa | | | 10.18 | 1.17 | 11.35 | |
| Singapore | | | | | 1.76 | Kondor et al (2020) |
| United States | | | | | 3.20 | Ben-Joseph (2012) |
| Los Angeles County | 1.00 | 1.70 | 2.70 | 0.60 | 3.30 | Chester et al (2015) |
| Phoenix | 1.28 | 1.26 | 2.54 | 1.73 | 4.27 | Hoehne et al (2019) |
| Illinois | | 2.81 | | | | Davis et al (2010) |
| Indiana | | 2.49 | | | | |
| Michigan | | 2.95 | | | | |
| Wisconsin | | 2.53 | | | | |
| Indiana | | 3.00 | | | | Pijanowski (2007) |
| London | 1.00 | 0.48 | 1.48 | 1.24 | 2.72 | Bates et al (2012) |

*Notes:* Most results are sourced directly from the cited studies. In the case of Scharnhorst (2018), we convert parking spaces per household to parking spaces per vehicle using demographic data on average household vehicle ownership in each city.

As most studies adopt similar methodologies, their results are, in our view, broadly comparable. The main methodological limitation is studies seem likely to understate the level of parking supply. Davis et al (2019), for example, describes their methodology as follows (p. 70, emphasis added):

> "*Parking lot coverage data was calculated from digitized orthophotos. Digitization is the process of visually delineating areas clearly visible on photographs … We only digitized paved surfaces where we could easily demarcate the stripes painted on a parking lot or where more than three cars were parked in an organized fashion. Truck storage areas, junk yards, gravel lots and access roads to parking lots were not digitized as parking lots in this study.* ***Similarly, we did not include on-street parking spaces, spaces in multi-level parking garages (other than the top floor if it had an open roof) and residential parking spaces that are not in parking lots …"***

Given most methodologies do not detect certain types of parking, for example multi-level parking, their estimates—as summarised in Table 12—seem likely to underestimate the total parking supply. This is especially likely in high-density environments, such as New York. Despite these methodological shortcomings, we consider most these estimates are reasonably comparable.

This begs the question: What factors might explain variation in the estimates of the average number of spaces per vehicle? To gain insight into this question, we considered the relationship between our estimates of parking supply per vehicle and average population density. The overall relationship is illustrated in Figure 6 for the city-level estimates in our data, where we exclude Des Moines as an outlier.

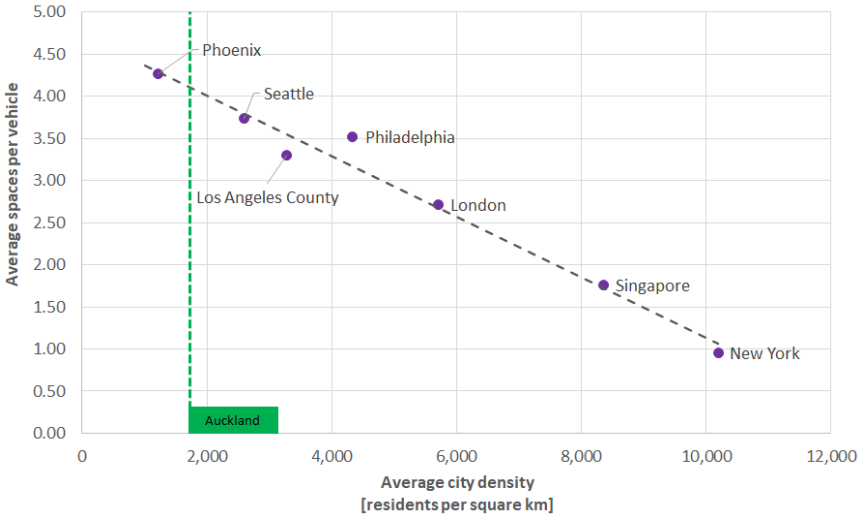


**Figure 6: Relationship between average parking supply per vehicle and average city density**

The simple linear trend line through our data points reveals a strong negative relationship. In our view, the relationship implied by our data—that is, parking supply becomes relatively scarce as density increases—seems intuitive given wider economic evidence on the effects of density on transport outcomes.[19] To quantify this relationship more precisely, including associated levels of

