Analysis of Mobile Bills

Original Report: 18 August 2020

Updated: 28 January 2021 to:

- acknowledge a methodological error identified in responses to the original analysis and correct the results; and

- address other responses to the original analysis and findings, including how these may affect the analysis and interpretation

Please see the memorandum attached at the end of this report for discussion of these issues.

For the New Zealand Commerce Commission

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Glossary of terms

Add-on: A retail mobile product purchased on a one-off or recurring basis that provides a fixed bundle of usage of one or more mobile services.

Average: The arithmetic mean of a set of numbers, i.e. the sum of the values divided by the number of values in the set.

Base plan: A retail mobile product that provides fixed usage quotas and possibly other services for a fixed period (e.g. one month) that is usually purchased on a recurring basis.

Billing type: The method by which a customer is charged for mobile services, either prior to using the services (prepaid) or after using the services (postpaid).

Casual usage: Usage of mobile services that is charged on a per-unit (e.g. per-minute or per-megabyte) basis.

Lower quartile: The value in a set of numbers that separates the lowest 25% of the values from the highest 75% of the values.

Median: The "middle" value of a set of numbers, i.e. the value that separates the lower half of the values from the upper half of the values.

Service provider: A business that provides retail mobile telecommunications services. This report is based on information provided by four service providers: 2degrees, Skinny, Spark, and Vodafone.

Standard deviation: A measure of the amount of variation or dispersion of a set of values around its average (mean) value. For normally distributed values, about 68% of the values lie within one standard deviation of the mean and 95% of values lie within two standard deviations of the mean.

Tenure: The length of time that a mobile customer has continuously been a customer of their current mobile service provider.

Upper quartile: The value in a set of numbers that separates the highest 25% of the values from the lowest 75% of the values.

Usage quota: The quantity of usage of mobile services associated with a base plan that can be used within a specific period without incurring additional charges.

1   Summary of main findings

This report summarises analysis for the NZ Commerce Commission of anonymised billing data for a random sample of almost 80,000 mobile telecommunications customers in New Zealand. Detailed information on the usage and expenditure of each customer in the sample was provided by 2degrees, Spark for both its Spark and Skinny brands, and Vodafone. These four brands have the largest market shares in the mobile market and together account for around 99% of mobile customers.[1] The analysis covers the 12-month period from September 2018 to August 2019 and is based on a dataset comprising 9.6 million data points that provides a very detailed snapshot of mobile customer usage and expenditure over those 12 months.

1.1   Objectives of this study

The main objectives of this study were to:

1.   better understand usage and expenditure patterns of active residential mobile customers; and

2.   investigate the extent to which such customers could save money by changing their purchasing behaviour.

The analysis was defined by a set of research questions provided by the Commission (see section 11.2) that focus on the two objectives above. This report is organised into themes that emerged from answering those questions.

1.2   Methods and limitations

The billing samples from the four service providers were standardised and combined before analysis (see section 11.3). This included removing some usage and expenditure that was not relevant for the analysis (see below), categorising products that customers purchased (e.g. into base plans and add-ons) and calculating various measures of monthly average usage and expenditure for each individual customer.

All aggregated statistics in this report such as averages and medians are aggregated across the four service providers to protect their confidential information and were weighted to reflect the service providers' market shares of residential customers and the sizes of the billing samples that each provided (see section 11.4). For practical reasons there were some restrictions on the customers that could be included in the sample, so it does not represent the total population of mobile customers in New Zealand (see section 3.1). An important limitation is that customers who switched from one service provider to another during the sample period were excluded from the sample. Since customers may switch provider in order to get a better deal, the potential savings identified for some customers in this report may not apply to the whole mobile market. Other limitations of the analysis are summarised in section 2.2.

The analysis in this report focuses on usage and expenditure of core mobile services: mobile data, NZ voice calls, and NZ SMS. Australian voice calls and SMS, and MMS are also included in some analysis, but most customers only use small amounts of those services (see section 4.1). Other services such as international roaming, international calls (except Australia), and purchases of devices were excluded from the analysis. Such services may be valuable to some customers, and this could explain some of the purchasing behaviour that we

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[1] NZ Commerce Commission, *Mobile Market Study – Findings*, final report of 26 September 2019.

observe. It could be useful to do further analysis to understand the extent to which customers value such services.

1.3 Key findings

1.3.1 Analysis of usage of mobile services

Each customer's monthly average usage of core mobile services was analysed to understand usage behaviour and how this varies across customers (see section 4). For customers buying base plans that provide fixed usage quotas for a fixed price, monthly usage was also compared to quotas to understand the extent to which plan quotas match usage patterns. This analysis showed that:

- The distribution of monthly average usage of core mobile services is highly skewed across customers (see section 4.1) and a small proportion of customers have very high usage compared to most other customers. For example, the median customer used about 1 GB of mobile data per month on average over the year, while the top 10% of customers used more than 5 GB per month and the top 1% used more than 21 GB per month. Some customers also have usage that varies a lot from month to month.

- Among customers buying base plans that provide monthly usage quotas, the nominal quota of voice minutes was exceeded in 15% of months, while the nominal quota of mobile data was exceeded in 31% of months (see section 4.2). Many customers appear to optimise their mobile data usage, with usage in 55% of months falling within 1 GB of quota (above or below).

This variation in usage across customers partly explains why a relatively large number of products (i.e. base plans and add-ons or usage packs) are offered by service providers in the retail market (see section 3.6). This diversity of products to some extent reflects the attempts of service providers to design and offer retail products that appeal to different types of customers, which may be expected in a competitive market. However, there is also a question of whether customers can choose the services that are the best value for them, given the number of alternatives and the complexity of such decisions.

Recognising the variation in usage, customers were divided into six usage groups for further analysis (see section 4.3):

- **High: All** – Customers in the top 25% of monthly average usage for *all* three of mobile data, NZ voice calls, and NZ SMS.

- **High: Data** – Customers in the top 25% of monthly average usage for mobile data *only*.

- **High: Voice** – Customers in the top 25% of monthly average usage for NZ voice calls *only*.

- **High: SMS** – Customers in the top 25% of monthly average usage for NZ SMS *only*.

- **Low: All** – Customers in the bottom 25% of monthly average usage for *all* three of mobile data, NZ voice calls, and NZ SMS.

- **Other** – All other customers who don't fall into any of the five groups above.

Table 1 summarises the proportions and usage characteristics of customers in these six groups.

Table 1 Summary of customer usage groups defined for analysis.

Usage group	Proportion of customers in this group	Median monthly usage of customers in this group		
		Mobile data (GB)	*NZ voice (mins)*	*NZ SMS (count)*
High: All	5.2%	4.8	379	411
High: Data	9.3%	3.8	79	60
High: Voice	8.9%	0.8	290	73
High: SMS	10.5%	0.9	84	347
Low: All	8.9%	0.0	8	1
Other	57.1%	0.8	83	70

1.3.2 Analysis of customer expenditure on mobile services

Monthly average expenditure of customers was analysed to understand typical expenditure and how this varies across customers (see section 5). The expenditure used in the analysis includes GST but is net of discounts given to mobile customers, particularly discounts for buying broadband services from the same service provider (see section 3.3). This showed:

- The average customer spent $33.85 per month, with the average postpaid customer spending more than twice as much as the average prepaid customer ($49.86 versus $21.65 per month).

- Expenditure varies considerably across the six usage groups defined above, with customers in the highest usage group spending seven times as much per month on average as customers in the low usage group (Figure 1).

Figure 1 Monthly average expenditure by usage group.
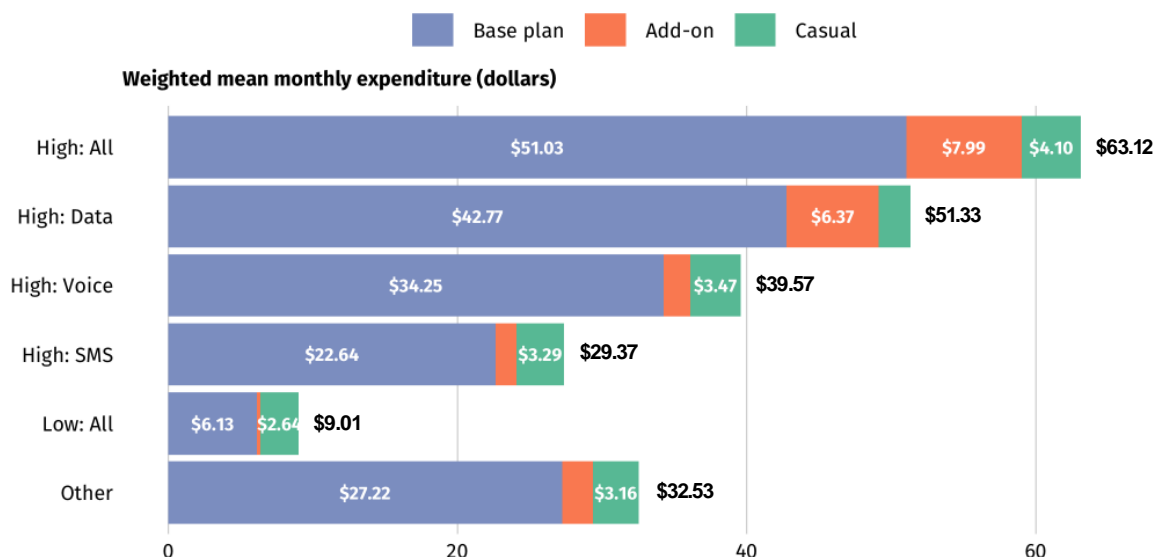
- There is also considerable variation of expenditure within usage groups. For example, about 0.6% of customers in the low usage group spend as much or more per month on average as the median customer in the highest usage group (see section 0).

- Customers who have been with their current service provider for a relatively long time (more than about six and a half years) spend around $3 per month more on average than customers who have been with their current service provider for a relatively short time (less than about two years).

The variation of expenditure across customer groups is expected given the variation of usage across those groups, but even within groups there is considerable variation of expenditure (see below) which raises questions of whether some customers are spending more than they need to, given their usage of mobile services.

1.3.3   Analysis of customers who switched base plans during the year

All postpaid customers and 81% of prepaid customers sometimes or always purchase base plan products. Base plans generally provide fixed monthly usage quotas and customers may choose to switch base plans to get better value, especially if their usage changes. For customers who purchased base plans, analysis of switching among these plans (from the same service provider) found (see section 6):

- Among customers who purchased base plan products in some or all months, about one-third switched base plans (while remaining with the same service provider) at least once during the year. Postpaid customers were more likely to switch base plans during the year than prepaid customers (43% vs 28% respectively). The billing data excludes customers who switched between service providers and who switched between prepaid and postpaid billing during the year, so the true extent of switching is higher than these figures imply.

- The billing data is consistent with the hypothesis that customers who switched base plans were motivated by increasing usage of mobile data and NZ voice calls (but it does not directly verify this hypothesis). Among customers who switched base plans only once during the year (see section 6.2):

  o   Median monthly data usage was 66% higher for prepaid customers and 32% higher for postpaid customers in the months after switching compared to the months before switching.

  o   Median NZ voice call usage was 10% higher for both prepaid and postpaid customers in the months after switching compared to before.

- Postpaid customers who switched base plans once during the year were about half as likely to use more than their quota of mobile data and three times less likely to use more than their quota of NZ voice minutes in the months after switching compared to the months before.

- Prepaid customers were slightly more likely to use more than their quota of mobile data in the months after switching compared to before.

- This result suggests that postpaid customers were better able to match base plan quotas to their usage after switching, but the same is not true for prepaid customers. However, prepaid customers make more use of add-ons or usage packs to meet their needs for mobile data compared to postpaid customers and this may be a cost-effective way of providing for their usage.

- Due to changes in usage for many customers who switched base plans, it is difficult to determine whether they saved money by switching. Customers who switched base plans and who maintained similar usage levels before and after switching tended to spend about the same amount per month on average after switching as before.

Overall, this analysis suggests relatively high rates of switching plans among customers who purchased base plans, even when switching across service providers or switching between prepaid and postpaid billing is excluded, which is a sign that many customers actively try to maximise the value that they get from mobile services. At least for postpaid customers, there is evidence that those who switched plans found a better match between plan quotas and their actual usage, which is an indication that they received better value after switching.

1.3.4   Estimating how much customers could save by changing their purchasing behaviour

Given the variation observed in expenditure across customers who have similar usage levels, it is possible that some customers are spending more than they need to. To test whether customers could save money by changing their purchasing behaviour while maintaining their usage patterns, each customer's expenditure was benchmarked against other customers in peer groups defined by usage and service provider (see section 7.1 and section 11.5 for details). This analysis found:

- Overall, about 7% of customers appear to have relatively high expenditure given their usage, with high expenditure somewhat more common for postpaid customers than prepaid in most usage groups. Figure 2 shows the proportions of prepaid and postpaid customers in each of the six usage groups defined above who were benchmarked as having relatively high expenditure given their own usage and given the expenditure of their peers.

Figure 2 Proportions of customers within each usage group benchmarked as having high expenditure given their usage.
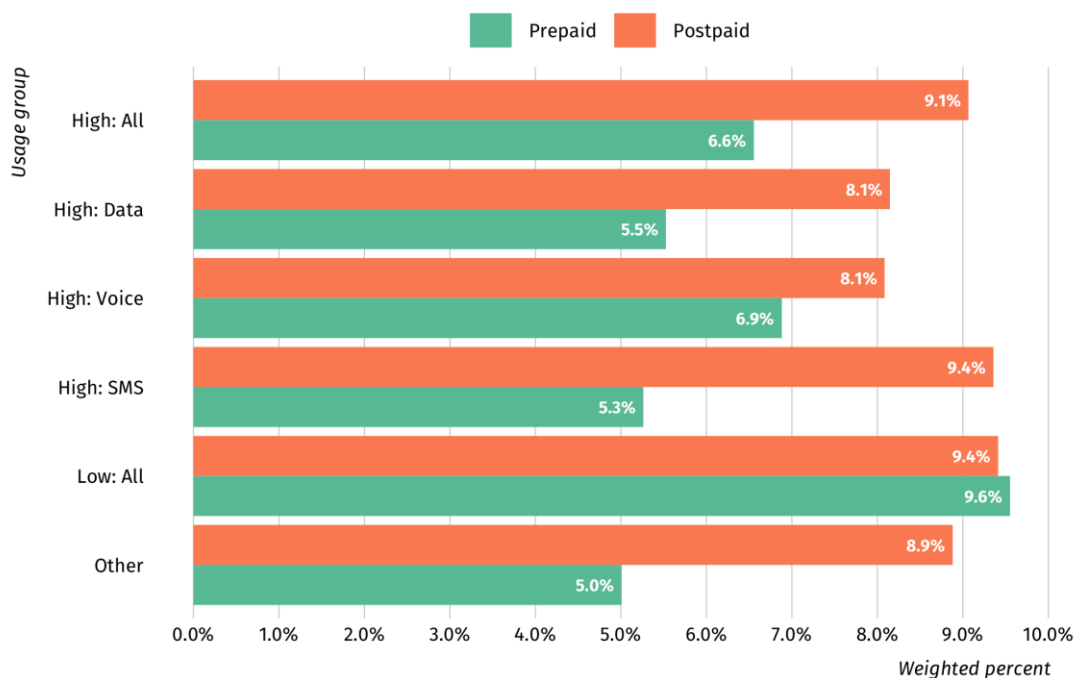
- On average overall, these high expenditure customers are estimated to be able to save $31.65 per month by changing their purchasing behaviour if we assume that they do not switch between prepaid or postpaid billing, or $48.65 if switching billing types is possible (Figure 3).

Figure 3 Estimated savings in monthly average expenditure for customers within each usage group benchmarked as having high expenditure given their usage.
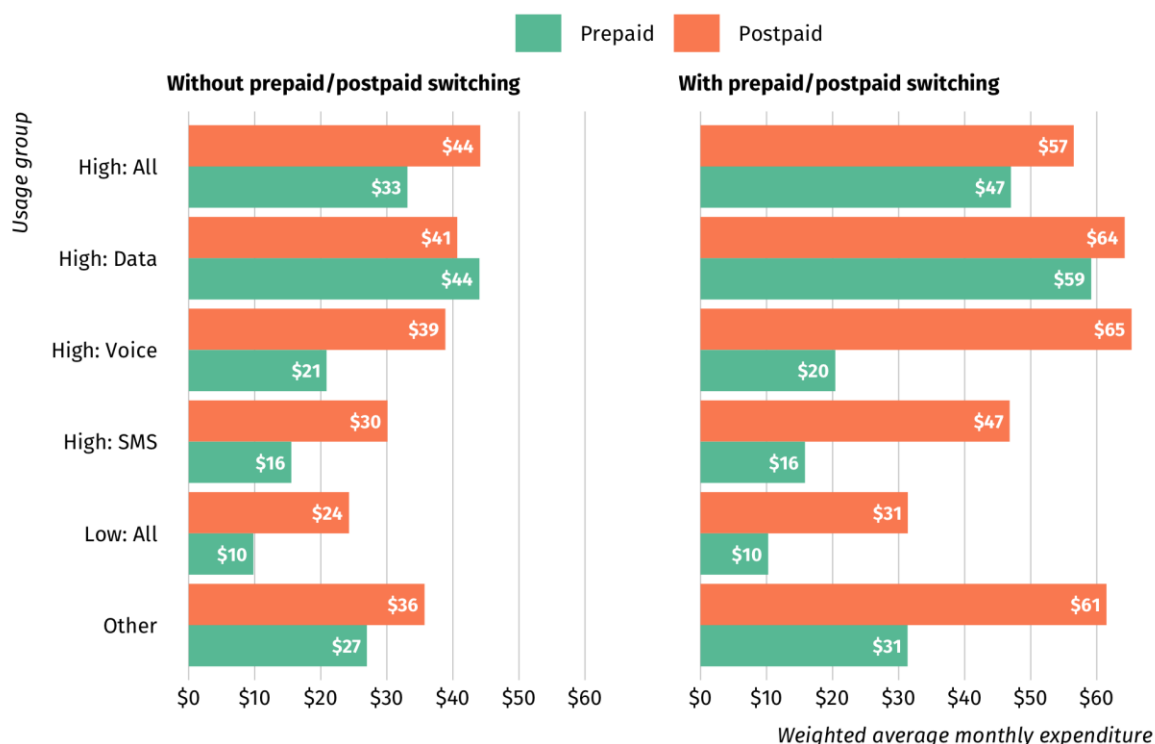
Customers who purchased a base plan in *every* month (all postpaid customers and about 55% of prepaid customers) were also analysed to see whether they could save money by switching to a different base plan (see section 7.2). For such customers, this analysis found:

> **It has been brought to our attention that there is a methodological error that affects the bullet point immediately below. The corrected analysis is contained in a supporting memorandum, which is appended to this document – See [paragraphs 15-18 on page 60](#).**

- About 35.8% of postpaid customers and 6.7% of prepaid customers used *less* than their quotas of mobile data and NZ voice calls in *every* month during the year.

   - Of these customers who always used less than their quota, 78% of postpaid customers and 71% of prepaid customers are estimated to be able to save money by switching to a cheaper base plan from the same service provider and of the same billing type with smaller quotas that still exceed their actual usage of mobile data and NZ voice calls in every month.

   - Such postpaid customers are estimated to be able to save $11.58 per month and prepaid customers are estimated to be able to save $4.36 per month from switching base plans.

- Between 2.0% and 12.6% of customers exceeded their quota of one or both of mobile data or NZ voice calls in 9 or more months out of 12 months.

   - Of those customers, around a quarter of postpaid customers and 4% of prepaid customers are estimated to be able to save money by switching to a base plan from the same service provider and same billing type but with larger quotas.

o Estimated savings for such customers vary depending on whether customers typically exceed their mobile data quota or voice quota (or both) but are around $20 per month for postpaid customers and $9 per month for prepaid customers.

