Appendix G: Quality and innovation

G.1 This appendix describes the evidence we have received from cloud providers in relation to quality and innovation.

Evidence on quality

G.2 We have gathered information and data from cloud providers on the metrics they use to measure the quality of their services internally. We aimed to understand what metrics are relevant to each provider and the extent to which internal measures of quality of have changed over time.

G.3 The information provided covers three main metrics:

(a) Quality assurance,

(b) customer satisfaction; and

(c) software updates.

G.4 The type of data differed across providers and this limits its comparability across them. In addition, there is no clear way for us to evaluate the significance of these metrics and levels, and there is only limited contextual evidence (eg customer evidence) that helps us interpret the measures submitted by cloud providers in absence of a yardstick. In addition, most of the data covered a short time period. For these reasons, we were generally not able to assess levels or trends in a meaningful way.

Product quality assurance metrics

G.5 We requested data on any internal metrics used for quality assurance of each provider's 20 most popular cloud services by revenue.

G.6 Responses varied by provider. For example,[1] some providers submitted data at an individual cloud service level, and other providers submitted data based on metrics across providers while Microsoft did not provide any performance metrics.

G.7 These metrics generally related to availability or the number and severity of incidents with cloud services.

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[1] Microsoft said that it does not have specific performance metrics for its most popular cloud services by revenue. Microsoft said the key metric used to monitor performance is revenue, but that it also considers metrics such as availability and latency. Microsoft's response to the CMA's information request [✂].

(a) AWS said that its performance metrics vary greatly by service, with any one service producing [✂] of data points that could be used to measure performance.[2] It provided an example of three metrics, relating to availability and latency, which are used to assess the performance of AWS Route 53, a domain name system used to route end users to internet applications. The data provided for these example metrics showed that [✂].[3]

(b) Google said that it uses no centralised performance metrics across all of its services, but that each of its product teams monitors the performance of the service they manage according to the technical features they consider are most important to customers and that these vary greatly between services.[4]

(c) Google said that it relies on certain availability metrics, which it said are distinct from performances metrics, to measure the reliability of all of its cloud services and it submitted information and data on one such metric, the [✂]. This metric estimates the overall business impact of a set of reliability events. Google calculated this metric by analysing [✂] and [✂] and then [✂]. Google supplied this monthly data on [✂] over the period January 2021 to November 2023 for its top 20 cloud services by revenue on aggregate. This data showed that [✂] – although it is not clear what an appropriate benchmark is.[5]

(d) [✂].[6] The [✂] to allow us to observe any trends with confidence and as elsewhere there is not [✂] for us to assess whether it is high or low.

(e) IBM submitted data based on a metric used across all of its cloud services: Customer Impact Events (CIEs). This metric measures unplanned disruptions or degradation of services, in each year over 2019 to 2023. CIEs are segmented into two categories depending on severity.[7] The data provided shows that [✂].[8] This data suggests that the provider has improved the quality of its service over time by reducing the number of events that impact customer experience over time.

Cloud service customer satisfaction metrics

G.8 We requested data on any internal metrics for quality assurance of customer service or systems for dealing with customer requests and complaints.

[2] AWS' response to the CMA's information request [✂].
[3] AWS' response to the CMA's information request [✂].
[4] Google's response to the CMA's information request [✂].
[5] Google's response to the CMA's information request [✂].
[6] [✂] response to the CMA's information request [✂].
[7] [✂].
[8] IBM's response to the CMA's information request [✂].

G.9 The response varied by provider. Microsoft and IBM did not provide any data related to KPIs or performance metrics related to customer queries or complaints and/or general customer service customer satisfaction metrics.[9] Other providers submitted data relating to customer satisfaction, but the nature of data provided differs across providers.

(a) AWS provided annual figures for its customer satisfaction metric for interactions with customers in the English language (which means data provided would also cover non-UK customers).[10] The data provided shows that customer satisfaction with respect to AWS [✂].[11]

(b) Google provided monthly data on the average number of cases opened per active Google Cloud Platform customer over the period January 2022 to September 2023. 'Cases' are defined as when a customer contacts Google to raise an issue with one of its cloud services. Google uses this metric to monitor the ability of its services to deliver against customer expectations.[12] For the short period covered [✂].