[19] See, for example, Bento, A. M., Cropper, M. L., Mobarak, A. M., & Vinha, K. (2005). The effects of urban spatial structure on travel demand in the United States. Review of Economics and Statistics, 87(3), 466-478.

statistical uncertainty, we estimate some simple (Bayesian) meta-analysis regression models of the following form:

$$c_i = \beta_0 + \beta_1 d_i + \zeta_s$$

Where $c_i$ denotes the average number of parking spaces per vehicle in city $i$, $d_i$ denotes the average population density of city $i$ in 1,000 people per square km, $\zeta_s$ denotes an individual study group effect[20], and $\beta_0$ and $\beta_1$ are parameters to be estimated, specifically the intercept and the coefficient on density, respectively (NB: Density in measured in terms of thousands of people per square kilometre). Table 13 summarises regression results for three variants of the above model.[21]

**Table 13: Regression results – Average parking spaces per vehicle**

| Predictors | Model 1 | | Model 2 | | Model 3 (preferred) | |
|---|---|---|---|---|---|---|
| | Estimates | CI (95%) | Estimates | CI (95%) | Estimates | CI (95%) |
| Intercept | 7.04 | 3.37 – 10.50 | 7.01 | 3.19 – 10.61 | 4.75 | 4.11 – 5.48 |
| Density | -0.69 | -1.35 – -0.01 | -0.71 | -1.36 – -0.05 | -0.37 | -0.47 – -0.27 |
| Random Effects | | | | | | |
| $\sigma^2$ | | | 7.19 | | 0.10 | |
| $\tau_{00}$ | | | 1.36 $_{Source}$ | | 0.05 $_{Source}$ | |
| ICC | | | 0.16 | | 0.33 | |
| N | | | 5 $_{Source}$ | | 5 $_{Source}$ | |
| Observations | 8 | | 8 | | 7 | |
| $R^2$ Bayes | 0.510 | | 0.527 / 0.541 | | 0.971 / 0.967 | |

Note in Model 1, we do not include study-level effects, $\zeta_s$,whereas in our preferred Model 3 we exclude Des Moines.[22] Nevertheless, we find somewhat similar estimates for $\beta_0$ and $\beta_1$ in all five models, increasing our confidence in the underlying direction of the quantitative relationship.

To transfer these results to the New Zealand context, we first calculate average population density in each of the geographies of interest (that is, for urban and rural areas in each regional council). Second, we use the results of Model 3 to estimate the average parking supply for a central (median) scenario as well as the high and low scenarios, where the latter are defined by 90% probability intervals.

Notwithstanding our efforts to review and synthesize research on the average number of car parks per vehicle, we suggest the importance of this assumption to our analysis warrants further research in the New Zealand context. Even a simple desktop spatial analysis—adopting

[20] Where $\zeta_s \sim N(0, \sigma_s^2)$. That is, we include group-level ("random") effects for individual studies, $\zeta_s$, where we assume studies are drawn from a normal distribution. Modelling individual study effects like this helps to control for heterogeneity at the level of individual studies while preventing issues with over-fitting. The latter is a concern in our situation given the small size of our sample, in which case the use of more conventional population-level (or "fixed") effects creates issues with identification.

[21] Specifically, we estimate Bayesian regression models in R Studio using BRMS with default priors for all parameters (R Core Team, 2020; RStudio Team, 2020). See Bürkner (2017) for an introduction to the BRMS package.

[22] Tests (namely PSIS-LOO information criterion) suggest Model 3 has the best out-of-sample performance, confirming our suggestion that the estimate for Des Moines contained in Scharnhorst (2018) is something of an outlier.

methodologies used in the above studies—for a representative sample of cities and towns would help inform chosen values for the average supply of parking per vehicle in New Zealand. Such results could even be included in the meta-analysis model estimated above, along with country random effects, to strengthen the results.

# Appendix 4 : Parking in Major City Centres

The following sub-sections present more detailed “case studies” of parking in the city centres in Auckland, Wellington, and Christchurch. These case studies draw on more detailed data supplied by the respective Councils on parking supply and parking charges. In addition to providing useful insight into parking in these city centres, we use this data to validate some of our assumptions.