Further analysis focussed on whether there are potential savings from switching base plans for customers on 'grandfathered' base plans (plans no longer offered to new customers), or customers with large rollover balances (see sections 7.2.3 and 8). This analysis was affected by limitations of the billing data, but found:

- Overall, around a quarter of postpaid customers and 5% of prepaid customers were estimated to be on 'grandfathered' base plans (plans that are no longer offered to new customers). For such customers it is estimated that they would spend $9.62 more per month on average by switching to a current base plan, given their usage. This may explain why customers choose to remain on grandfathered plans.

- There is limited evidence that customers who have accumulated very large rollover balances of mobile data (more than 100 GB) could save money by switching to a different base plan with smaller data quota.

1.3.5 Usage and expenditure of low users

Customers in the low usage group are those in the bottom 25% of monthly average usage for all mobile data, NZ voice calls, and NZ SMS. Such customers use less than 201 MB of mobile data, 33 minutes of NZ voice calls, and 23 NZ SMS messages per month on average. Closer analysis of expenditure for this group was done as such customers may be less able to afford mobile services and may be more sensitive to high charges than other customers.

This found that a small proportion of low users appear to have very high expenditure given their usage (see section 9.1):

- The top 10% of low users spend more than $20.74 per month on average over the year and the top 1% spend more than $48.99, versus a median for low users of $6.46 per month.

- Most of the high spenders are on postpaid plans with relatively large usage quotas that do not appear to be necessary given the customers' usage levels.

It is not clear why these low users have such high expenditure, but there may be a justification for proactively alerting some low users on base plans that they are spending more than then need to. It is also the case that low users pay for casual usage relatively frequently, with low users having only casual expenditure in 39% of months.[2] Looking specifically at casual expenditure of low users found (see section 9.2):

- Three quarters of low users had some casual expenditure during the year and 52% of low users on prepaid billing had only casual expenditure.

- On average, low users had casual expenditure of $1.31 per month on NZ voice calls, $0.98 on mobile data, and $0.58 on NZ SMS.

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[2] Casual expenditure is usage that is paid for on a per-unit basis. This typically occurs when a customer has not bought a base plan or other product that provides usage quota or has exceeded the quota of the product(s) they have bought previously.

- Only 7% of low users who have *only* casual expenditure are estimated to be better off by switching to a base plan from their current service provider. On average, these customers could save $4.38 per month by switching to a base plan.

- Among low users who sometimes or always bought base plans and/or add-ons or usage packs, 20% are estimated to be better off by switching to casual usage. On average, such postpaid customers could save $12.38 and prepaid customers could save $5.09 per month by switching to casual usage. However, there may be other reasons for purchasing base plans and usage packs, such as convenience, reducing the risk of bill shock, and other value-added services.

These results imply that, given existing products and prices in the market, it can be reasonable for low users to use casual usage, including using only casual usage in some cases. However, it is still possible that low users would be better off if different products were available that suited them better, such as low usage base plans.

1.4   Concluding remarks

This report demonstrates how analysis of billing data for a random sample of customers can help to understand and monitor customer behaviour and outcomes in the residential mobile market. Using individual customer data rather than aggregated data enables more detailed analysis by revealing the distribution of usage patterns and expenditure across customers. Compared to a simple analysis of aggregated market outcomes, this gives a much richer understanding of what consumers actually buy and whether the market is working well for them. As shown above, using billing data we can answer specific questions such as whether people who never exceed their base plan quotas could save money, or whether it makes sense for low users to buy a base plan.

Overall, this analysis provides evidence that there are 'pockets' of residential mobile customers who could save money by changing their purchasing behaviour. Thus, while the majority of customers appear to be getting good value for money, it is likely that actions to encourage and/or enable mobile customers to shop around could be beneficial for consumers. This could include, for example, providing information to consumers about their usage and expenditure trends, and proactively alerting customers who are consistently using less or more than their quotas that they may be able to save money by changing plans. However, this analysis was limited to usage and expenditure on core mobile services, and there could be other reasons beyond use of these services that explain why consumers choose the mobile services that they buy. This means that some possible interventions to improve consumer outcomes could benefit from additional analysis and evidence, to mitigate the risk of unintentionally making consumers worse off.

It could be useful to repeat this analysis regularly, to enable existing and emerging trends to be tracked and to see whether outcomes for consumers are getting better or worse over time. Most of the analysis contained in this report could be done with a simplified dataset that contains monthly records for individual customers of usage of key services, expenditure, base plan quotas, and discounts. Simplifying the analysis and the dataset would mean that more timely results could be produced, which would help the Commission to be more proactive in its monitoring and management of market outcomes. A significant challenge was combining the billing data from different service providers. If this analysis is repeated in future, it is also recommended that a standardised billing data format be developed that all service providers are capable of conforming to and that provides sufficient information for analysis.

Disclaimer

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2 Introduction

This report summarises analysis for the NZ Commerce Commission of billing data for a random sample of customers provided by the major mobile telecommunications network operators in New Zealand: 2degrees, Spark (for both its Spark and Skinny brands), and Vodafone. As described in section 3, each operator provided extensive data relating to the billing and usage of a random sample of customers who met some basic criteria. The dataset contained anonymised billing information of 79,944 customers and the analysis in this report relates to the 12-month period from September 2018 to August 2019 inclusive.

2.1 Objectives

The overall objectives of this analysis were to understand the usage and expenditure patterns of active residential customers in the mobile market and to investigate the extent to which customers could save money by changing their purchasing behaviour. The analysis was defined by a set of research questions provided by the Commission (see section 11.2) and the results in this report are organised into common themes that emerged from answering those questions.

2.2 Important caveats and limitations

The analysis focuses on usage and expenditure of core mobile services, namely New Zealand domestic voice calls, domestic SMS, and mobile data. Australian voice calls and SMS, and MMS messages were also included in the billing data but are not the main focus of the analysis as the average customer spends relatively little on these services (see section 5). The following services were explicitly excluded from this analysis:

- International calls and SMS (except to Australia)

- International roaming

- Purchases of mobile devices including "interest free" purchase offers

When interpreting the results in this report, it should also be noted that:

- The billing sample pertains to a particular period (September 2018 to August 2019). Since then, there has been some evolution of the products offered in the retail mobile market. For example, base plans with unlimited mobile data quota are now more common.

- Certain criteria were applied to the selection of customers included in the billing sample. The criteria are described in section 3.1 and care should be taken when applying the results to other customers who do not meet these criteria.

- The billing sample includes only customers who purchased products aimed at residential customers, but it is possible that some business customers purchased these products and are included in the sample.

- There were some differences in formats and definitions of the data provided by the four service providers. To the extent possible, the data was standardised so that combined data from different service providers could be analysed (see section 11.3) but it is possible that aggregated statistics in this report are distorted by underlying differences in billing data across providers.

3   Billing data overview

The billing data provided included information on 79,944 unique and anonymised prepaid and postpaid customers across the four service providers.[3] Service providers were requested to generate samples of at least 10,000 postpaid customers and 5,000 prepaid customers, and all samples contained at least the requested number of customers. The operators provided billing samples for slightly different time periods (Table 2), so the analysis is based on the most recent 12-month period that is common to all samples, i.e. September 2018 to August 2019 inclusive. After cleaning and combining data from the service providers, the final dataset used for analysis contained around 9.6 million data points and provides a very detailed snapshot of residential mobile customer usage and expenditure.

Table 2 Time period of the billing samples provided.

Service provider	Postpaid		Prepaid	
	First month	Last month	First month	Last month
2degrees	Jul 2018	Aug 2019	Jul 2018	Aug 2019
Skinny	NA	NA	Jun 2018	Sep 2019
Spark	Jun 2018	Oct 2019	Jun 2018	Oct 2019
Vodafone	Jul 2018	Aug 2019	Jul 2018	Aug 2019

3.1   Criteria for including customers in the sample

In order to simplify the analysis, customers in the billing sample were required to have:

- Remained with their current service provider for the duration of the sample; and

- Did not switch from prepaid to postpaid billing or vice versa during the sample (however, customers who switched to a different base plan with the same type of billing were included in the sample); and

- Had some usage of at least one core mobile service (voice calls, SMS, and mobile data) in every month; and

- Purchased only products aimed at "household" or "residential" customers.

Given these criteria, the analysis in this report essentially relates to residential customers who were continuously active with their current service provider for at least a year. Customers who switched to a different service provider or who remained with the same service provider but changed their billing type are excluded from the billing sample.

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[3] In all analysis, Spark and Skinny were treated as separate service providers as they offer distinct sets of products and pricing and have separate sets of customers.

3.2   Contents of the billing samples

For each customer, the billing sample includes records of:

- **Monthly usage of specific mobile services:** NZ and Australian voice calls, NZ and Australian SMS, MMS, and mobile data.

- **Individual product purchases and expenditure:** Base plans, add-ons (also called usage packs), casual usage, and various discounts and 'bonus' usage given to customers.

- **Usage quotas:** For customers on base plans, their monthly usage quotas of voice calls, SMS, and mobile data, including any additional quota offered on a promotional basis.

- **Customer information:** The number of months each customer had continuously been a customer of their current service provider (customer tenure), and their monthly rollover balances (if any) of voice minutes, SMS, and mobile data.

In some cases, the billing data provided included information that was not requested, such as international roaming charges and charges for purchases of devices. Such information was removed from the dataset as part of the cleaning process (see section 11.3).

3.3   Treatment of discounts

Some mobile customers are given discounts for various reasons, including for buying fixed-line broadband and mobile services from the same service provider. In order to simplify the analysis, the full amount of such discounts recorded in the billing data, including fixed/mobile bundle discounts, was deducted from the customer's mobile expenditure. Thus, any expenditure statistics presented in this report reflect such discounts, to the extent that they are applied to customers in the billing sample. This is a conservative assumption that may understate true expenditure on mobile services since it is arguable that some portion of fixed/mobile bundle discounts should be attributed to purchasing the fixed-line service.

3.4   Illustration of usage data

To illustrate the underlying data in the billing sample, Figure 4 shows the monthly mobile data usage of all the individual customers in the billing sample (each line is an individual customer). This shows several important features:

- A general upward trend in mobile data use over time.

- The bulk of customers have relatively low data usage, but some customers have very high data usage at least in some months, i.e. the usage distribution across customers is highly skewed.

- The distribution of usage across customers appears to 'spread out' over time, i.e. usage of higher users tends to increase faster than that of lower users over time.

- Some individual customers have highly variable data usage with large changes in their usage from month to month.

Figure 4 also demonstrates the richness of the billing sample. By analysing usage and expenditure of individual customers, it is possible to see and analyse patterns of consumer behaviour that may not be apparent from aggregated statistics such as average usage and expenditure.

Figure 4 Monthly mobile data usage of individual customers in the billing sample.
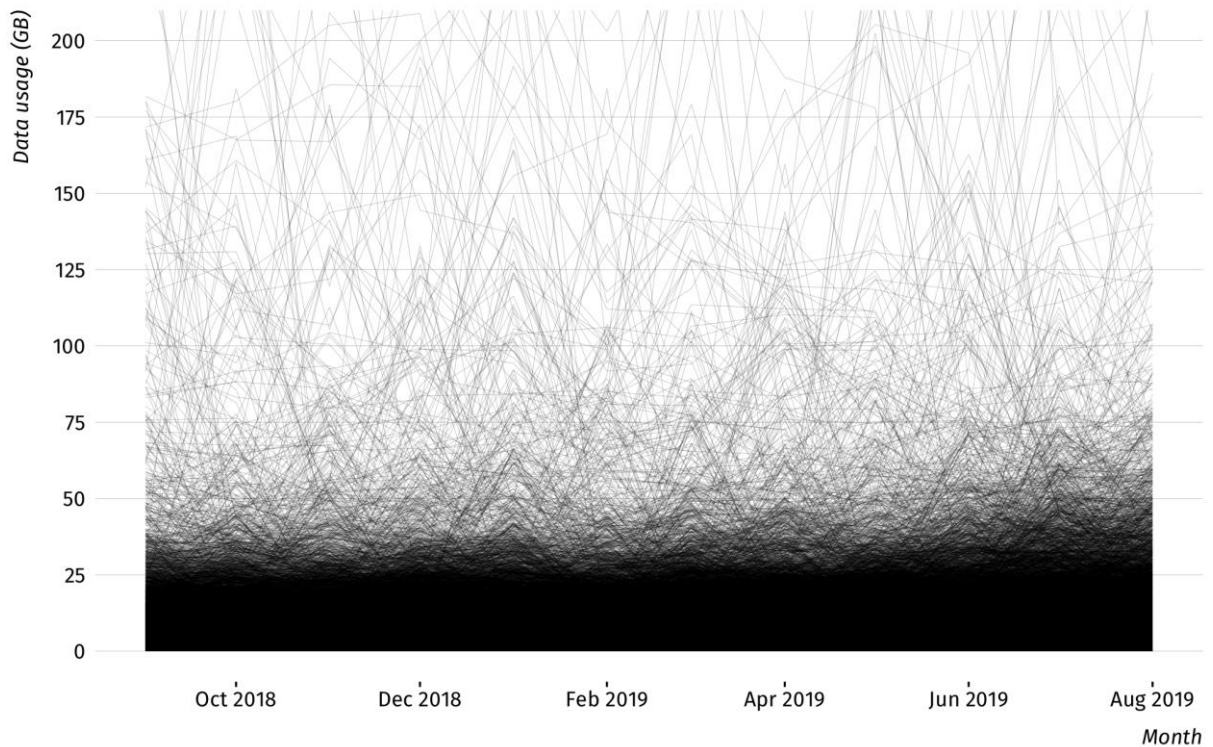
3.5   Customer tenure

As at the start of the billing sample (1 September 2018), the median customer had been with their current service provider for four years (Table 3) and three-quarters of customers had been with their current service provider for almost two years or more. Postpaid customers tend to have been with their current service provider for slightly longer than prepaid customers, and a quarter of postpaid customers have been with their current service provider for 7.5 years or more. When interpreting these figures, it is important to note that the billing sample excludes customers who switched between service providers in the 12 months from September 2018 to August 2019.

Table 3 Customer tenure with current service provider as at 1 September 2018.

Billing type	Lower quartile (months)	Median (months)	Upper quartile (months)
All	23	48	80
Prepaid	20	43	74
Postpaid	27	54	90

3.6 Number of unique products purchased

Table 4 shows the total numbers of unique base plan and add-on products purchased by customers in the billing sample (in addition, customers also purchased casual usage). While this shows that a large number of products were purchased, it should be noted that:

- The number of prepaid base plans counts each variation of Vodafone's MyFlex prepaid plan that was actually purchased as a distinct product. The number of prepaid base plans is smaller if MyFlex is treated as a single product.

- The numbers include products that were no longer actively promoted in the market ('grandfathered' products) at the start of the billing sample, or that became grandfathered or obsolete during the billing sample.

- Some unique products are in fact minor variations of other products, e.g. changes to the product name or minor changes to terms and conditions.

Table 4 Number of unique base plans and add-ons purchased in the billing sample.

Billing type	Base plans	Add-ons
All	479	266
Prepaid	359	164
Postpaid	120	102

4   Usage analysis

The results below summarise analysis of usage of core mobile services. Since usage of individual customers varies from month to month, for each customer their monthly average usage of each service was calculated for the 12-month period. The analysis below reflects the distribution of these monthly averages across customers.

4.1   Distribution of monthly average usage across customers

Table 5 provides summary statistics of monthly average usage. The distribution of usage is highly skewed across customers, reflected by the fact that the average usage is significantly greater than the median for all services. It is also clear that for most customers usage of MMS, and Australian voice and SMS is very low compared to NZ domestic voice and SMS. For this reason and for simplicity, some later analysis of usage and expenditure in this report focuses on mobile data, NZ voice, and NZ SMS only.

Table 5 Statistics calculated from monthly average usage across customers.

Usage type	Lower quartile	Median	Upper quartile	Average
Data MB	200.8	943.6	2,202.9	2,226.5
NZ voice mins	32.8	89.5	196.6	163.6
NZ SMS count	22.5	78.3	206.0	176.1
MMS count	0.0	0.3	1.1	1.2
AU voice mins	0.0	0.0	0.1	4.1
AU SMS count	0.0	0.0	0.1	0.9

The skewed distribution of usage is also illustrated in Figure 5 on the following page, which shows the distribution of average monthly usage of each mobile service across customers. Most customers cluster towards the lower end of the usage distribution, but there are some customers with very high usage compared to the others.

Figure 5 Distribution of average monthly usage across customers.

Data MB

NZ voice mins

NZ SMS count
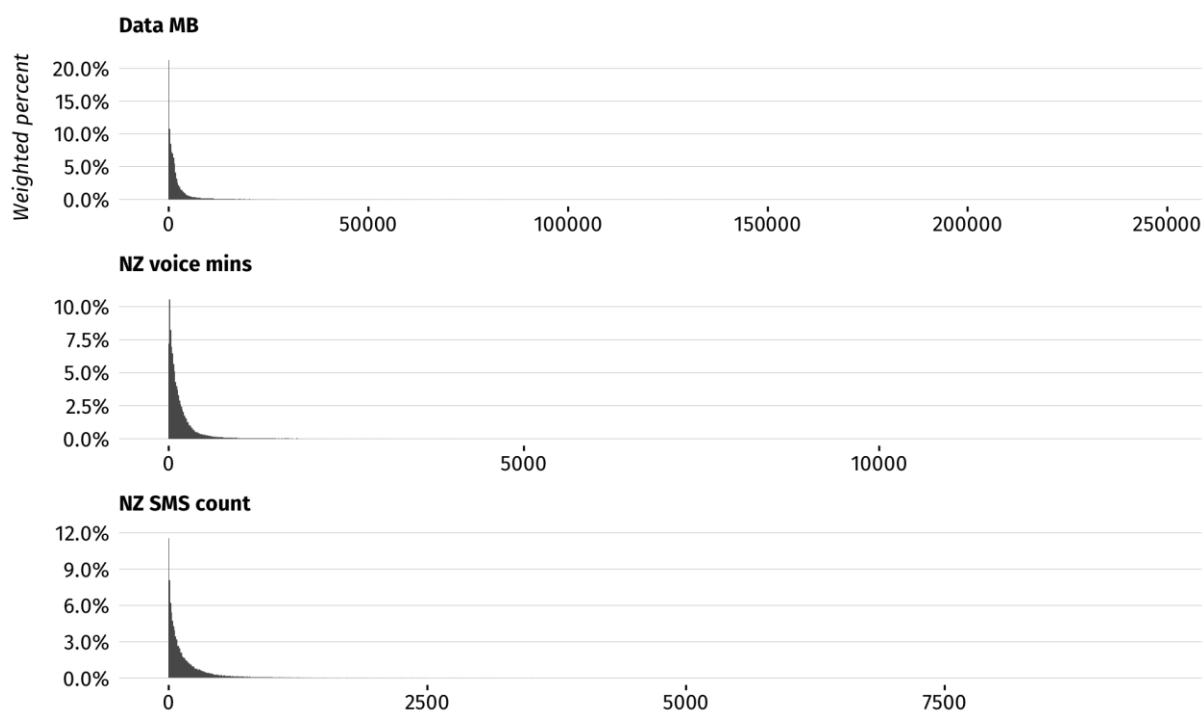
Some customers have monthly usage that is quite variable. This is illustrated by Table 6 which shows statistics calculated from the standard deviation of monthly usage over 12 months, across customers.[4] These standard deviations are relatively high in comparison to the statistics of average monthly usage in Table 5, reflecting the fact that usage can change a lot from month to month. These standard deviations are also affected by any upwards or downwards trends in usage over time for each service.

Table 6 Statistics calculated from the standard deviation of monthly usage across customers.

Usage type	Lower quartile	Median	Upper quartile	Average
Data MB	157.0	551.6	1,285.3	1,392.6
NZ voice mins	21.2	46.8	90.3	78.3
NZ SMS count	13.7	36.5	89.8	89.8
MMS count	0.0	0.5	1.5	1.3
AU voice mins	0.0	0.0	0.3	4.2
AU SMS count	0.0	0.0	0.3	1.2

4.2   Comparing usage and quotas for customers on base plans

For customers who purchased postpaid or prepaid base plan products with monthly usage quotas, their monthly usage was compared to their quota in each month. This is a simple comparison that does not consider

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[4] In this case the standard deviation measures the variability of each customer's monthly usage around their average usage per month over the year. A higher standard deviation implies greater variability of usage from month to month, everything else equal.

how customers accommodated usage that exceeded their quota, such as by using rollover balances, buying add-ons or usage packs, or paying for casual usage.

The following charts show the distribution of monthly usage versus quota of mobile data and NZ voice minutes.[5] The charts show the difference between actual usage and quota ("excess usage"), which is positive if a customer used more than their nominal quota, and is negative if a customer used less than their nominal quota. For customers on base plans with unlimited quota, the difference between usage and quota is zero by definition.

Figure 6 shows the distribution of usage versus quota for monthly mobile data.[6] It was more common to exceed data quota than voice quota, with this occurring in 31% of months for data, compared to 15% of months for voice. Many customers exceeded their data quota by a relatively small amount, with 17% of months being up to 1 GB over quota.

Figure 6 Distribution of monthly usage versus quota for mobile data for customers on base plans.

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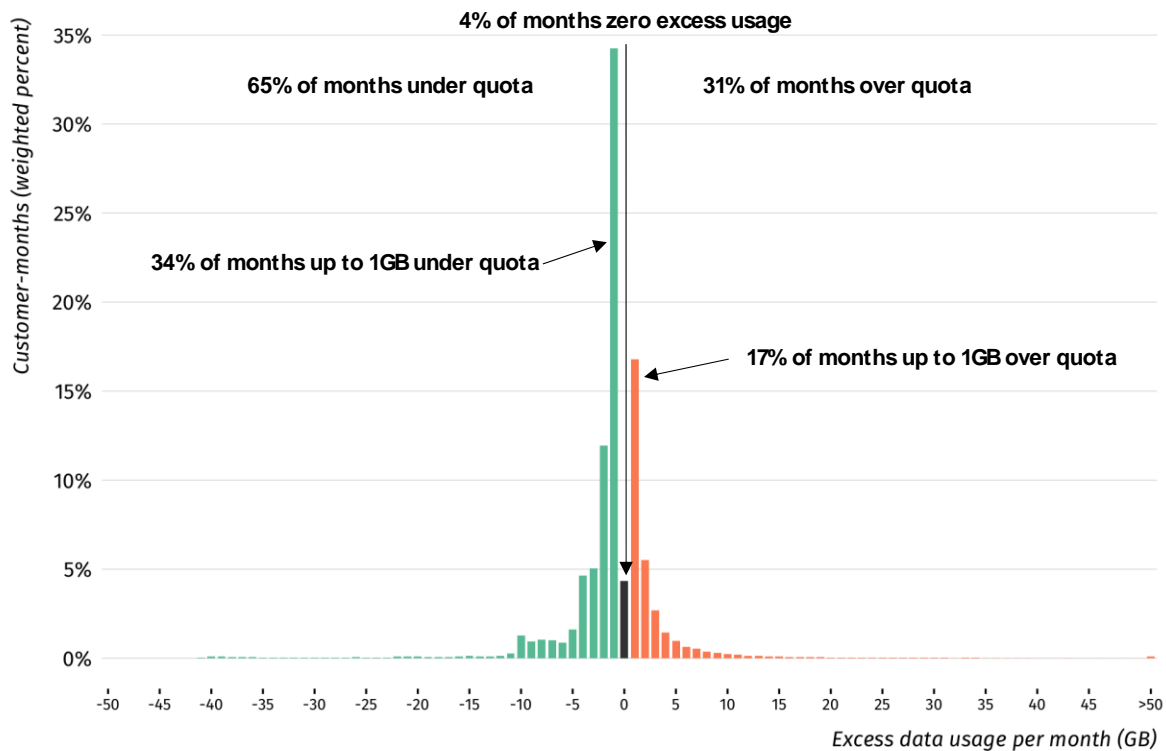
[5] SMS was excluded as the majority of base plans offer unlimited SMS quotas.

[6] The bars in Figure 6 represent increments of 1 GB, except for the bar at zero, which represents exactly zero GB of excess usage. A customer has zero GB of excess usage in a month if they have an unlimited quota of mobile data or if their usage exactly equals their quota in that month.

Figure 7 gives a closer look at the distribution of usage versus quota for mobile data by showing the difference between usage and quota for customers who used within 3 GB of their nominal quota, in increments of 100 Mb. This shows that many customers optimised their data usage by using just slightly less than their quota, while many customers who used more than their quota used only slightly more.

Figure 7 A closer look at the distribution of monthly usage versus quota of mobile data.
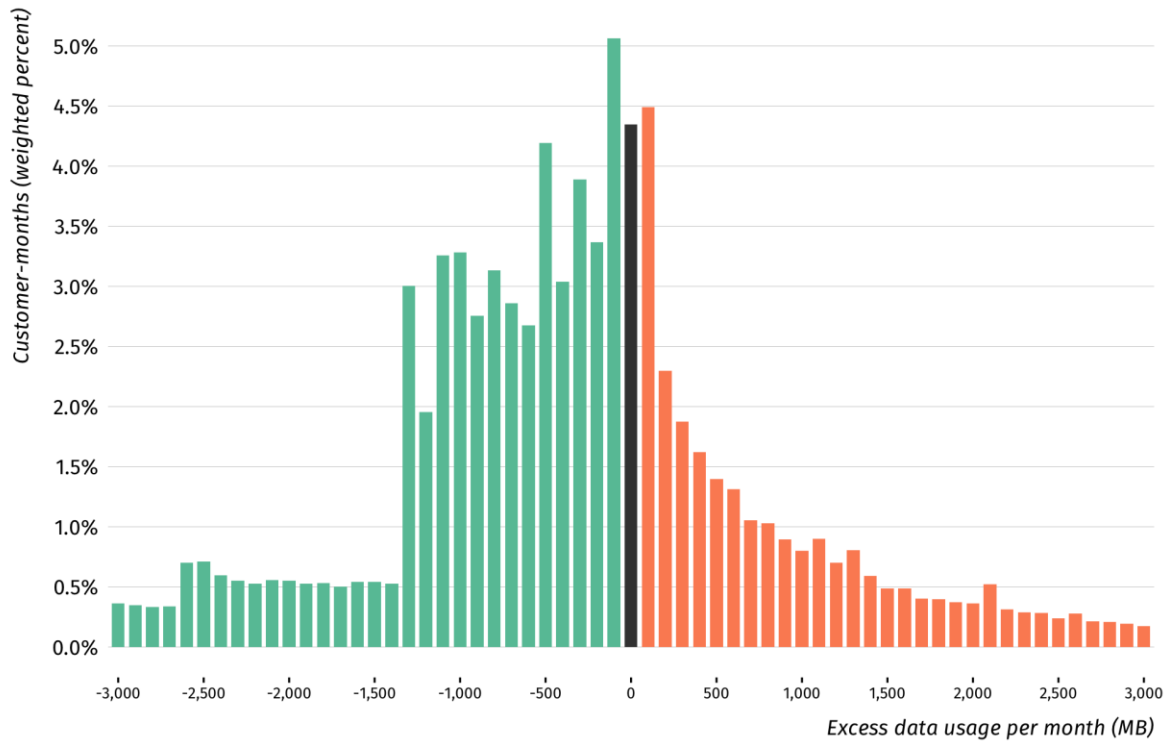
Figure 8 on the following page shows the distribution of usage versus quota of NZ voice minutes.[7] In 85% of months, customers on base plans did not exceed their quota of minutes, either because they used less than their nominal quota or because they had an unlimited quota.

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[7] The bars in Figure 8 represent increments of 10 minutes, except for the bar at zero, which represents exactly zero minutes of excess usage. A customer has zero minutes of excess usage in a month if they have an unlimited quota of voice minutes or if their usage exactly equals their quota in that month.

Figure 8 Distribution of monthly usage versus quota of NZ voice minutes for customers on base plans.
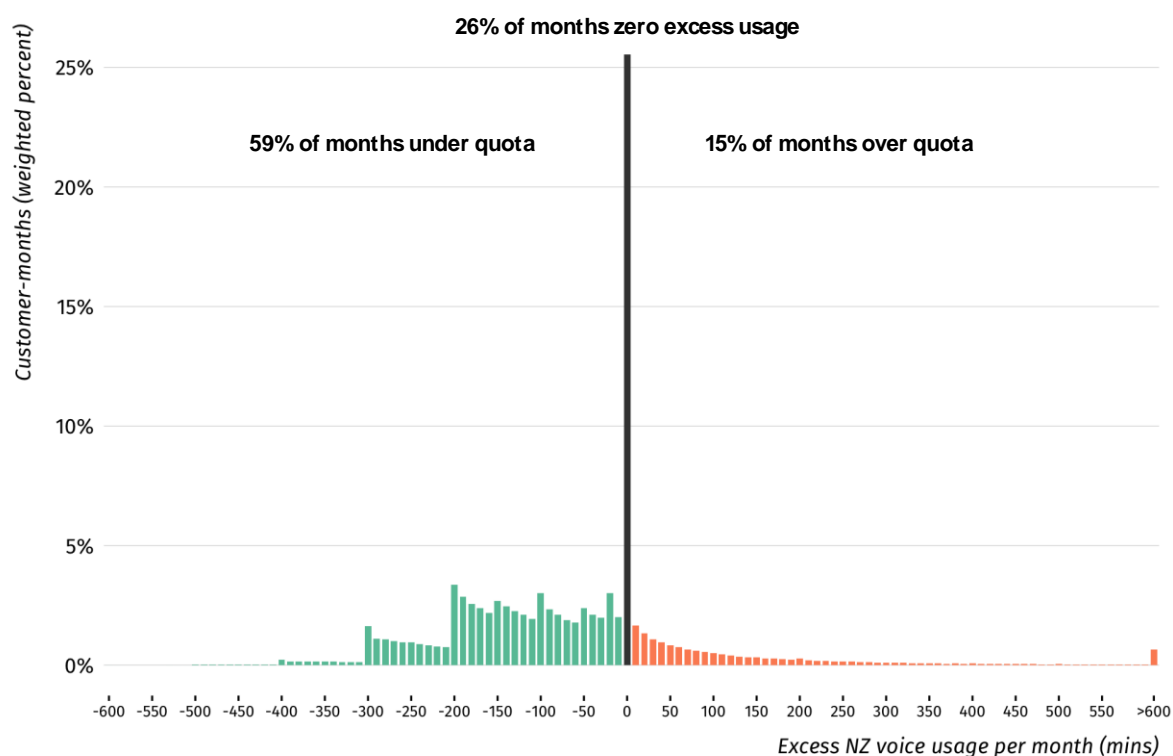
4.3 Defining customer usage groups for further analysis

Given the wide variation in usage across customers, a set of six customer groups were defined based on each customer's average monthly usage of NZ voice minutes, NZ SMS, and mobile data:

- **High-all:** Customers in the top 25% of usage for *all* three services, i.e. average data usage > 2,203 MB/month, average NZ voice > 197 mins/month, and average NZ SMS > 206/month.

- **High-data:** Customers in the top 25% of usage for data *only*, i.e. average data usage > 2,203 MB/month.

- **High-voice:** Customers in the top 25% of usage for NZ voice *only*, i.e. average NZ voice > 197 mins/month.

- **High-SMS:** Customers in the top 25% of usage for NZ SMS *only*, i.e. average NZ SMS > 206/month.

- **Low-all:** Customers in the bottom 25% of usage for *all* of data, NZ voice, and NZ SMS, i.e. average data usage < 201 MB/month, average NZ voice < 33 mins/month, and average NZ SMS < 23 mins/month.

- **Other:** All other customers.

Figure 9 shows the distribution of customers across these six groups, overall and by billing type. Customers in the high usage categories except for High-SMS are more likely to be postpaid customers than prepaid customers, and customers in the Low-all category are more likely to be prepaid customers.

Figure 9 Distribution of customers across usage groups.
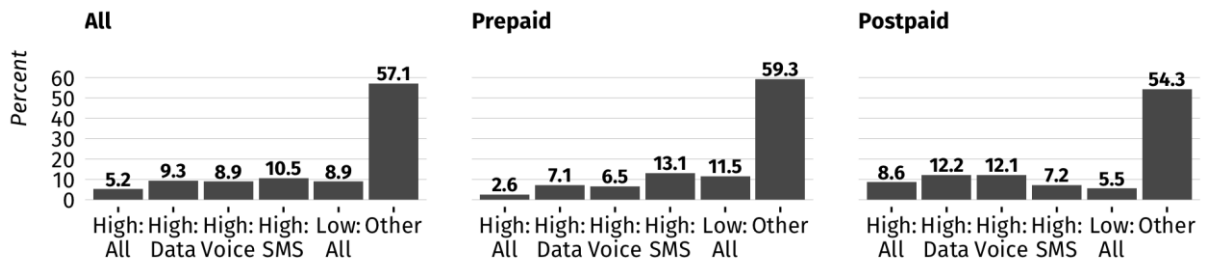
Figure 10 shows the median of monthly average usage across the customers in each of the six usage groups. Customers in the High-data, High-voice, and High-SMS categories have similar median usage to customers in the Other category for services other than the service used to define the usage category.

Figure 10 Median monthly average usage across customers in each usage group.
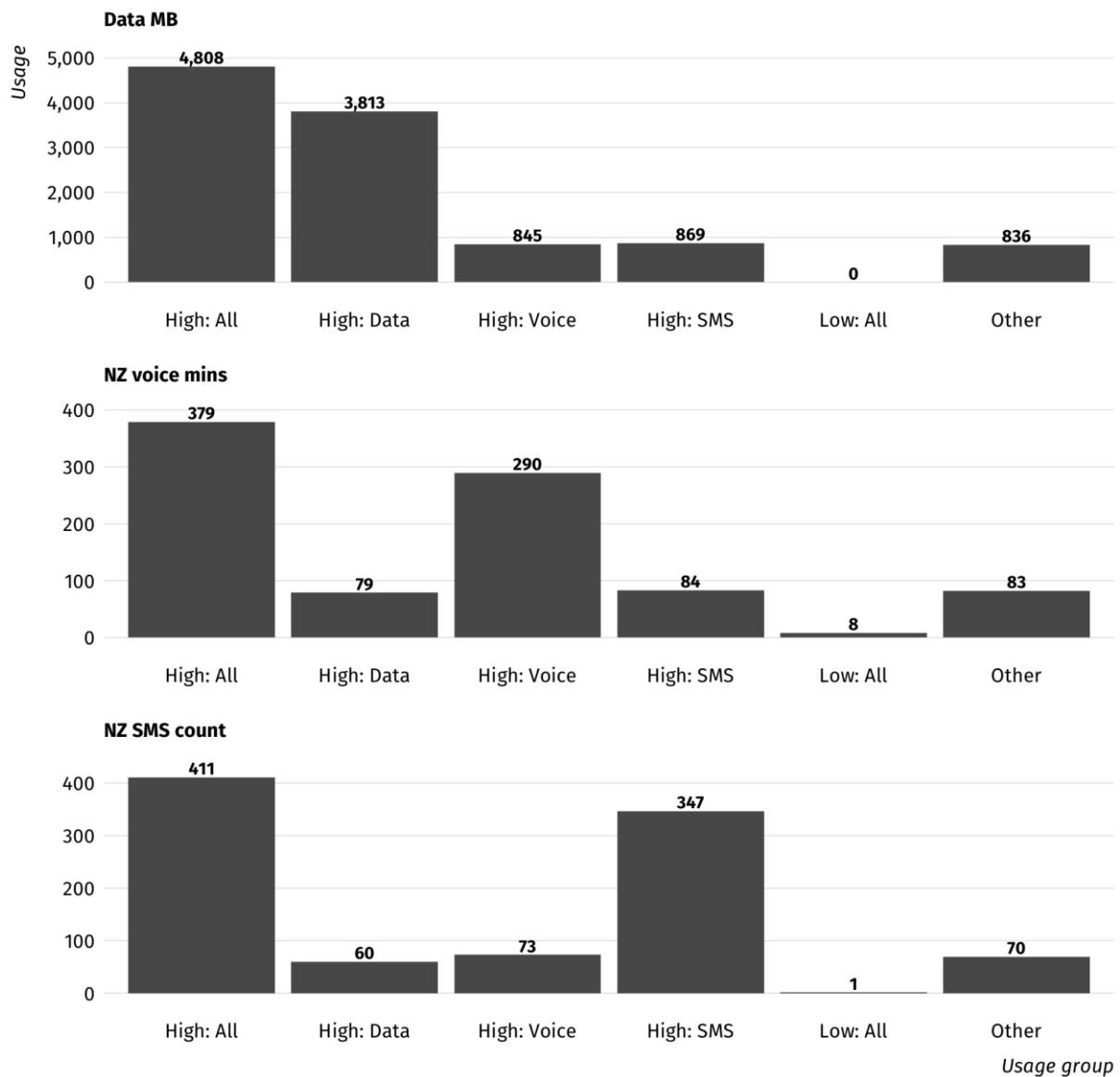
As well as usage levels, variability of usage could also be used to define customer groups. Figure 11 shows the proportion of customers in each usage group with relatively high usage variability.[8] It is relatively more common for customers in the High-data, High-SMS, and Low-all usage groups to have high usage variability, compared to customers in the other three usage groups. Overall, prepaid customers are slightly more likely to have high usage variability than postpaid customers.

Figure 11 Proportion of customers in each usage group with relatively high usage variability.

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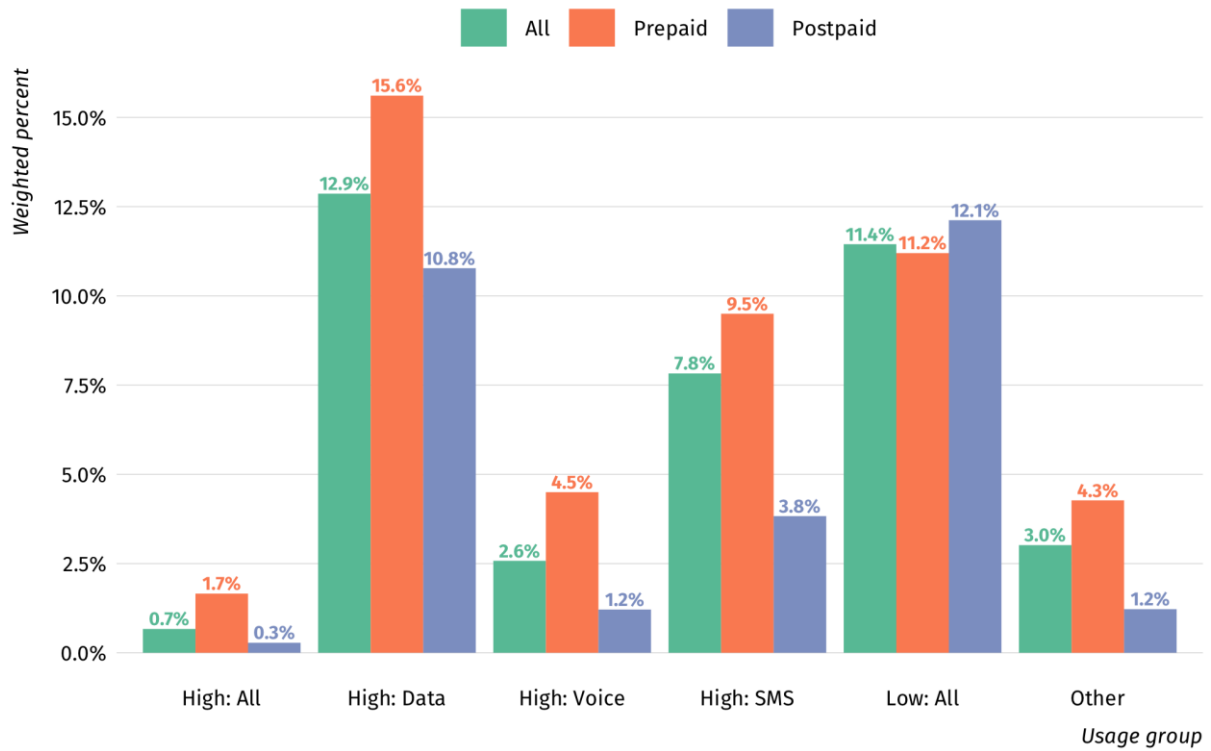
[8] In Figure 11, high usage variability was defined as where the standard deviation of the customer's monthly usage is greater than their average monthly usage

5 Expenditure analysis

The results in this section summarises analysis of mobile customer expenditure on base plans, add-ons (or usage packs), and casual usage.[9] As noted above, expenditure on international calls and SMS (except to Australia), international roaming, and purchases of devices are excluded. Total expenditure is net of any discounts recorded in the billing sample, including fixed/mobile bundle discounts if applicable.