## Auckland

Table 14 summarises the supply of parking in Auckland City Centre by type of parking. Private parking makes up approximately 84% of total parking supply in Auckland city centre. Even as the number of people who live and work in the city centre has grown significantly[23], the number of on-street spaces appears to have fallen—reducing by approximately 100 spaces p.a. over the last decade.[24] Most of the reduction in on-street parking supply is attributable to street upgrades. We could find no clear trends in the private parking supply. Though more parking is being provided with new developments, some of this is at the expense of existing surface parking. As such, the net effect on parking supply is hard to gauge.

**Table 14: Supply of parking in Auckland City Centre[25]**

| Owner | Parking type | AKL | |
|---|---|---|---|
| | | Supply | % |
| Council | On-street | 3,500 | 7 |
| | Public off-street | 4,900 | 9 |
| Private | Public off-street | 15,400 | 30 |
| | Ancillary off-street | 21,500 | 42 |
| | Residential off-street | 6,500 | 13 |
| **Totals** | | **51,800** | **100%** |

Auckland Transport kindly provided detailed information on three large off-street parking buildings located in the city centre—namely the Civic, Downtown and Victoria Street facilities—for the financial year from July 2018 to June 2019, which we summarize in Table 15. Though revenue for each site is predominately from parking, some income is generated from leasing floor space attached to the buildings. Parking revenue is made up of leased parking and casual parking. Usefully, we compare this data to our estimated parking unit cost. Specifically, average operating costs for these three off-street parking facilities vary from $3.92 to $8.97 per space per day, or $1,430 to $2,047 per space p.a.

In contrast, in Chapter 3.1.2 ‘Operating and maintenance costs’ we use independent data to arrive at average O&M costs for structured off-street parking spaces of $1,464 per space p.a. and capital depreciation of $1,423 per space p.a., yielding total costs of $2,887 per space per annum. While this is somewhat higher than the costs for Auckland Transport’s parking buildings, we suspect the latter experience some economies of scale compared to the average. Indeed, our analysis of Parkopedia data for Auckland finds the median private parking facility supplies around 150 parking

[23] https://www.censusauckland.co.nz/files/Auckland%20City%20Centre%202018%20Census%20info%20sheet.pdf

[24] In 2020, approximately 2,500 spaces are listed in the AT Parking App compared with the 3,500 on-street spaces noted in Auckland Transport’s Parking Discussion Document (2012).

[25] https://at.govt.nz/media/503106/ATParkingDiscussion.pdf

spaces vis-à-vis the 895 to 1,944 parking spaces supplied in Auckland Transport's parking buildings. Due to their larger size, we suggest Auckland Transport's costs per space are relatively low. On this basis, we consider our cost estimates to be reasonable.

**Table 15: Revenue and costs for three AT car park buildings July 2018 - June 2019 (Auckland Transport 2020)**

| Item | | Civic | Downtown | Victoria |
|---|---|---|---|---|
| Revenue | | $6,225,755 | $10,490,086 | $4,807,702 |
| Operating costs | Personnel | $95,501 | $2,323 | $128,365 |
| | Information technology | $13,524 | $13,524 | $13,524 |
| | Occupancy | $470,581 | $1,078,342 | $501,656 |
| | Service delivery and professional services | $293,869 | $476,839 | $181,927 |
| | Other expenditure | $183,680 | - | $176,972 |
| | Bad Debts | - | $975 | $104 |
| | Depreciation | $1,982,821 | $1,207,869 | $830,359 |
| | Total operating costs | $3,039,977 | $2,779,870 | $1,832,907 |
| Summary statistics | Operating surplus | $3,185,778 | $7,710,215 | $2,974,795 |
| | Number of parking spaces | 928 | 1,944 | 895 |
| | Gross revenue per day per parking space | $18.38 | $14.78 | $14.72 |
| | Operating costs per day per parking space | $8.97 | $3.92 | $5.61 |
| | Net revenue per day per parking space | $9.41 | $10.86 | $9.11 |
| | Book value (30/06/2020) | $75,829,775 | $27,611,029 | $16,741,026 |

## Wellington

We use data from Wellington City Council (WCC) and Let's Get Welly Moving to estimate the parking supply in Wellington city centre, as per Table 16—where we append data for Wellington to that previously presented for Auckland in Table 14. We find Wellington has approximately 40% fewer spaces compared to Auckland, with a larger share of on-street and a smaller share of public off-street parking. The composition of private supply is broadly similar across the three typologies we consider.