5.1 Overall monthly average expenditure

Overall (Figure 12 top panel), the average customer in the billing sample spent $33.85 per month, and the average postpaid customer spent more than twice as much as the average prepaid customer ($49.86 versus $21.65).[10] For both prepaid and postpaid customers, base plans are the largest proportion of expenditure, but prepaid customers spend a greater proportion on add-ons and casual usage than postpaid customers (Figure 12 bottom panel).

Figure 12 Monthly average expenditure per customer by billing type.

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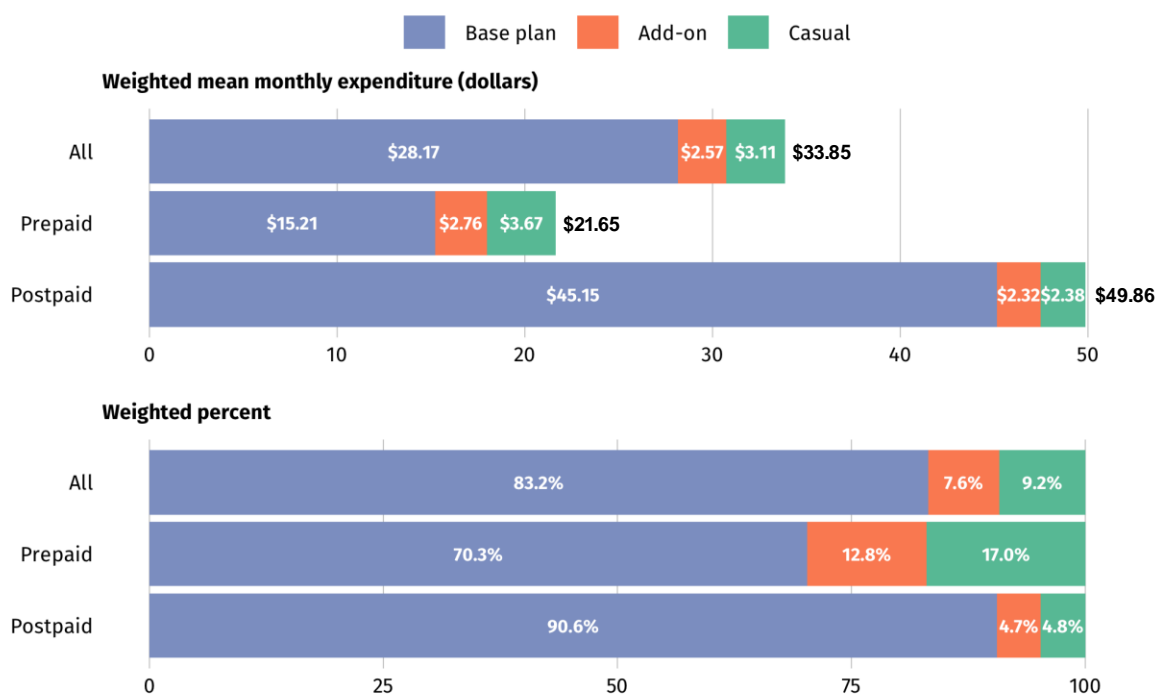
[9] The billing data does not directly divide products purchased into base plans and add-ons. Products were classified based on their descriptions and it is possible that some products were incorrectly classified.

[10] Customers were only included in the billing sample if they had at least some usage in every month. Average expenditure per customer may be lower if customers who are less active (i.e. who have some months with *no* usage) were included in the sample, particularly for prepaid customers.

5.2   Monthly average expenditure for customer groups

Figure 13 shows how monthly average expenditure varies across the customer usage groups defined in section 4.3. Across the groups there is considerable variation in average monthly expenditure, with customers in the High-all group spending on average seven times more per month than customers in the Low-all group (Figure 13 top panel). Base plans also make up a smaller proportion of expenditure for low users compared to other groups, while low users spend proportionately more on casual usage (Figure 13 bottom panel). Additional analysis also found that customers with low variability of usage within each usage group tend to spend more per month on average than customers with high variability of usage in the same usage group, but the reasons for this are not clear.

Figure 13 Monthly average expenditure per customer by usage group.
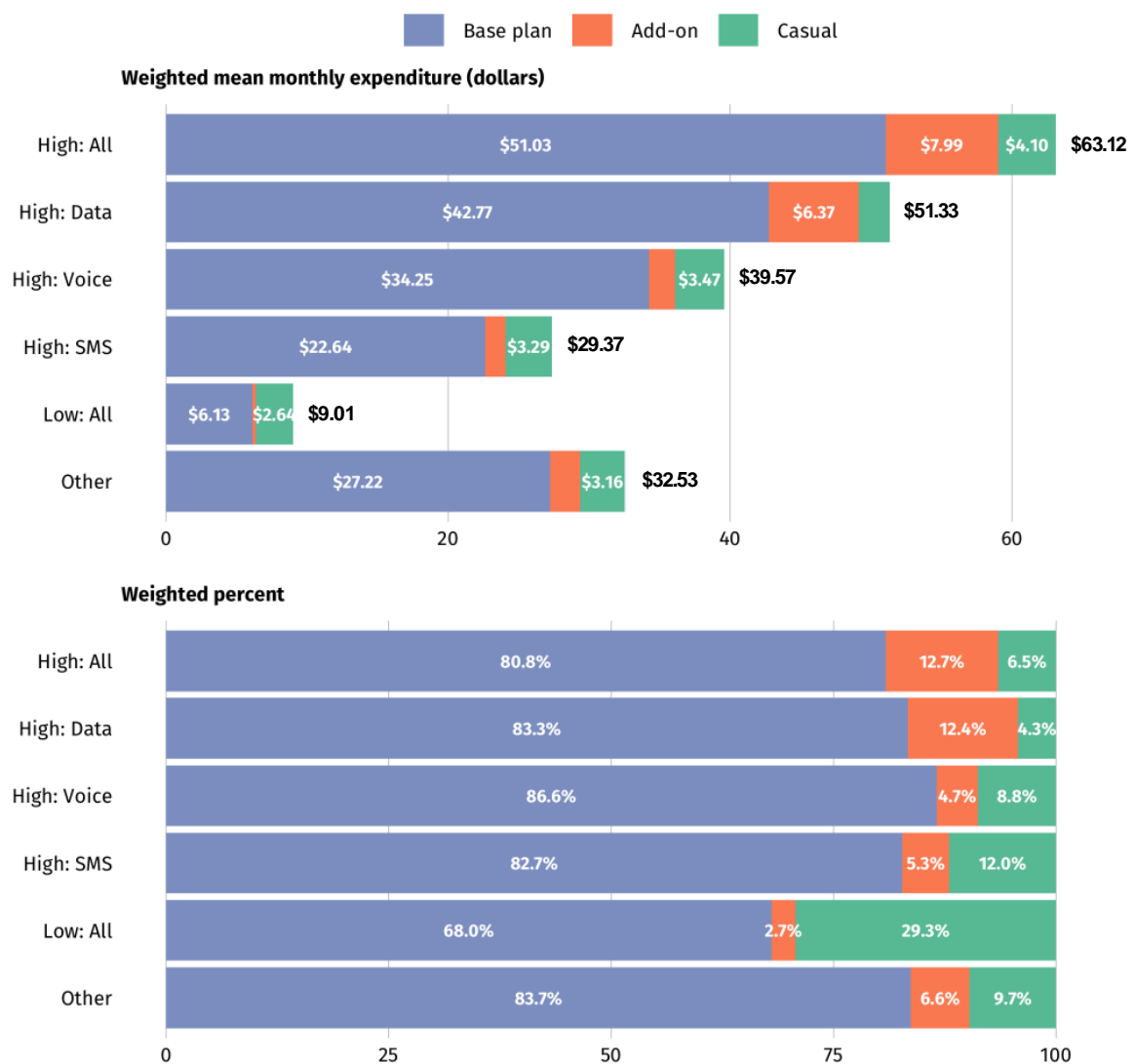
As well as variation across usage groups, there is considerable variation of expenditure among customers *within* each usage group. Figure 14 illustrates this by showing the distribution of expenditure across all customers within each of the six usage groups. This shows that, for example, there are some customers in the Low-all group who have monthly average expenditure similar to the median expenditure of customers in the High-all group. Within each usage group, there are also customers who spend considerably more than other customers in that group and who spend more than most customers in other usage groups, indicated by the outliers (dots) in Figure 14. To some extent this is explained by differences in usage across customers within these six groups, but there are at least some customers whose expenditure appears to be very high given their usage.

Figure 14 Weighted distribution of expenditure across customers within each usage group.

Average expenditure per month ($)
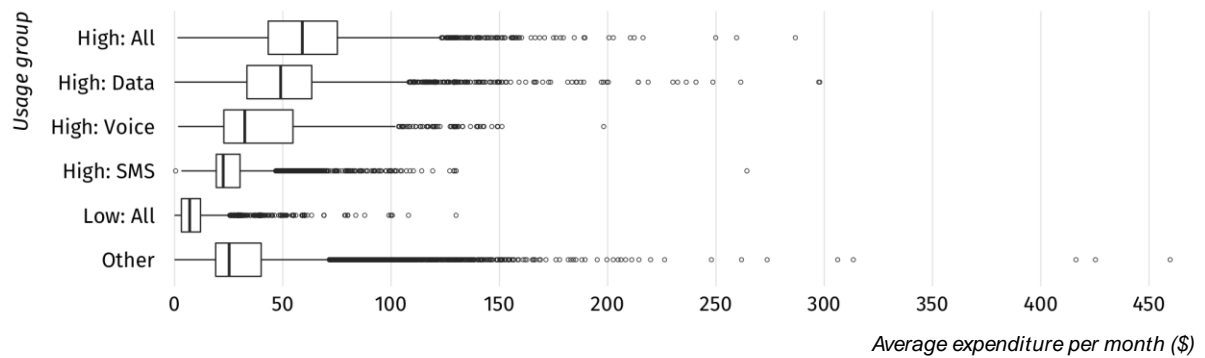
See section 11.1 for a guide to how to interpret this chart.

5.3   Monthly average expenditure vs customer tenure

Figure 15 on the following page shows how monthly average expenditure varies overall by customer tenure (see section 3.5). Customers with relatively long tenure tend to spend slightly more on average than customers with relatively short tenure, but the difference is small at just over $3 per month on average. This suggest that customers who have been with their service provider for a shorter amount of time may be getting better value, but the evidence is not conclusive as there could be various reasons for this difference, including differences in plans and services chosen by long tenure versus short tenure customers, and differences in usage patterns across such customers.

Figure 15 Monthly average expenditure versus customer tenure.

Weighted mean monthly expenditure (dollars)

	Base plan	Add-on	Casual	Total
Short tenure	$25.85	$3.23	$3.04	$32.12
Medium tenure	$28.75	$2.67	$2.66	$34.08
Long tenure	$29.40	$1.73	$4.11	$35.24

Weighted percent

	Base plan	Add-on	Casual
Short tenure	80.5%	10.1%	9.5%
Medium tenure	84.4%	7.8%	7.8%
Long tenure	83.4%	4.9%	11.7%
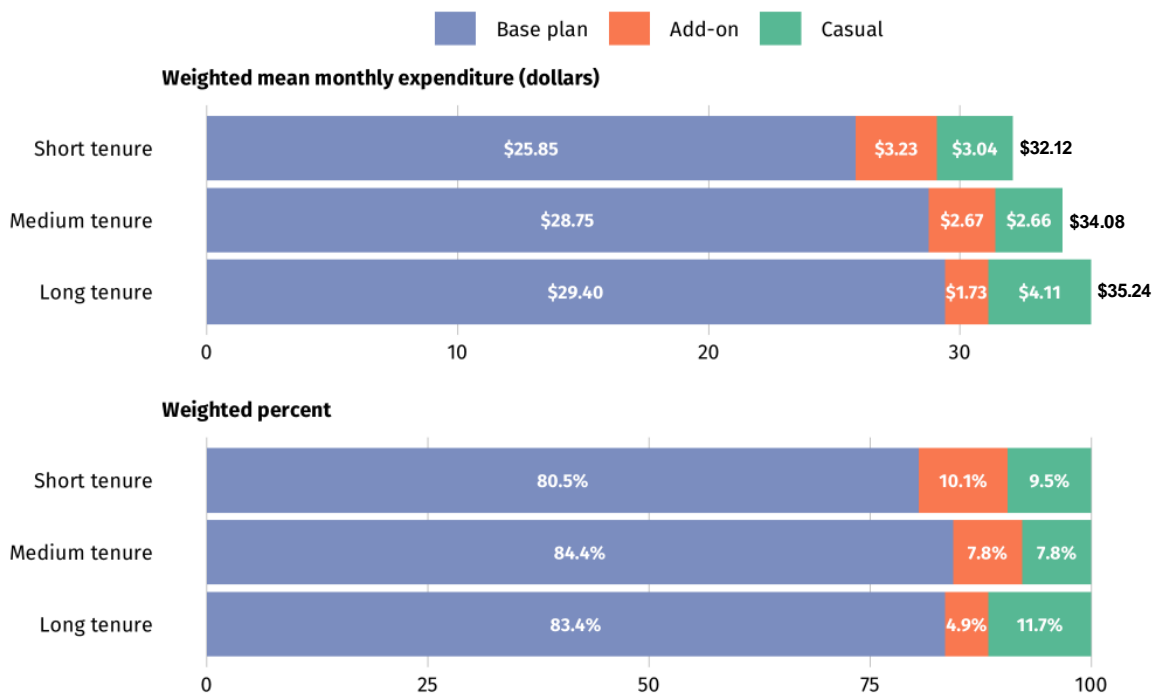
Short tenure: In the lower quartile of tenure (less than 23 months)

Long tenure: In the upper quartile of tenure (more than 80 months)

6   Analysis of base plan switching

This section describes analysis of customers in the billing sample who switched base plans during the year from September 2018 to August 2019. This analysis encompasses all postpaid customers in the sample and prepaid customers who purchased base plan products. Among prepaid customers, 55% purchased a base plan product in every month of the year, 26% purchased a base plan product in some but not all months, and 19% did not purchase a base plan product in any month.

6.1   Extent of switching

Among the customers who purchased at least one base plan product during the year (i.e. all postpaid customers and 81% of prepaid customers in the billing sample), Figure 16 shows the distribution of the number of base plan switches recorded in the billing sample during the year, where a switch is defined as when a customer buys a base plan product that differs from their immediately prior base plan purchase (if any).[11] Overall around one-third of customers switched base plans during the year by this definition, with generally greater rates of switching for postpaid customers compared to prepaid customers. It should be noted that the billing sample excludes customers who switched between prepaid and postpaid billing, and customers who switched service providers during the year. Thus, the rates of switching shown in Figure 16 understate the total extent of switching in the market.

Figure 16 Base plan switching for customers who purchased at least one base plan product during the year.

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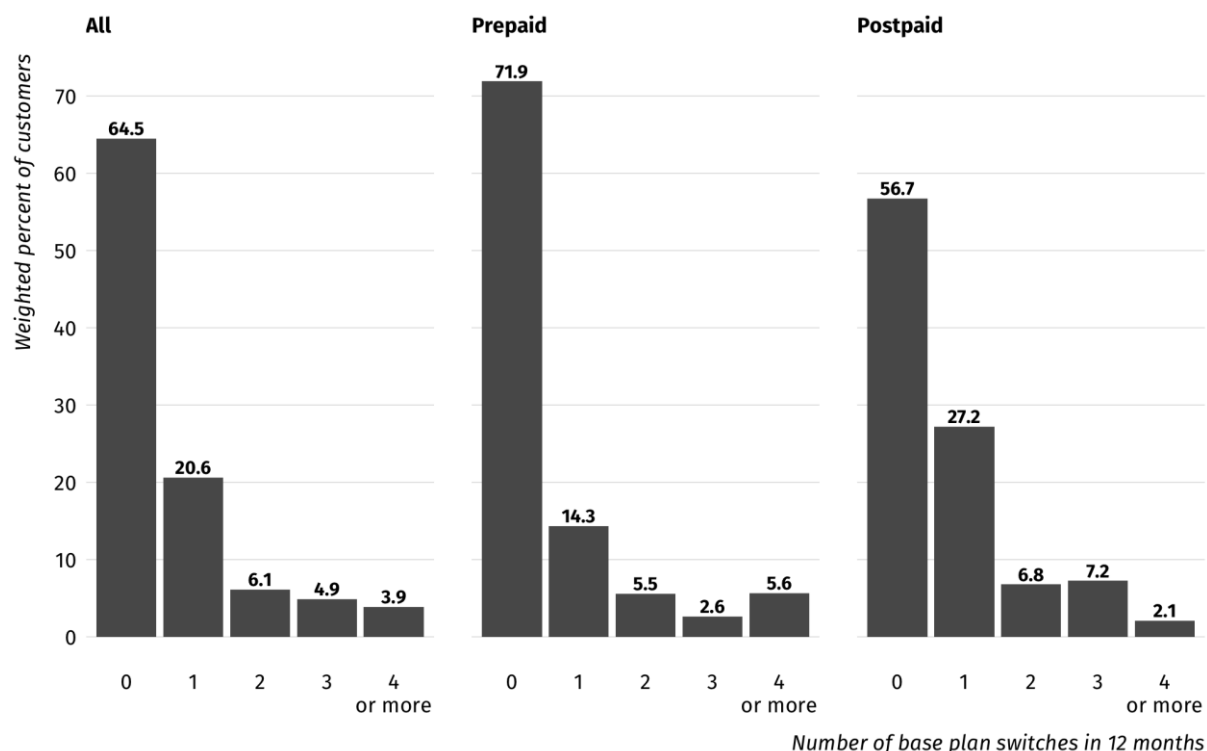
[11] Prepaid customers do not necessarily buy a base plan in every month, and any gaps in base plan purchases were ignored when calculating switches. If Vodafone MyFlex customers changed the configuration of their plan but remained on MyFlex, this was counted as a switch.

6.2 Comparison of usage before and after switching

Figure 17 and Figure 18 compare usage before and after switching for prepaid and postpaid customers respectively who switched base plans only once during the year and for whom at least four months of usage before and after switching is included in the billing sample. This shows that switching is generally associated with an increase in mobile data usage and to a lesser extent voice usage, while SMS volumes are falling. Thus, it is plausible that customers who switch plans do so in order to accommodate changing usage patterns, particularly increasing data usage.

Figure 17 Monthly usage for prepaid customers who switched base plans only once during the year.
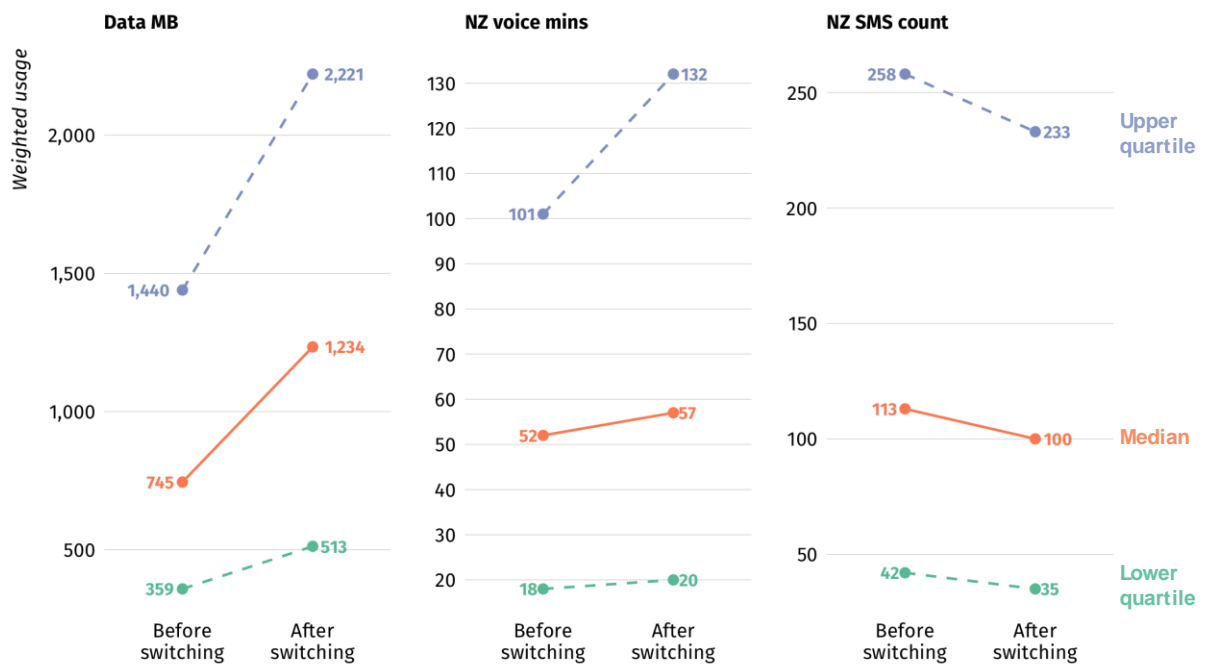
Figure 18 Monthly usage for postpaid customers who switched base plans only once during the year.
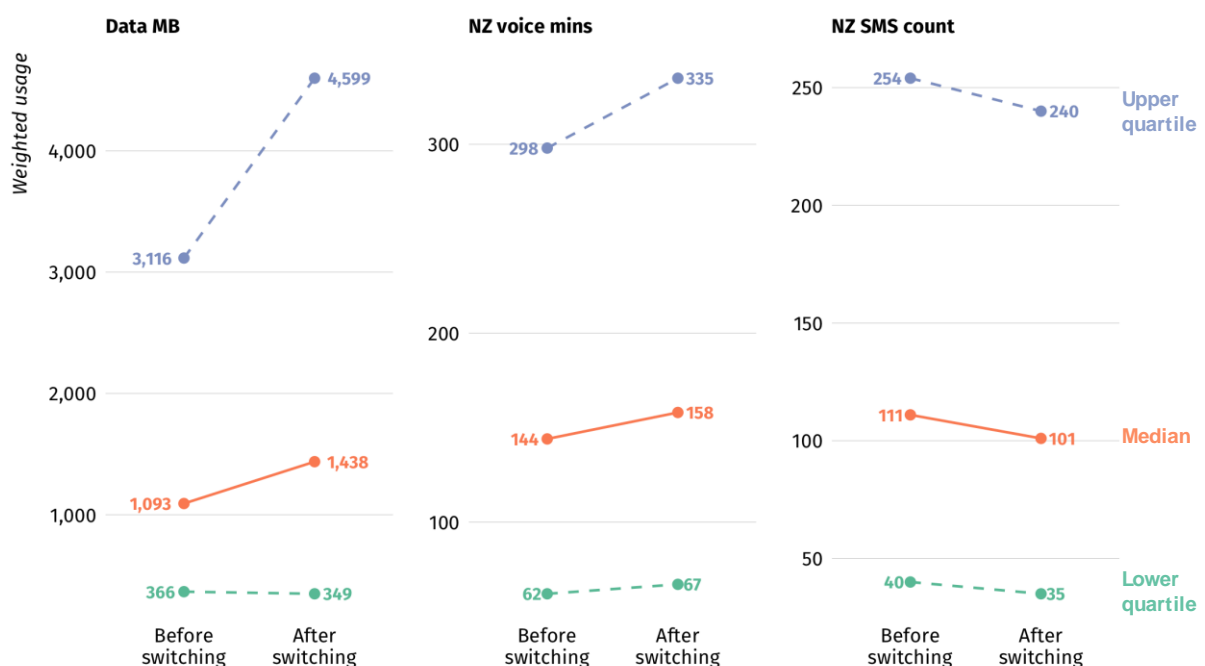
For the same set of customers who switched base plans only once and who had at least four months of usage recorded before and after switching, Figure 19 shows the proportion of months where customers' usage exceeded nominal base plan quotas before and after switching. Overall, postpaid customers had significantly lower proportions of months where usage exceeded quotas of mobile data and voice calls after switching compared to before switching. For postpaid customers this suggests that switching was motivated by changing usage patterns and after switching customers generally have base plan quotas that better match their usage compared to before switching.

For prepaid customers the proportion of months where usage exceeded quota of mobile data increased after switching, while the proportion of months exceeding voice quota was essentially unchanged. This may suggest that prepaid customers who switch are less able to find base plans that match their usage, however it should be noted that prepaid customers generally use more options than postpaid customers for dealing with usage that exceeds their quota, including buying one-off or recurring add-ons or usage packs, or buying multiple base plans in a month.

Figure 19 Proportion of months with usage greater than quota, for customers who switched base plans only once during the year.
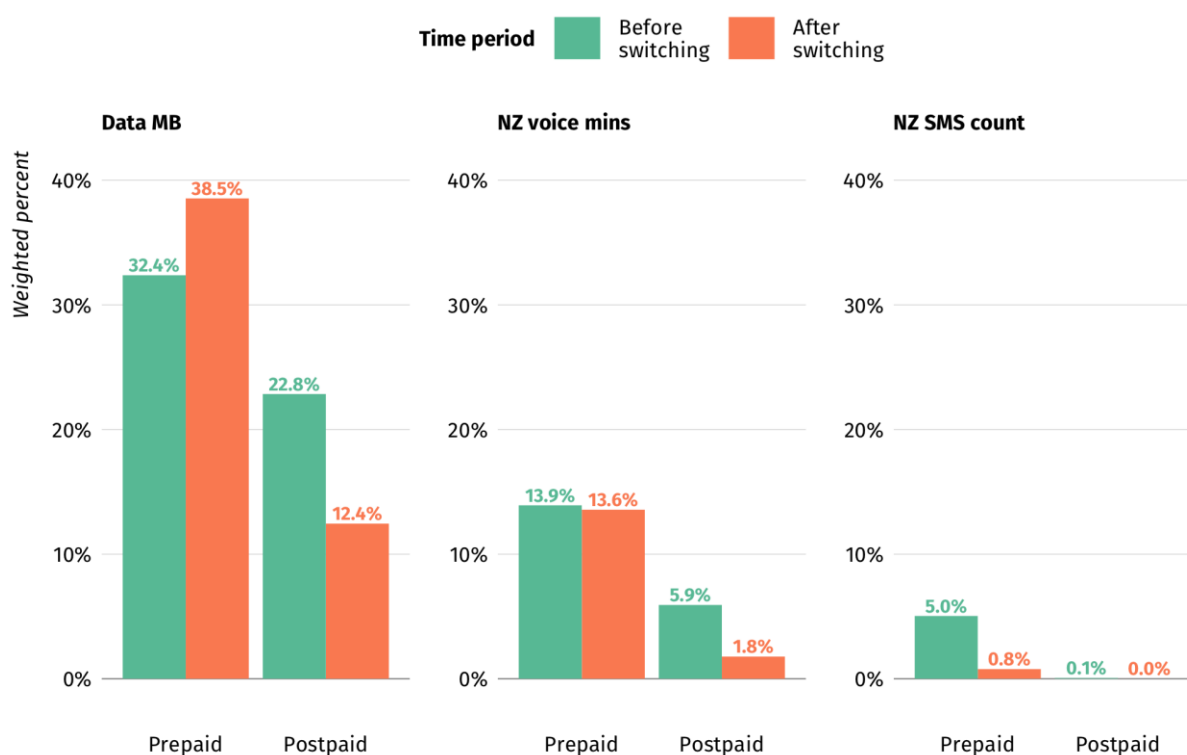
6.3   Comparison of expenditure before and after switching

As shown above, customers who switched base plans tended to have higher usage of mobile data and NZ voice after switching compared to before. This makes it difficult to determine whether people who switched base plans saved money. In many cases, people who switch base plans due to increasing usage actually increase their expenditure by buying base plans with larger quotas to accommodate their greater usage and/or expected future increases in usage.

Given this, as a basic test of the effect of switching base plans on expenditure, expenditure before and after switching was compared for customers in the billing sample who had similar average monthly usage before and after switching. Specifically, this comparison was done for customers who satisfied all the following criteria:

1. Purchased a base plan in every month.

2. Switched base plans only once during the year.

3. Had at least four months of usage recorded on both their old and new base plans.

4. Their average monthly usage of all of NZ voice, NZ SMS, and mobile data in the months after switching was within one standard deviation of these averages before switching.

The results of this comparison are shown in Figure 20. While some customers spent more and some spent less after switching, the median difference in expenditure is very close to zero. This implies that, on average, customers who switched base plans and who had similar usage before and after switching spent around the same amount per month on average after switching as before.

Figure 20 Distribution of difference in monthly average expenditure for customers who switched base plans and who had similar usage levels before and after switching.
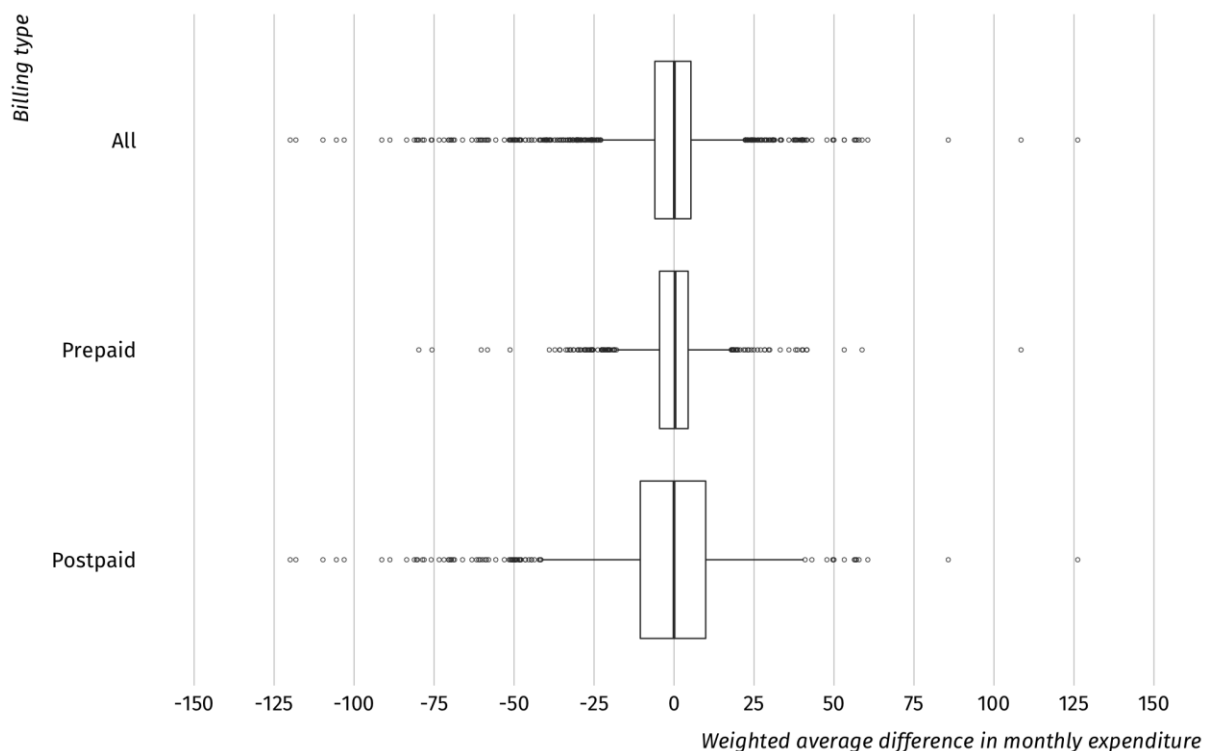
See section 11.1 for a guide to how to interpret this chart.

7 Estimating potential savings for consumers

Given the variation of expenditure across customers in usage groups (see Figure 14 above), it is likely that some customers could save money by changing their purchasing patterns. This section reports on analysis aimed at identifying customers who could save money while maintaining the same usage levels by changing the products that they buy. This was done in four different ways:

1. Benchmarking expenditure of customers against their peers with similar usage, to identify whether some customers spend more than they need to, given their usage.

2. Testing whether customers who buy base plans and who consistently use less than their quota could save money by switching to a different base plan.

3. Testing whether customers who buy base plans and who consistently use more than their quota could save money by switching to a different base plan.

4. Testing whether customers buying grandfathered base plans could save money by switching to newer base plans.

Customers' usage varies from month to month, and customers have access to a variety of base plans and add-ons that can be combined in various ways. On some plans it is also possible to use rolled-over quotas and/or to share quotas with other customers. This means that determining the optimal (i.e. least expenditure) purchasing pattern for any given customer can be a very difficult task. Given this complexity, the analysis presented in this section is simplified and aims at identifying some subsets of customers who are very likely to be able to save money given their usage patterns.

It should also be noted that the analysis in this section focuses only on usage of the three core mobile services (mobile data, NZ voice, and NZ SMS) and there may be other reasons why people exhibit the purchasing behaviour that they chose. For example, they may want to be on a base plan that provides a subsidised or interest-free handset or that bundles value-added media services such as Spotify, or that offers better value for other services such as international calls or roaming.

7.1 Customer expenditure benchmarking

The total monthly average expenditure of each customer on base plans, add-ons, and casual usage of mobile data, NZ voice, and NZ SMS was benchmarked against expenditure for peer customers to determine whether each customer had high expenditure given their usage, and if so, how much they could potentially save by changing their purchasing behaviour. This analysis relies on the assumption that some customers will discover the relatively inexpensive ways to purchase a given amount of usage, while other customers will make less cost-effective choices.

Prior to benchmarking, customers were divided into a number of peer groups and benchmarking was conducted among customers within each of these groups separately. In total, 42 customer peer groups were defined, based on all combinations of service provider, billing type (prepaid/postpaid) and the six usage groups defined in section 4.3 above. For each of these groups separately, an expenditure benchmarking regression model was trained using the billing data for customers in that group that predicts monthly average

expenditure as a function of a customer's monthly average usage of mobile data, NZ voice, and NZ SMS (see section 11.5 for more details of these benchmarking models).

The trained benchmarking models were used to predict expenditure for each customer given their actual monthly average usage of mobile data, NZ voice, and NZ SMS. As the models cannot predict the expenditure of any individual customer exactly, an 80% prediction interval around each of these expenditure predictions was also generated.[12] Then customers whose actual monthly average expenditure exceeded the upper limit of the 80% prediction interval were deemed to be 'high expenditure' customers, given their usage. The idea of this approach is that the benchmarking models will predict average expenditure for a customer with given usage levels, and then anyone who actually spends significantly more than that average could probably save money by maintaining the same usage levels but changing their purchasing behaviour.

Using this approach, Figure 21 shows the proportion of customers in each combination of usage group and billing type that are estimated to have high expenditure given their usage.[13] Overall, about 7% of customers are benchmarked as having high expenditure compared to their peers. This shows that there is generally a higher proportion of high expenditure customers on postpaid billing than on prepaid, except in the low user group where the proportions are similar. Overall, 8.8% of postpaid customers and 5.7% of prepaid customers are benchmarked as having high expenditure by this method.

Figure 21 Proportions of customers benchmarked as having high expenditure given their usage.

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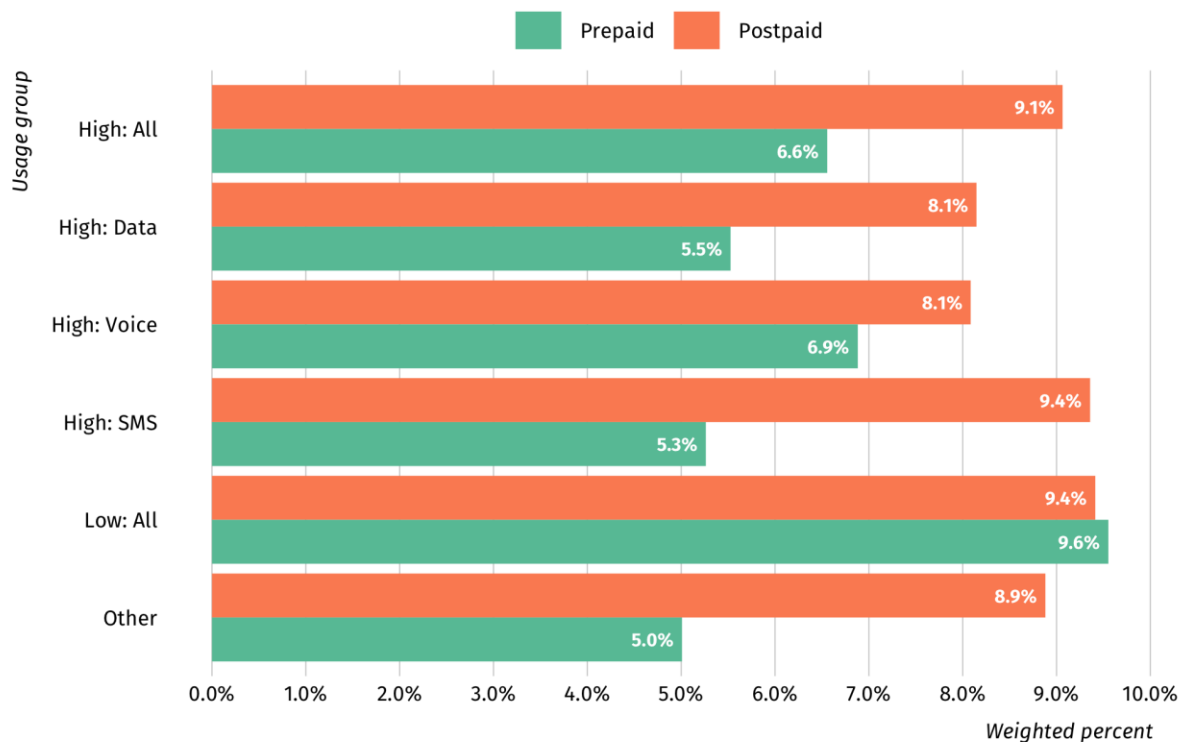
[12] For an individual customer, a prediction interval gives the range within which their expenditure is expected to fall with a given degree of certainty (80% in this case).

[13] As described above, the benchmarking analysis was done for each of the 42 combinations of service provider, billing type, and usage group separately. The results shown in Figure 21 have been aggregated across service providers.

Estimates of potential savings for those customers who were benchmarked as having high expenditure were produced in two ways, by taking the difference between the customer's actual monthly average expenditure and two alternative benchmarks:

5. The amount predicted for that customer given their usage by expenditure benchmarking model for their peer group.

6. The lower of the two amounts predicted for that customer given their usage given by the expenditure benchmarking models for their peer group and for the equivalent peer group from the alternative billing type.

The first approach calculates savings under the assumption that customers remain with their current service provider and billing type but change purchasing patterns given what is available from that service provider and billing type. The second approach assumes that customers remain with their current service provider but could switch between prepaid and postpaid billing if the alternative billing type offered a cheaper way to pay for the same expenditure.

For customers benchmarked as having high expenditure given their usage, Figure 22 shows the estimated reductions in monthly average expenditure under these two approaches. Overall, high expenditure customers are estimated to be able to save $31.65 per month if switching billing types is not possible, or $48.65 per month if it is possible.