**Table 16: Supply of parking in Wellington City Centre[26]**

| Owner | Parking type | AKL | | WGN | |
|---|---|---|---|---|---|
| | | Supply | % | Supply | % |
| Council | On-street | 3,500 | 7 | 3,270 | 11 |
| | Public off-street | 4,900 | 9 | 830 | 3 |
| Private | Public off-street | 15,400 | 30 | 9,264 | 30 |
| | Ancillary off-street | 21,500 | 42 | 13,237 | 43 |
| | Residential off-street | 6,500 | 13 | 4,329 | 14 |
| **Totals** | | **51,800** | **100%** | **30,930** | **100%** |

WCC kindly provided detailed data on parking charges, which we summarise in Table 17. Though a small proportion of the revenue from "permits and coupons" and "fines and penalties" will be collected outside of the city centre, we expect most revenue is generated by parking spaces in the city centre. Using the data in Table 16 and Table 17, we estimate average revenue per parking

[26] Sourced from communications with Alastair Patrick, Let's Get Welly Moving and Wellington City Council's "Parking Policy Review – Background Information and Issues Report", available online here.

space by dividing total Council revenue ($28.2 million) by total Council supply (4,100), which yields $6,873 per parking space p.a. or approximately $27 per day. This aligns closely with the estimates for costs and charges we present earlier in Table 9, where we find average daily costs of $16-$22 and average charges of $27.

Of course, there is at least one notable difference between charges for private parking vis-à-vis that provided by WCC: The latter generates almost one-quarter of its revenue from fines and penalties, which we suspect is higher than the corresponding figure for private parking—where a greater proportion of revenue seems likely to be generated from direct user charges. Notwithstanding differences in the composition of revenue, our results suggest the combined direct and indirect parking charges in Wellington City Centre approximate charges for private parking.

**Table 17: Breakdown of parking charges in Wellington FY 2018/19 ($000)[27]**

| Type | Charges |
|---|---|
| Permits and coupons | $2,346 |
| Fines and penalties | $6,464 |
| On-street meters | $15,648 |
| Off-street (Clifton) | $3,120 |
| Parking app | $602 |
| **Total** | **$28,179** |

## Christchurch

Christchurch City Council (CCC) kindly supplied data on the supply of parking in the city centre, as summarised in Table 18, where we append this data to that for Auckland and Wellington.

**Table 18: Supply of parking in Christchurch City Centre[28]**

| Owner | Parking type | AKL | | WGN | | CHC[29] | |
|---|---|---|---|---|---|---|---|
| | | Supply | % | Supply | % | Supply | % |
| Council | On-street | 3,500 | 7 | 3,270 | 11 | 6,750 | 17 |
| | Public off-street | 4,900 | 9 | 830 | 3 | 913 | 2 |
| Private | Public off-street | 15,400 | 30 | 9,264 | 30 | 8,537 | 22 |
| | Ancillary off-street | 21,500 | 42 | 13,237 | 43 | 18,300 | 47 |
| | Residential off-street | 6,500 | 13 | 4,329 | 14 | 4,666 | 12 |
| **Total** | | **51,800** | **100%** | **30,930** | **100%** | **39,216** | **100%** |

In terms of composition, we find Christchurch has a relatively high share of on-street parking, at 17% versus 7% and 11% in Auckland and Wellington, respectively. Of the three cities, Christchurch has the smallest proportion of off-street public parking at 24%, whether owned by Council or privately. In contrast, off-street public parking represents 39% and 33% of the supply in Auckland and Wellington, respectively.

[27] Sourced from communications with Helen Bolton, Wellington City Council.

[28] Sourced from communications with Nick Lovett, Christchurch City Council.

[29] Authors estimates combining data from (1) Census 2018 and (2) MOT vehicle registrations, as per Chapter 3.1.3.