Figure 22 Estimated savings in monthly average expenditure for customers benchmarked as having high expenditure given their usage.
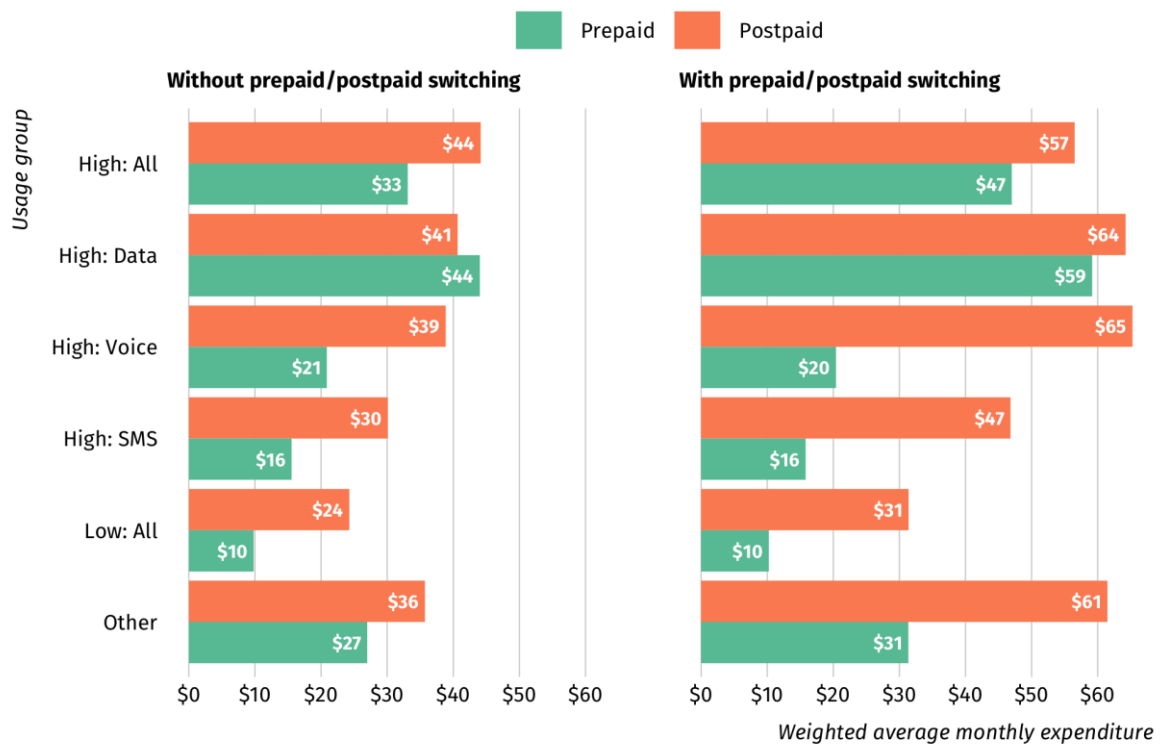
Potential savings are generally higher for postpaid customers than for prepaid customers. High expenditure postpaid customers are estimated to be able to save an average of $36.23 per month if switching billing types

is not possible, or $58.82 per month if it is possible. High expenditure prepaid customers are estimated to be able to save an average of $24.52 per month if switching billing types is not possible or $27.54 per month if it is possible.

Figure 23 on the following page shows how the benchmarked savings for customers identified as "high" expenditure in each usage group vary with their tenure with their current service provider. In most usage groups, the median monthly estimated savings for customers with long tenure (in the upper quartile of tenure, i.e. greater than 80 months) is slightly greater than the median for customers with short tenure (in the lower quartile of tenure, i.e. less than 23 months). While small, these differences suggest that customers who have been with their current service provider for longer may have some more opportunities to save money by changing their purchasing behaviour, once usage levels are considered.

Figure 23 Distribution of benchmarked savings in monthly average expenditure for high expenditure customers by usage group and tenure group.
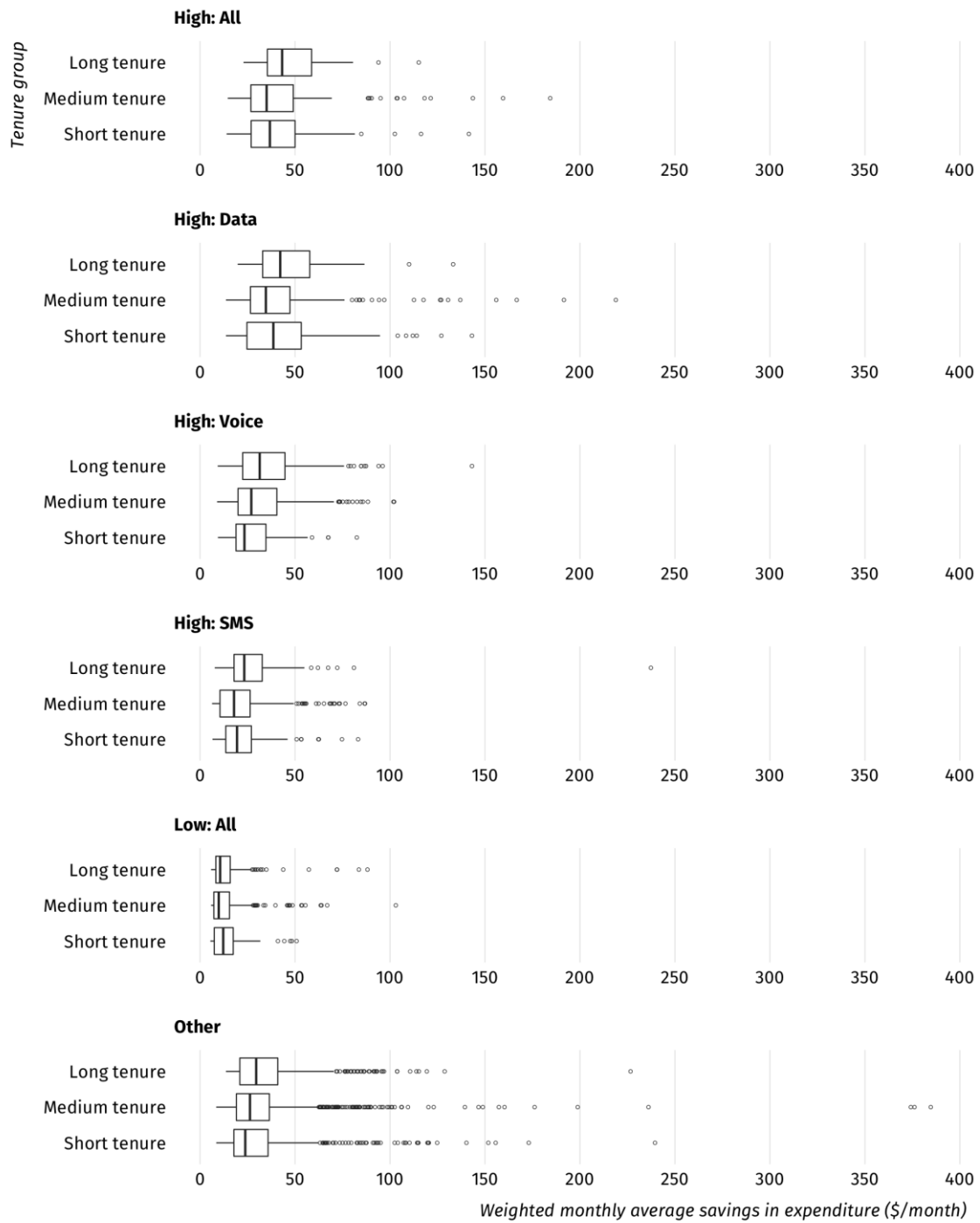
See section 11.1 for a guide to how to interpret this chart.

7.2 Savings for customers on base plans

Further analysis of potential savings was done for customers who bought a base plan product in every month. As noted in section 6, this includes all postpaid customers and 55% of prepaid customers. For such customers, potential savings were identified for customers who either use consistently less or more than their nominal base plan quotas. Some analysis was also done of expenditure by customers on 'grandfathered' base plans.

7.2.1 Customers who use consistently less than their quota

Customers who consistently use less than their nominal base plan quota may be able to save money by switching to a cheaper base plan with smaller quotas. To test this, customers who bought a base plan product in every month and whose usage of mobile data and NZ voice was less than their quota in every month were identified.[14] For such customers, their actual base plan expenditure was compared to expenditure on other base plans from the same service provider and billing type that offered monthly quota sufficient to meet their actual usage in every month.[15] Savings were calculated as the difference between the customer's actual base plan expenditure and expenditure on the cheapest such alternative base plan, if any.

> **It has been brought to our attention that there is a methodological error which affects the paragraph immediately below. The corrected analysis is contained in a supporting memorandum, which is appended to this document – See .**

Overall, 35.8% of postpaid customers and 6.7% of prepaid customers who purchased a base plan in every month used less than their nominal quota of mobile data and NZ voice in every month. Of these customers who were consistently under quota, 78% of postpaid and 71% of prepaid customers are estimated to be able to save money by switching to a cheaper base plan from the same service provider and billing type but with smaller quotas that still exceed their actual usage of mobile data and NZ voice in every month. Monthly average savings for such customers from switching base plans are estimated to be $11.58 for postpaid and $4.36 for prepaid customers.

7.2.2 Customers who use consistently more than their quota

Customers who consistently use more than their nominal base plan quota may also be able to save money by switching to a (possibly more expensive) base plan with larger quotas. To test this, customers who bought a base plan product in every month and whose usage of mobile data and NZ voice was more than their quota in 9 out of 12 months were identified.[16]

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[14] Usage of NZ SMS was excluded from this analysis since most base plans have unlimited SMS quota. This analysis was limited to customers who used less than their quota in *every* month, because there are many ways that customers who use more than their quota in some months can meet the excess usage in those months, such as buying add-ons and usage packs, using rollover quotas, or paying for casual usage. This makes it difficult to determine whether customers who used less than their quota in some months and more than their quota in other months could save money by switching to a base plan with smaller quotas, because it is difficult to work out the least-cost purchasing behaviour in the over-quota months.

[15] Base plans accounting for less than 1% of base plan purchases from each service provider were excluded from this comparison, to avoid distortions caused by purchases of a small number of obsolete plans. Spark's "companion" plan was also excluded as it is not a standalone plan.

[16] Unlike the previous analysis, this analysis focused on customers who exceeded their quota in most but not all months. This is because the estimated savings are based on whether customers could save money by switching to a base plan with *larger* quotas that would cover their usage in *every* month. Under such a plan, a customer would not need to purchase add-ons or casual usage, or use rollover, to meet their usage in any month, so it is more straightforward to calculate if they could save money by switching base plans.

Table 7 shows the proportions of customers of each billing type who purchased a base plan product in every month who used more than their nominal quota of mobile data and NZ voice in 9 out of 12 months or more. Consistent with the analysis in section 4.2, it is less common for customers who buy base plans in every month to be consistently over quota than to be consistently under quota. One exception is prepaid customers, of which 12.6% of those who bought base plans in every month were over quota for mobile data in 9 out of 12 months or more.

Table 7 Proportions of customers who purchased a base plan in every month who were over quota for mobile data and NZ voice in 9 out of 12 months or more.

Group	Billing type	Weighted % of customers
Consistently over NZ voice quota	Postpaid	2.0%
	Prepaid	5.4%
Consistently over data quota	Postpaid	5.5%
	Prepaid	12.6%
Consistently over both NZ voice and data quotas	Postpaid	0.3%
	Prepaid	1.7%

For those customers who purchased a base plan in every month and who consistently used more than their quota of either mobile data or NZ voice (or both), Table 8 shows the proportions of customers who could save by switching to a base plan from the same service provider and billing type but with larger quotas that exceed their usage in every month, and the corresponding monthly average savings from switching to such a base plan. In calculating these savings, the difference in base plan expenditure was accounted for, and it was assumed that on the base plan with larger quotas, the customer would not need to purchase any usage-related add-ons or usage packs and would no longer have any casual usage expenditure for NZ voice calls or mobile data.

Table 8 Estimated savings for customers who are consistently over quota of mobile data and NZ voice.

Group	Billing type	Weighted % of customers	Monthly average savings ($)
Consistently over NZ voice quota	Postpaid	21.4%	19.21
	Prepaid	3.9%	7.30
Consistently over data quota	Postpaid	25.3%	21.85
	Prepaid	4.8%	9.71
Consistently over both NZ voice and data quotas	Postpaid	30.8%	18.72
	Prepaid	2.4%	10.57

7.2.3 Customers on grandfathered base plans

Over time some base plans become 'grandfathered' as new plans are introduced. Customers already on grandfathered base plans are usually allowed to remain on those plans but customers not already on grandfathered plans are not allowed to switch to them. Grandfathered base plans are not directly identified in the billing sample. Instead the likely set of grandfathered plans was identified by looking at customer

purchasing patterns. The 12 months from September 2018 to August 2019 was divided into two six-month periods. Grandfathered plans were then identified as those that were purchased in the second six-month period only by customers who had also purchased those plans in the first six-month period. Similarly, any plans that were purchased by some new customers in the second six-month period were determined to be not grandfathered in that period.

Using this process, almost all base plans in the billing sample were classified as grandfathered or not grandfathered. A small number of base plans were classified as 'new' plans that were purchased by some customers in the second six-month period but were not purchased by any customers in the first six-month period, or 'obsolete' plans that were purchased by some customers in the first six-month period but were not purchased by any customers in the second six-month period. Table 9 shows the results of this classification for base plans purchased in the second six-month period (from March to August 2019). Slightly more than a quarter of postpaid base plans purchased during this period were inferred to be grandfathered, while only around 5% of prepaid base plans were grandfathered.

Table 9 Inferred grandfathering status of base plans purchased in the six months from March to August 2019.

Billing type	Inferred base plan status	Weighted % of base plan purchases
Postpaid	Grandfathered	26.6%
	Not grandfathered	68.8%
	New	4.6%
Prepaid	Grandfathered	5.1%
	Not grandfathered	94.4%
	New	0.5%
All	Grandfathered	16.1%
	Not grandfathered	81.3%
	New	2.6%

Expenditure of customers on grandfathered plans was compared to those on non-grandfathered plans using a similar benchmarking approach as described in section 7.1. Specifically, the expenditure benchmarking models for the subsets of customers defined by all combinations of service provider, billing type, and usage group were re-estimated using expenditure only of customers who purchased non-grandfathered plans during the second six-month period (March to August 2019). These models were then used to estimate (i.e. benchmark) the expenditure of customers who purchased grandfathered plans during that period, given their actual monthly average usage of mobile data, NZ voice, and NZ SMS.

Overall, this exercise found that customers on grandfathered plans would spend $9.62 per month more on average if they switched to a non-grandfathered plan, given their usage. Prepaid customers on grandfathered plans were estimated to spend $2.96 more per month on average by switching to a non-grandfathered plan, while postpaid customers were estimated to spend $10.67 more. This provides an explanation for why postpaid customers may choose to remain on grandfathered plans, since on average such plans are less expensive than non-grandfathered plans, given their usage.

8   Analysis of rollover balances

Data limitations prevented robust analysis of customers' accumulated rollover balances of voice minutes and mobile data quota. However, the following conclusions can be drawn about rollover from the available information:

- Rollover balances for most customers are capped at certain limits, e.g. 200 minutes, and billing rules typically require that rollover balances are used first before any newly available quota is used each month. This means that for most customers, rollover balances alternate between low values and values that are close to or at those limits.

- Some customers are on plans that do not have rollover balance limits, and some of these customers have accumulated very large rollover balances of minutes and mobile data.

- There is some evidence that customers on postpaid plans who have accumulated relatively large mobile data rollover balances (in excess of 100 GB) could save money by switching to different base plans, but the number of such customers is small.

9 A closer look at low users

Further analysis was done of the purchasing patterns of customers in the low usage group defined in section 4.3. These are customers in the lower quartile of monthly average usage of all mobile data, NZ voice, and NZ SMS. Such customers use less than 201 MB of mobile data, 33 minutes of NZ voice calls, and 23 NZ SMS messages per month on average. Overall, 11.5% of prepaid customers and 5.5% of postpaid customers are low users by this definition. Among the low users in the billing sample, 73% were prepaid customers and 27% were postpaid customers.

9.1 Purchasing patterns of low users

The average low user spent $9.01 per month (see Figure 13 above) and the median user spent $6.46 per month. The top 10% of low users spent more than $20.74 per month on average over the year. There is a small proportion of low users who appear to have very high expenditure given their monthly average usage, with the top 1% spending more than $48.99 per month (Figure 24).

Figure 24 Distribution of monthly average expenditure among low users, by type of expenditure.
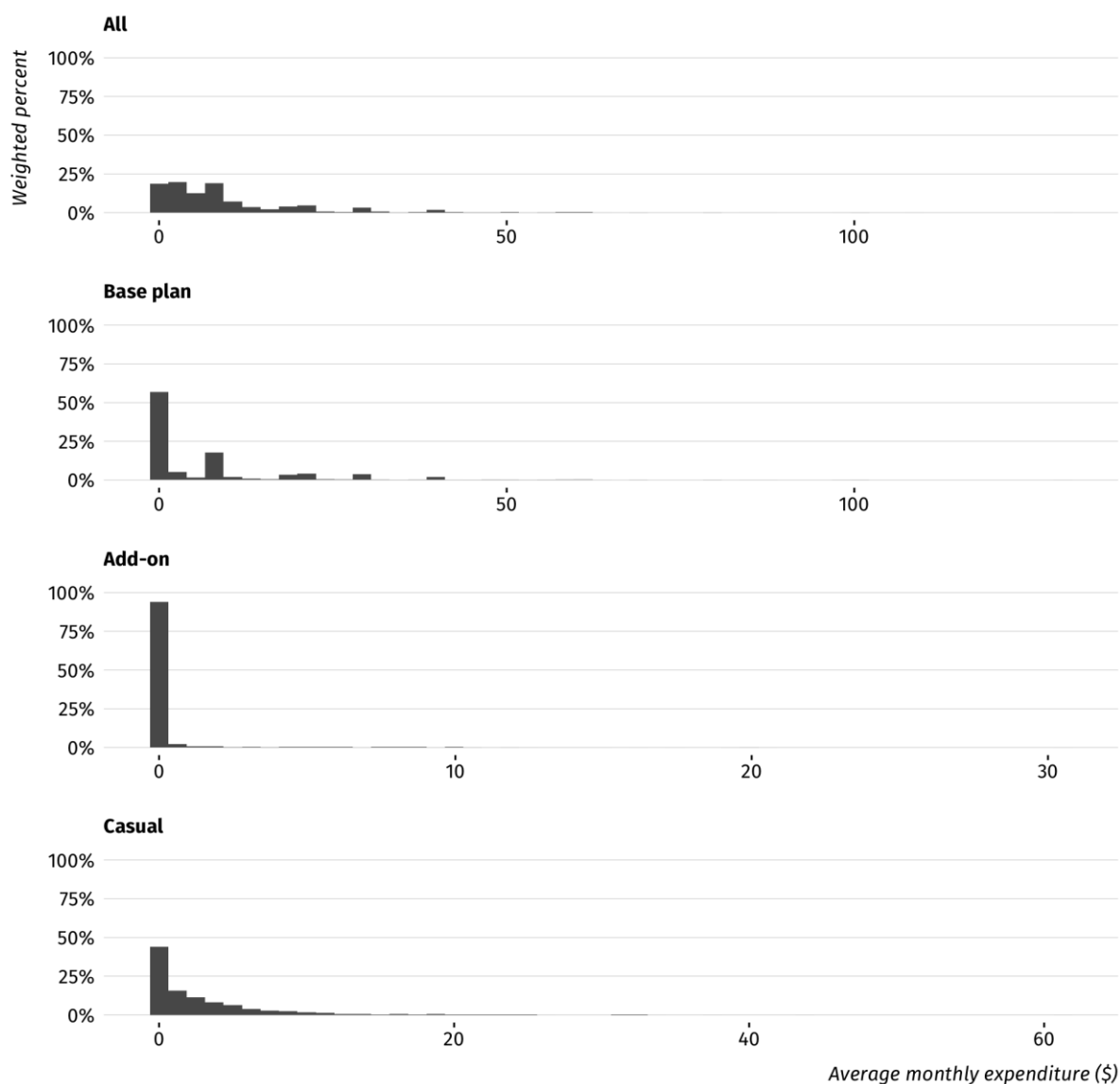
Table 10 shows statistics calculated from the monthly average expenditure of low users. The average postpaid low user spends more than three times as much as the average prepaid low user. Relatively high spending low users are mostly postpaid customers, and the upper quartile of prepaid expenditure is less than the median of postpaid expenditure.

Table 10 Monthly average expenditure statistics for low users by billing type and product type.

Billing type	Product type	Lower quartile ($)	Median ($)	Upper quartile ($)	Average ($)
All	All	2.11	6.46	10.70	9.01
	Base plan	0.00	0.00	6.99	6.13
	Add-on	0.00	0.00	0.00	0.24
	Casual	0.00	1.07	3.73	2.64
Prepaid	All	1.25	3.60	8.25	5.53
	Base plan	0.00	0.00	0.00	2.06
	Add-on	0.00	0.00	0.00	0.31
	Casual	0.16	1.78	4.54	3.15
Postpaid	All	7.05	11.72	28.99	18.42
	Base plan	6.99	6.99	28.99	17.12
	Add-on	0.00	0.00	0.00	0.05
	Casual	0.00	0.04	0.94	1.26

Table 11 reports the results of classifying the basic purchasing patterns of low users (ignoring amounts spent). In 38.7% of months, low users had only prepaid casual expenditure, while in 21.7% of months low users had no expenditure and in 20% of months low users bought a postpaid base plan only. It was relatively less common for low users to combine products such as base plans and add-ons, or to buy prepaid base plans.

Table 11 Classifying purchasing patterns of low users.

General purchasing pattern	Percent of customer-months
Prepaid casual only	38.7
Prepaid no expenditure	21.7
Postpaid base plan only	20.0
Postpaid base plan + casual	6.9
Prepaid base plan only	6.2
Prepaid base plan + casual	3.1
Prepaid add-on + casual	1.8
Prepaid add-on only	1.3
Other	0.3

9.2 Casual expenditure by low users

Customers in the low usage group use casual usage relatively frequently compared to other usage groups. Overall, about three-quarters of low users had some casual expenditure during the year and 52% of low users on prepaid billing had only casual expenditure. Figure 25 shows how the average monthly casual expenditure of low users is distributed across different services. The greatest source of casual expenditure among low users is for NZ voice calls, followed by mobile data and SMS.

Figure 25 Distribution of casual expenditure by low users across services.

9.2.1 Should low users with only casual expenditure buy a base plan instead?

The monthly usage of mobile data, NZ voice, and NZ SMS of each low user who only had casual expenditure during the year was compared to the quotas available on base plans from the same service provider to check whether these customers could save money by switching to a base plan. This analysis found that only 7% of low users who only have casual expenditure would be better off by switching to a base plan from their current service provider. On average, these customers could save $4.38 per month by switching to a base plan.

9.2.2 Should other low users stop buying base plans or add-ons?

Further analysis was done of low users who sometimes or always bought base plans and/or add-ons or usage packs to see whether they could save money by switching to casual expenditure with their current service provider, given their monthly usage of mobile data, NZ voice, and NZ SMS.[17] Among these customers, this analysis found that 20% could save money by switching to casual usage. On average, such customers who

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[17] The per-unit casual charges used in this analysis were calculated from casual usage and expenditure of customers in the billing sample who only had casual usage. Thus, the charges reflect prices actually paid by customers for casual usage.

bought postpaid base plans would save $12.38 per month, and customers who bought prepaid products would save $5.09 per month.

9.2.3 Interpretation of findings about casual expenditure by low users

These findings suggest that for customers who have very low usage levels, given the existing base plans in the market, it can be a rational choice to have only casual usage, despite the relatively high per-unit prices that must be paid. However, it is possible that low users may still prefer to buy base plans or other products, even if these are more expensive, for convenience or other reasons.

10 Concluding remarks

The analysis in this report demonstrates the usefulness of analysing billing data for random samples of customers to understand and monitor customer behaviour and outcomes in the residential mobile market. Using individual customer data rather than aggregated data enables more detailed analysis by revealing the distribution of usage patterns and expenditure across customers. This is important because there is a lot of variation in usage across customers, and customers in the mobile market can choose from many different products and services. For example, it is only possible to see that some customers have high expenditure given their usage by analysing individual customers' billing data.

Key findings from this analysis include:

- There is wide variation in expenditure across customers, even for those that have similar usage levels. While the majority of customers appear to be getting good value for money, there is evidence that some residential mobile customers could save money by changing their purchasing behaviour and it is likely that market outcomes for consumers could be improved by actions taken by service providers and/or the Commission that encourage or enable consumers to shop around.

- Certain indicators may help to identify customers who could save money by changing their purchasing behaviour, such as those who consistently use less or more than their base plan quotas. However, this analysis was limited to usage and expenditure on core mobile services, and there could be other reasons beyond use of these services that explain why consumers choose the mobile services that they buy.

- There appears to be relatively high rates of switching among base plans for customers who buy such plans, even when switching across service providers or switching between prepaid and postpaid billing is excluded. Given that around a third of customers on base plans switched plans (from the same service provider) within the year, this suggests that many customers do actively seek to get the best value from their mobile services by evaluating and changing plans regularly.

- Given existing products and prices in the market, it can be reasonable for low users to use casual usage, including using only casual usage in some cases. However, it is still possible that low users would be better off if different products were available that suited them better, such as low usage base plans.

Overall, this analysis provides evidence that there are 'pockets' of residential mobile customers who could save money by changing their purchasing behaviour. Thus, while the majority of customers appear to be getting good value for money, it is likely that actions by service providers and/or the Commission to encourage or enable mobile customers to shop around could be beneficial for consumers. This could include, for example, providing information to consumers about their usage and expenditure trends, and proactively alerting customers who are consistently using less or more than their quotas that they may be able to save money by changing plans. However, this analysis was limited to usage and expenditure on core mobile services, and there could be other reasons beyond use of these services that explain why consumers choose the mobile services that they buy. This means that some possible interventions to improve consumer outcomes could benefit from additional analysis and evidence, to mitigate the risk of unintentionally making consumers worse off.

It could be valuable to repeat some of the analysis summarised in this report on a regular basis, to allow trends to be tracked and see if outcomes for consumers are getting better or worse over time. Most of the key

analysis contained in this report could be done with a simplified dataset that contains monthly records for individual customers of:

- Usage of key mobile services (mobile data, NZ voice calls, and NZ SMS), separated into usage that was charged at casual (per-unit) rates, and other usage.

- Expenditure on base plans, add-ons or usage packs, and casual usage for each of the three key mobile services above.

- For customers who purchased base plans, their monthly quota of mobile data, NZ voice calls, and NZ SMS.

- Any discounts applied to the customer's expenditure during the month, separated into fixed-mobile bundle discounts and other discounts.

A significant challenge in doing this analysis was combining billing data from different service providers. If this analysis is repeated in future, it is recommended that a standardised billing data format be developed that all service providers are capable of conforming to and that provides enough information for analysis. This would simplify the analysis and reduce the risk of errors arising from combining data in different formats or that uses different definitions. Standardisation would also likely reduce the burden on service providers to extract billing data from their systems, once a process is established. Where customer billing cycles do not align with calendar months, a method will need to be agreed for converting these to monthly equivalents, bearing in mind that in most cases it makes sense to base analysis on annual averages or totals and hence the exact timing of monthly usage and expenditure is not important. A similar issue arises where customers are on 28-day billing cycles rather than calendar month billing.

11 Appendix

11.1 Guide to reading box and whisker charts

This report uses some "box and whisker" charts to illustrate the distribution of data values. Figure 26 below shows an example of these charts, with the following features:

- The central (thick) line is at the **median** of the data values.

- The upper and lower ends of the "box" are at the **upper quartile** and **lower quartile** of the data values.

- Half of the data values lie within the "box" and the length of this box is the **interquartile range** (i.e. the difference between the upper and lower quartiles).

- The two ends of the "whiskers" are a distance 1.5 times the interquartile range away from the upper and lower quartiles.[18]

- Any **outliers** beyond the ends of the two whiskers are plotted individually.

Figure 26 Example box and whisker chart.
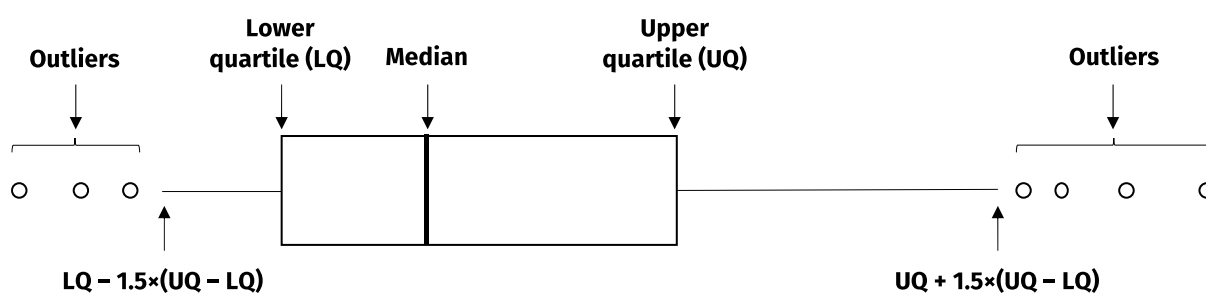
11.2 Research questions

The following set of research questions was provided by the Commission to define the scope of this analysis.

11.2.1 Understanding mobile consumer behaviour

1) How many different base plans and usage packs are purchased in the retail market and which are the most popular?
2) What are the usage characteristics of different customer segments?
3) How is mobile consumer expenditure distributed between base plans, packs, and casual usage, and how does this distribution differ for:
   a) Prepaid vs postpaid customers?
   b) Consumers in different segments (as defined above)?
   c) Consumers with long vs short tenure?
4) What products do low users buy?
5) To what extent do people use rollover rationally?

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[18] If the data values are normally distributed, then approximately 99% of the values will lie between the ends of the two "whiskers".

6) What happens to usage when consumers switch base plans? Does their usage typically increase, decrease, or stay the same after switching? Does their new plan better match the new usage?

11.2.2 Identifying potential savings

1) How does expenditure vary across consumers in each segment (defined above) and what are the potential savings if relatively high spenders in each segment adopted the purchasing patterns of relatively low spenders in each segment?
   a) To what extent do potential savings vary with tenure?
   b) To what extent can savings be realised by switching between prepaid and postpaid services from the same service provider?
2) For consumers on base plans (either prepaid or postpaid):
   a) How does the distribution of usage of mobile data and voice calls compare to base plan quotas?
      i) For customers that consistently use less than their quota, how much money could they save by switching to a plan with lower quotas?
      ii) For customers that consistently use more than their quota, how do they pay for their additional usage (via rollover, packs, and/or casual), and how much money could they save by switching to a plan with larger quotas?
   b) What typically causes consumers to exceed their base plan quota – use of voice, mobile data, or both?
   c) Do consumers who switch base plans and maintain similar usage patterns after switching tend to save money?
   d) Can consumers save money by switching to a different base plan if their rollover balance exceeds a certain level?
   e) What proportion of consumers are currently on base plans that are no longer offered in the retail market ('grandfathered' plans), and would such consumers spend more or less if they switched to a newer plan?
3) Could low users save money by changing their purchasing patterns, and if so, how?
   a) What proportion of consumers only have casual usage and do not buy base plans or usage packs?
   b) Does it ever make sense to only have casual usage?

11.3 Preliminary data manipulation and cleaning

The billing data was provided by the four service providers separately in somewhat different formats and with some differences in level of detail that reflected the capabilities of their respective billing systems. Prior to analysis, a significant amount of effort was undertaken to combine the separate samples into a single dataset that could be used for analysis. The combined dataset consists of the following data tables:

- **Customers:** A set of unique and anonymised customer IDs with records of each customer's service provider, billing type, and tenure.

- **Usage**: Monthly usage records for each customer of mobile data, NZ voice minutes, NZ SMS, Australian voice minutes, Australian SMS, and MMS.

- **Expenditure**: Monthly total expenditure for each customer on base plans, add-ons, and casual usage. A separate casual expenditure table was also created giving monthly total expenditure for each customer on the six services listed above.

- **Products**: Records of each individual base plan and add-on purchased by each customer including the date of purchase and amount.

- **Base plan quotas**: For each base plan purchased by a customer, a record of the associated quotas of voice minutes, SMS, and mobile data.

- **Rollover balances**: For customers on rollover base plans, a record of their rollover balances of mobile data and voice minutes at the beginning of each month.

A consistent set of customer IDs were used in all these data tables so they can be joined as required for analysis. Some service providers reported expenditure data for each customer's billing cycle, which do not typically align with calendar months, and in some cases billing cycles are 28 days rather than once per month. Other service providers reported data for calendar months. To combine these, expenditure and usage data that was reported for non-calendar-month billing cycles was assigned to the month of the starting date of that billing cycle.[19] As all of the analysis in this report is based on monthly averages for each customer, any potential differences between billing cycles and calendar months will significantly not affect the results.

The following cleaning was performed on the data to remove apparent errors and to help standardise the data across service providers:

- A small number of reported customer tenure values greater than 360 months (30 years) were removed as these are implausibly high for mobile customers.

- Purchases of services specifically excluded from this study were removed from the data, namely expenditure relating to international roaming, purchases of devices, and international calls and SMS (except Australia).

- Discounts relating to base plans (typically fixed-mobile bundle discounts) were recorded as "purchases" of add-ons in some cases or were recorded separately in other cases. These were removed from the add-ons and all base plan discounts were combined with base plan purchases so that base plan expenditure is net of discounts including fixed-mobile bundle discounts.

Basic checks were performed to test consistency of the combined data versus the original raw data. This included checking the number of customers was unchanged and expenditure totals for each customer were unchanged (except for the effect of the exclusions listed above).

11.4 Weighting

A simple weighting procedure was used to improve the accuracy of all aggregated statistics presented in this report and to account for the different sizes of the billing samples across service providers. The weights were calculated as the ratio of the number of customers in the billing sample to the ratio of the number of 30-day active customers as at 30 June 2019 for each combination of service provider and billing type. The use of 30-day active customers to calculate weights reflects the fact that the billing sample was restricted to customers

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[19] For customers on 28-day billing (i.e. who receive approximately 13 bills in 12 months), there will typically be one calendar month in which two bills are recorded. Across a large group of customers, monthly averages calculated by assigning 28-day bills to the calendar month in which they occur will be very similar to a more complicated approach of adjusting the 28-day bills to monthly equivalents and then averaging those adjusted figures.

who had some usage in every month. This gave a set of seven weights that were applied to all customers based on their service provider and billing type.

11.5 Expenditure benchmarking models

As described in section 7.1, statistical benchmarking models were used to compare the expenditure of groups of customers (similar models were also used in the analysis of customers on grandfathered plans in section 7.2.3). For a given group of customers, these models explain each customer's monthly average expenditure as a function of their monthly average usage of mobile data, NZ voice, and NZ SMS.

There is generally not a simple linear relationship between monthly average usage and expenditure across customers. For example, customers on the same base plan can have similar levels of expenditure even if their usage levels are somewhat different. Given this, the explanatory variables of the benchmarking models are a set of 30 dummy variables that indicate which decile of monthly average usage each customer is in for each of mobile data, NZ voice, and NZ SMS, among the subset of customers used to estimate the model. This setup allows for various forms of non-linear relationships between usage levels and expenditure.

In the benchmarking analysis in 7.1, a separate model was estimated for each subset of customers defined by service provider, billing type, and usage group, i.e. 42 models were estimated for customers with all possible combinations of these characteristics.[20] The estimated model for each subset was then used to predict the expenditure for each customer in that subset, and an 80% prediction interval for each customer's expenditure was generated. As described in section 7.1, a customer was determined to have high expenditure if their actual monthly average expenditure was greater than the upper limit of their 80% prediction interval for expenditure given their usage.

To illustrate the goodness of fit of these models, Figure 27 shows the average R-squared value for each combination of billing type and usage group (R-squared values have been averaged across service providers). On average the models explain between 15% and 60% of the variation in monthly average expenditure across customers in each subset used to estimate the models.

The extent to which the model for a given subset of customers fits the expenditure data will be reflected in the width of the expenditure prediction intervals generated for each customer in that subset. Models that fit less well will have wider prediction intervals, and therefore it will be less likely to find customers who are relatively high spenders within that subset, as high spending customers are defined as those who spend more than the upper limit of the 80% prediction interval for their expenditure, given their usage.

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[20] Since all customers used to estimate each model are of the same service provider and billing type, the weights described in section 11.4 were not used to estimate these models.

Figure 27 Average R-squared values for expenditure benchmarking models.
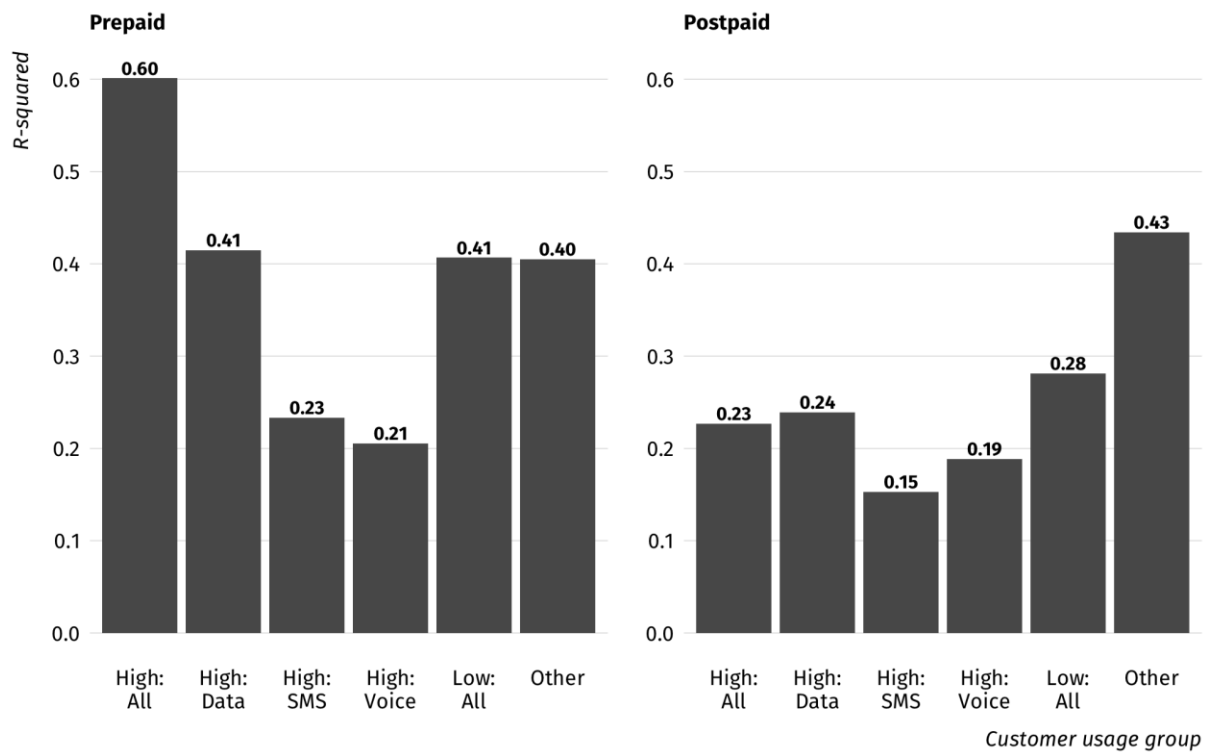
12 Memorandum addressing responses to the original analysis and findings

28 January 2021

To: Commerce Commission

From: Aaron Schiff, Schiff Consulting (aaron@schiff.nz)

Subject: Response to submissions on the Mobile Bill Review Analysis Report

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Summary

1. This memo responds to issues raised in submissions from Spark, NERA, 2degrees and Vodafone to the Commerce Commission in response to Schiff Consulting's report on analysis of usage and expenditure of a sample of residential mobile customers.[21]

2. This memo sets out a brief exploration of the main issues raised in the responses that directly relate to Schiff Consulting's report and its conclusions, and then responds to each in more detail. I would be happy to discuss any of these issues further. The memo does not comment on elements raised by responses to the contents of the Commission's Open Letter.[22].