Table 19 summarises revenue from on-street parking in several locations around Christchurch City Centre. Interestingly, this data suggests revenue per on-street parking space varies within a relatively narrow range of $8.65 to $12.59 per day—yielding an average of $10.21 per space per day. Comparing with Table 9, we see this lies close to the costs predicted by our model ($10-$13 per day) as well as the user charges suggested by Parkopedia data ($9 to $12 per day).

**Table 19: Demand for on-street parking in Christchurch City Centre[30]**

| | Mid High | Upper High | Victoria Nth | St Asaph E | Hereford Br. |
|---|---|---|---|---|---|
| Type of parking | P60, Mon-Sun | P60, Mon-Sun | P60, Mon-Sun | P60, Mon-Fri | P60, Mon-Sun |
| Av. Hours parked/space | 4.35 | 2.86 | 2.79 | 4.06 | 3.94 |
| Av. Transaction | $2.70 | $2.18 | $2.61 | $2.52 | $2.82 |
| Revenue per space/day | $8.70 | $8.88 | $8.64 | $12.59 | $12.22 |
| Av. mins parked per space/day | 81 | 42 | 51 | 49 | 55 |
| Cars per day | 3.20 | 4.08 | 3.31 | 4.99 | 4.33 |
| Occupancy | 46% | 30% | 29% | 71% | 69% |

[30] Sourced from communications with Nick Lovett, Christchurch City Council.

# Appendix 5 : Pilot Survey of Businesses

To better understand how businesses manage parking, we distributed a pilot questionnaire to businesses in Auckland. Below, we briefly describe our approach and results.

## Approach

The pilot questionnaire sought to collect information on (1) the composition of business (e.g. location, sector, size, and income) and (2) the provision and management of parking and related facilities and policies. Survey questions are available from the authors on request. To promote the survey, we shared a link via social media channels (specifically LinkedIn and Twitter) as well as by making direct contact with the following business associations:

- Ponsonby Business Association
- Parnell Incorporated
- Uptown Business Association
- Remuera Business Association
- Mt Eden Business Association
- Newmarket Business Association
- Takapuna Beach Business Association

The opt-in nature of the questionnaire, as well as the somewhat limited channels used for promotion, mean the results of our pilot survey are unlikely to be representative. As such, we present them as a complement too, rather than a substitute for, the analyses presented in the body of the report.

## Results

A total of 30 businesses responded to the questionnaire, with an even split between those who found out via social media vis-à-vis business associations. These businesses employed a total of 628 employees (562 full-time, or FT, and 66 part-time) yielding an average of 21 FT employees per business, which is higher than the Auckland average. When we exclude the largest business in our sample, which has 160 FT employees, the average falls to 14 FT employees per business. Approximately 17% of responses (employing 9% of FT employees) are in the City Centre, with the balance located elsewhere in Auckland. The estimated annual average salary of full-time employees is approximately $100,000 p.a., which is significantly higher than the Auckland average. When we consider the sectoral composition of businesses, we find 47% (employing 60% of FT employees) deliver “Professional, Scientific and Technical Services”, which is also higher than the Auckland average for this sector. The high average salary is likely explained by this sectoral compositional.

In terms of parking, 30% of firms (employing 10% of FT employees) do not have exclusive access to parking. For those that do, we find a total of 239 parking spaces, or 12 parking spaces per firm, which is about 60% of the average number of FT employees. Respondents estimate these spaces have an average market value of $11.20 per day. We note this compares well to the predictions of our economic cost model, which reports an average economic cost (ex GST) of around $9.38 per day ($2,346/250) for off-street surface parking spaces in urban Auckland. Businesses reserve a total of 198 parking spaces for

their 562 FT employees, with only four businesses (employing 3% of FT employees) reserving parking for all employees. We find 50% of businesses (employing 37% of FT employees) bear the costs of parking themselves; 7% of businesses (employing 17% of FT employees) share costs with employees; and 7% of businesses (employing 32% of FT employees) pass on all costs to employees. The relatively small number of businesses that pass on parking costs to employees aligns broadly with HTS data. Finally, we find three-quarters of employees that pay for parking costs do so via salary sacrifice, although we have relatively few responses to this question.

# Domestic Transport Costs and Charges Study

## Working paper C7
## Parking

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New Zealand Government