3. *Overall conclusions:* The submissions broadly agree with the main conclusions of my report but argue that the estimates of potential savings for residential mobile customers are overstated for various reasons. I agree with several points made in the submissions (see below). Potentially offsetting these adjustments, none of the submitters appear to recognise that the 'right planning' analysis undertaken so far was limited to certain groups of customers on base plans: those who used less than their quota in every month and those who used more than their quota in nine out of 12 months or more. A full 'right planning' analysis for all customers would almost certainly find more customers who could save, but this was not done due to the difficulty of working out the cheapest purchasing behaviour for any given customer. The econometric analysis in my report does look across all customers in the sample, but it is less precise than the 'right planning' analysis as it is based on benchmarking.

4. *Error in the 'right planning' analysis:* NERA's review has found an unintentional error in part of the 'right planning' analysis that relates to customers on base plans who used less than their quota in every month (section 7.2.1 of the report). I estimate that correcting this error on its own reduces the proportion of such customers who could save by changing base plans from 78% to 40% for postpaid customers and from 71% to 59% for prepaid customers. I estimate that correcting this error on its own causes average savings for customers who could save by changing base plans to increase from $11.58 to $18.28 per month for postpaid customers and to decrease from $4.36 to $3.43 for prepaid customers.

5. *Treatment of value-added services:* I agree that value-added services could explain why some customers appear to spend more than they need to give their usage of core mobile services, but lack of complete information about actual take-up (as opposed to availability) of value-added services and the actual value

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[21]*Analysis of Mobile Bills*, Schiff Consulting report for the Commerce Commission, (17 September 2020).

[22] Commerce Commission "Open Letter – Addressing transparency and inertia issues in the mobile market", (17 September 2020).

of those services to customers who do take them up makes it difficult to incorporate these in the billing analysis. I agree that value-added services should be taken into account when interpreting the results, as was noted in my report.

6. *Econometric benchmarking:* The choice of cut-off for the prediction intervals used in the econometric benchmarking analysis is a matter of judgement. In my view an 80% interval is a reasonable choice, but to aid interpretation I have tabulated some high-level results for different intervals. I disagree that the econometric models are too complex and are statistically unreliable. The models have a simple functional form and the method used to arrive at these models is robust in my opinion, as explained below.

7. *Including customers who switched plans:* I am not convinced that customers who switched base plans during the sample period should be excluded from the analysis. It is not proven that all such customers 'right planned' themselves and some may not have chosen the best option.

8. *Customers on shared plans:* The analysis assumed that both usage and expenditure recorded in the billing data for customers on shared plans reflected combined totals of customers in the sharing group (as requested) so that sharing groups could be treated as a single 'customer' for the purpose of analysis. If this is not the case, then it would be best to correct the billing data rather than to exclude customers on shared plans.

9. *Treatment of grandfathered plans:* The analysis included some grandfathered plans as plans that customers could switch to due to lack of information about grandfathering status of plans and the fact that this changes over time. Grandfathered plans appear to be cheaper than current plans (on average) for similar levels of usage so this may affect the estimated savings, but further analysis is needed to estimate the impact of this.

10. *Other issues:*

    10.1 Discounting: It is important for the billing analysis to reflect realistic pricing practices including discounts that lead to some customers paying less than 'headline' prices for some base plans. Incorporating these discounts in the analysis does not imply that such discounts should not be offered.

    10.2 Customers on fixed-term contracts: It may take time for such customers to realise any potential savings, but it is still useful to include them in the analysis and this does not imply that fixed contracts should be broken when new plans are introduced.

    10.3 Implications of volatile usage: The 'right planning' analysis explicitly incorporates month-to-month variation in usage over 12 months and none of the analysis involves comparing monthly average usage with base plan quotas.

    10.4 Restrictions on unlimited mobile data plans: I agree that unlimited mobile data plans with restrictions may not be viable choices for some customers but the extent of this is unknown and unlimited mobile data plans were not very common during the analysis period.

    10.5 Value of analysis of switching between prepaid and postpaid billing: Many prepaid plans have similar characteristics to postpaid plans including recurring billing and fixed usage quotas, such that many residential customers are likely to view prepaid and postpaid plans as viable alternatives. In my view it is therefore useful to analyse potential savings if customers can switch between prepaid and postpaid billing.

10.6 Lack of adjustment for switching between providers: Customers who switched providers during the analysis period were intentionally excluded from the billing sample and this should be taken into account when interpreting the results of the analysis.

Overall conclusions

11. The submissions broadly agree with the overall conclusions that some residential mobile customers may be paying too much given their usage, but the submissions argue that the proportion of customers in that category is smaller than was estimated in my report when the analysis is adjusted in various ways. Some of the suggested changes to the analysis proposed by submitters have the effect of eliminating customers who had relatively small potential dollar savings from changing their purchasing behaviour, and thus the average value of potential savings for remaining customers may increase.

12. None of the submitters appear to recognise that the 'right planning' analysis in my report was conservatively limited to customers who purchased base plans and who either used less than their plan quota in *every* month, or who used more than their plan quota in nine out of 12 months or more. This limitation was due to the analytical complexity of identifying savings for other types of customers, but it is almost certain that such customers exist, for example among those who used less than their quota in 10 or 11 months and slightly more than their quota in the other months.

13. Regardless of any other adjustments, a 'right planning' analysis for *all* customers would likely identify more customers who may be able to save by changing their purchasing behaviour than those who were identified in my report. Such an analysis was not done for all customers because selecting the optimal purchasing pattern for any given customer is complicated due to the number of pricing options in the market, the coexistence of time-based and volume-based pricing, and factors such as quota roll-over and sharing.

14. Having attempted a limited form of 'right planning' analysis for some groups of mobile customers, I agree with NERA's comments that 'right planning' for all customers in the mobile market would be more complicated to implement than in the electricity market.[23] In my view this implies that 'right planning' is also a potentially complicated exercise for an individual mobile consumer depending on their usage patterns and preferences. It is not only the existence of value-added services that makes 'right planning' complicated. To fully minimise expenditure for a given pattern of usage, it is also necessary to consider various characteristics of usage including how it varies over time, so as to make best use of features of mobile retail pricing such as quota roll-over, time-based pricing (e.g., 'data clock' type products), and discounted pricing that applies at certain times of day (e.g., weekends) or for certain types of usage (e.g., social media).

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[23] Spark "Submission on mobile bill review NERA attachment" (30 November 2020) section 3.2, page 6.

Error in the 'right planning' analysis for customers who always use less than their quota

15. Spark and NERA are correct that there is an error in the analysis of savings for customers on base plans who used less than their quota in every month (section 7.2.1 of the report).[24] This part of the analysis intentionally used the average monthly amount charged to customers for each base plan as its 'price' in order to reflect realistic features of billing such as those which Vodafone refers to in its submission as "time limited promotional offers, and those offered below the line for retention or other reasons".[25] If the analysis instead used the 'headline' price of each base plan, it would be open to the criticism that it did not account for realistic pricing practices that lead to customers on average paying less than the headline prices for some base plans.

16. However, this part of the analysis unintentionally identified potential savings for some customers who used less than their quota in every month and who met both of the following criteria:

    16.1 paid more on average per month than the overall monthly average amount paid across all customers on the same base plan; and

    16.2 where the difference between the actual average amount that they paid for their base plan and the average amount paid for that plan across all customers was greater than what the customer could save by switching to another plan that has sufficient quota for their usage.

17. I regret that this unintended outcome was not picked up earlier. NERA does not appear to report the impact of correcting this error alone, so I have estimated that by using the maximum amount paid rather than the average amount as the 'price' of each base plan (as NERA suggested). On this basis I estimate that 40% of postpaid and 59% of prepaid customers who used less than their quota in every month could save by switching to a different base plan (down from 78% of postpaid and 71% of prepaid customers who used less than their quota in every month, in the original analysis). The average savings for such customers are $18.28 for postpaid customers and $3.43 for prepaid customers (versus $11.58 for postpaid and $4.36 for prepaid in the original analysis).

18. The increase in the average for postpaid customers reflects the fact that the estimated savings are small for most of the customers who were incorrectly identified as being able to 'save' by staying on their current plan. As above, I note that using the maximum amount paid as the 'price' of each plan does not account for realistic features of billing and may underestimate potential savings.

Treatment of value-added services

19. NERA, and Vodafone argue that value-added services such as bundled media services (e.g., Spotify or Netflix) and handset discounts were not taken into account in the analysis and this could explain why customers appear to spend more than they need to, given their usage.[26] I agree this could be true for some customers, and limitations around the exclusion of value-added services were discussed in my report, including in the conclusions section.

20. However, not all customers will actually use the value-added services that are available to them, and some that do use those services may value the services at less than their standalone retail prices. Thus, while value-added services should be considered when interpreting the results of my analysis, the type of

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[24] Spark "NERA attachment" section 3.3 page 4-5; Spark "Review of Consumer mobile bills" (30 November 2020) para 24.

[25] Vodafone "Response to Open Letter: Addressing transparency and inertia issues in the mobile market" (30 November 2020) page 14.

[26] Spark "NERA attachment" Section A.1.3; Vodafone page 19.

adjustment suggested by NERA (e.g., their Figure A.5) is an upper bound of such effects as it assumes full take-up and that all customers are willing to pay at least the standalone price of value-added services. It is my understanding that while mobile operators know which customers have access to bundled value-added services, they do not know which customers have actually taken up those offers in all cases, particularly where the value-added services are provided by third parties. This limitation is why value-added services were not explicitly included in the analysis, but the existence and potential value to customers of these services should still be considered when interpreting the results.

Econometric benchmarking

Use of 80% prediction intervals

21. NERA argue that a 95% prediction interval should be used instead of an 80% interval to identify customers who are relatively high spenders given their usage in the econometric benchmarking analysis.[27] The upper limit of a prediction interval was used to identify high spenders because the econometric benchmarking models are relatively simple and only attempt to explain each customer's expenditure as a function of their usage of core mobile services. There may be legitimate reasons why two customers with the same levels of usage spend different amounts. Using the upper limit of a prediction interval is therefore a way of identifying customers whose expenditure appears to be relatively high given their usage.

22. The choice of prediction interval used in this analysis involves a trade-off between being confident that identified customers are indeed high spenders versus the magnitude of potential savings for that group. As NERA shows, using a 95% interval rather than 80% reduces the overall proportion of customers benchmarked as having high expenditure but increases the average potential savings of those customers.[28] Similarly, using a 99% interval would find even fewer high expenditure customers with even greater average savings, while using a 65% interval would have the opposite effect.

23. The prediction interval cut-off used in this analysis is a tool for identifying customers that are reasonably likely to have high expenditure given their usage, and there is no particular reason to favour the 95% interval that is often used in statistical hypothesis testing. The choice of cut-off in this analysis is a matter for judgement and in my view an 80% interval strikes a reasonable balance for identifying potentially high-spending customers. It is however useful to see how the results of the econometric benchmarking analysis vary with different cut-offs, and I have tabulated some high-level results across all customers below (the estimated dollar savings assume switching between prepaid and postpaid billing is possible).

Prediction interval cut-off	Estimated proportion of high-expenditure customers	Estimated monthly average potential savings for high-expenditure customers
65%	11.65%	$40.65
80%	7.04%	$48.65
95%	3.43%	$61.67
99%	1.97%	$71.41

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[27] Spark "NERA attachment" Section A1.4 page 10-11.

[28] Spark "NERA attachment" Section 3.2 page 3-4.

<u>Model specification and robustness</u>

24. Vodafone argues that the econometric benchmarking modes are "very complex" and "it is not clear that they represent a statistical relationship".[29] Vodafone notes that many of the estimated coefficients of the models are individually statistically insignificant at the 5% level.[30]

25. I disagree that the models are complex. The explanatory variables in the models are a set of dummy variables that reflect the percentile of each customer's relative usages of mobile data, NZ voice, and NZ SMS, within the group of customers that they are being benchmarked against. This approach was chosen in order to have a single consistent set of models that could be applied to different groups of customers and which could capture the apparent non-linear relationships between usage and expenditure in a relatively simple way. The alternative would be to fit some kind of non-linear model, which would be more difficult to estimate and explain.

26. Statistically insignificant levels of the dummy variables could have been dropped from each benchmarking model, but this would have required a large number of hypothesis tests and raises questions about 'p-hacking' (i.e., excessively fine-tuning the models in order to get statistically significant results). In my view a more robust approach is to specify a single functional form and apply this consistently to all the groups of customers in the benchmarking analysis, and then to test the overall significance of the full set of variables in each model. F-tests of joint significance indicate that the variables are highly jointly significant (at the 1% level or better) in 25 out of the 27 econometric benchmarking models.

Including customers who switched plans during the sample period

27. Spark, NERA, and Vodafone argue that customers who switched base plans during the sample period should be excluded from the analysis as it is likely that they have 'right planned' themselves by switching.[31] I agree that customers who switch plans may have done so in order to get a better deal for themselves. In addition, prepay customers in particular may choose to switch between base plans frequently in response to expected changes in their usage from month to month. However, I am not convinced that this justifies excluding such customers from the analysis. It is not proven that customers switched to a plan that was cheaper for them and it is possible that some customers did not choose the best option due to lack of complete information about their own usage and/or the complexity of pricing.

28. NERA show that high expenditure customers are more likely to have switched base plans during the sample period than all customers in the sample (their figure A.7). This difference seems to be greater for prepaid customers than for postpaid,[32] which is consistent with prepaid customers changing base plans in response to expected changes in usage. I note that the analysis of switching counts any change to a customer's quota allocations on Vodafone's "MyFlex" prepaid plans as a plan switch, which may help to explain this difference.

Treatment of customers on shared plans

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[29] Vodafone, page 16-17.

[30] Vodafone, page 17. Note this is expressed in their submission as "do not pass a standard 95th percentile significant test".

[31] Spark "NERA attachment" Section 3 page 4; Vodafone, page 13; Spark, page 2.

[32] Using NERA's figures, the proportion of high-expenditure prepaid customers who switched plans at least once during the year is 40.4% versus 28.1% for all prepaid customers. The equivalent figures for postpaid customers are 46.7% and 43.3%.

29. NERA and Vodafone claim that including customers on shared quota base plans in the analysis biases the results because expenditure of customers on shared plans reflects the total across all customers in the sharing group, but usage only reflects that of the primary account holder. NERA and Vodafone argue that customers on shared quota base plans should be excluded from the analysis.[33]

30. The billing data request sent to mobile operators asked that both usage and expenditure for customers on shared quota plans reflect the combined total of all customers in the group, so that a sharing group could be treated as a single 'customer' for the purpose of analysis. If this is not the case and if expenditure reflects the whole group while usage only reflects the account holder then I agree that this could make customers on shared quota plans appear to have high expenditure given their usage. In my view the best way to resolve this issue is to correct the billing data so that usage reflects the combined total for all customers in groups on shared quota plans, rather than to exclude such customers from the analysis.

Treatment of grandfathered plans

31. NERA and Vodafone observe that the analysis includes grandfathered plans as plans that customers could potentially switch to.[34] This is correct and was due to lack of information about the grandfathering status of plans and the fact that grandfathering status of base plans evolves over time. Section 7.2.3 of the report implements a method for inferring the grandfathering status of plans from purchasing patterns, but this is likely to be imperfect and does not allow for changes in grandfathering over time.

32. The analysis in section 7.2.3 of the report suggests that customers on grandfathered base plans would on average have to spend more to switch to a current plan that accommodates their usage. This means that potential savings may be smaller if grandfathered plans are excluded, but further analysis is needed to determine the impact. It also raises a question of why current plans appear to be more expensive than grandfathered plans (on average). One possibility is if current plans offer more value-added services than grandfathered plans, but this would need to be tested.

Other issues

Treatment of discounts

33. Vodafone argues that discounts have been treated incorrectly as estimates of potential savings are based on amounts actually charged to customers (rather than 'headline' prices) which incorporate "time limited promotional offers, and those offered below the line for retention or other reasons"[35]. As discussed above, this was done intentionally to reflect realistic pricing practices. It appears that some customers do pay less than 'headline' prices for some products and, in my view, it is important for the billing analysis to reflect this.

34. I disagree with Vodafone's claim that including discounts in the analysis is equivalent to saying that mobile operators should offer no discounts "so as to ensure all customers are paying the same amount for the same service"[36]. All of the expenditure estimates in the analysis are averages across groups of customers, and within these groups there could be customers who pay amounts that differ from the average due to discounting.

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[33] Vodafone, page 13-14. Spark "NERA attachment" Sections A2.1. and B2, pages 12 and 20.

[34] Vodafone, page 17.

[35] Vodafone, page 14.

[36] Vodafone, page 14.

<u>Inclusion of customers on fixed-term contracts</u>

35. Vodafone argues that customers on fixed-term contracts should not be included in the analysis because they are not able to immediately switch to an alternative plan.[37] In my view it is still useful and reasonable to include these customers in order to estimate potential savings across all customers. For customers on fixed-term contracts, it may take one or two years for them to be able to realise any savings by switching plans, but the potential savings still exist. I disagree that this implies that fixed term contracts should be broken when new plans are introduced. In my view, it just means that some potential savings may take time to be achieved.

<u>Implications of volatile usage</u>

36. Vodafone argues that the analysis is susceptible to volatility in customers' monthly usage.[38] I agree that volatility of usage is high for some customers, but this does not affect the analysis in the way that Vodafone suggests. In the 'right planning' analysis, the actual usage of each customer in each of 12 months (not average usage across those months) was compared to the customer's plan quotas in that month, thus month-to-month volatility of usage is explicitly taken into account in the 'right planning' analysis. The econometric analysis uses monthly average usage for each customer over 12 months to benchmark their expenditure against other customers with similar monthly average usage levels, but this does not involve a comparison of those averages against plan quotas.

<u>Restrictions on unlimited plans</u>

37. Vodafone points out that some of its 'unlimited' mobile data plans included restrictions such as no tethering and 'soft' data caps that were reflected in lower pricing, and Vodafone argues that these plans may not be viable alternatives for some customers due to the restrictions.[39] I agree this may be true for some customers, but it is not possible to know how many customers can accept the restrictions or not, or what they would be willing to pay for an unrestricted plan. Given that unlimited mobile data plans were relatively uncommon in the market at the time when the billing sample was extracted, this may not be a material issue. It may be a more important issue if the analysis is repeated with more recent billing data.

<u>Value of the analysis of switching between postpaid and prepaid billing</u>

38. Vodafone argues that there is little value in comparing postpaid and prepaid billing as it ignores additional value provided to postpaid customers in the form of value-added services and billing certainty.[40] As discussed above, in my view value-added services should be taken into account in the interpretation of the analysis, and billing certainty could be considered as another type of value-added service of postpaid billing.

39. I disagree that there is little point to compare expenditure under postpaid and prepaid billing. Many prepaid base plans have similar characteristics to postpaid, offering fixed quotas and recurring monthly charges, except that prepaid plans are paid in advance rather than afterwards. Prepaid billing also has a

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[37] Vodafone, page 18.

[38] Vodafone, page 15,16.

[39] Vodafone, page 18.

[40] Vodafone, page 20.

relative advantage that it is easier to change base plans from month to month to accommodate variable usage. Given that the analysis focused on residential customers (rather than business customers), in my view it is reasonable to assume that many customers do have the option to choose between postpaid and prepaid billing.

Lack of adjustment for switching between providers

40. Vodafone notes that the analysis does not account for customers who switched between providers during the sample period.[41] This is correct and such customers were intentionally excluded from the billing sample so that 12 months of usage over the same period of time could be observed for every customer in the sample. This limitation was noted in the report and should be taken into account when interpreting the results.

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[41] Vodafone, page 20.