(c) [✂] said that in the period from November 2022 to November 2023[13] its 'service response customer satisfaction' level was at [✂] in this period.[14] However, as with others it is not clear what an appropriate benchmark is.

Number and purpose of software updates

G.10 We also requested data on the number and purpose of software updates that each cloud provider implemented in each year since 2018. Specifically, how many updates were made to fix bugs and technical difficulties versus updates to improve or add new features of services. This was to observe the extent to which providers are working to maintain and improve the quality of their cloud services.

G.11 Only two providers were able to submit data on the number of software updates.[15]

(a) Google submitted data showing the number of updates made to each of its top 16 services by revenue over the years 2018-2022 segmented into (i) updates to fix bugs or technical issues, (ii) updates to improve or add new features, and (iii) other updates. The data provided generally shows a positive trend over time in the number of updates made with significantly

[9] Microsoft said that customer feedback is monitored by individual product teams, but it does not systematically record any quality assurance metrics in relation to responses to customer complaints or queries. [✂]; Microsoft's response to the CMA's information request [✂]; IBM's response to the CMA's information request [✂].
[10] [✂].
[11] AWS response to the CMA's information request [✂].
[12] Google's response to the CMA's information request [✂].
[13] [✂] response to the CMA's information request [✂].
[14] [✂] response to the CMA's information request [✂].
[15] [✂] [✂] response to the CMA's information request [✂].

more updates being made to improve services or add new features compared with updates to fix bugs or technical issues.[16]

(b) Microsoft submitted data on the number of software updates that it made to each of its top 20 services by revenue over the period 2018 to 2022. However, this data covered all updates (including both bug fixes and feature additions or improvements) rather than being segmented by type. The data provided generally shows the number of updates increasing over time.[17]

Evidence on innovation and range

G.12 We have gathered data from providers related to levels of innovation. This was to understand the extent to which large providers are continuing to innovate at a similar rate over time and whether large providers appear to be innovating more or less than smaller providers.

G.13 The information provided covers three main metrics:

(a) The number of new services, uptake and features of services launched,

(b) The number of patents and patent citations received

(c) Levels of investment in R&D.

G.14 Overall, the nature of the data provided differs across providers and this limits its comparability across providers. In addition, the lack of clear benchmarks against which we could compare each metric, together with the short time period covered by most of the data provided, means we were generally not able to assess levels or trends in a meaningful way.

G.15 Before assessing the information we have gathered, we present a submission made by Microsoft in relation to innovation spend.

Microsoft's submission on innovation

G.16 Microsoft submitted some analysis of innovation in cloud services. Microsoft said that the submission provided evidence of the customer benefits that have been brought about by cloud technology in terms of performance, reliability, scalability and security.[18]

G.17 Microsoft's submission covered three areas:[19]

[16] Google's response to the CMA's information request [✂].
[17] Microsoft's response to the CMA's information request [✂].
[18] Microsoft's submission to CMA [✂].
[19] Microsoft's submission to CMA [✂].

(a) R&D and capital expenditure: Microsoft said that the three main cloud providers have invested significant capital expenditure and R&D in the cloud. Microsoft said its own R&D and capital expenditure had increased since its launch of Azure.

(b) Product innovation: Microsoft said that cloud providers are constantly developing new products and features across the entire cloud stack (IaaS and PaaS) and are at the forefront of cutting-edge technologies such as Machine Learning and Artificial Intelligence.

(c) Infrastructure innovation: Microsoft said that it has invested and continues to invest in expanding the capacity of its data centres, improving resource utilisation, and improving the security and reliability of its services.

G.18 We acknowledge that cloud providers are investing in R&D and capital expenditure such as new data centres. However, we note that:

(a) The evidence we have reviewed represents the short-term outcomes of the competitive process rather than the long-term outcomes. As such there may be limitations on the extent to which they can inform us about the long-term state of competition in this market.

(b) There is no clear way for us to evaluate the significance of existing levels of innovation and limited contextual evidence to assist us in doing so absent a yardstick – see the section on Market outcomes in chapter 3.

(c) There appear to be caveats to some of the analysis provided. For example:

(i) The data on R&D and capital expenditure is not specific to cloud services.

(ii) Some of the trends observed, for example, in capital expenditure are consistent with a market that is expanding and requires significant upfront investments. This may not represent direct evidence of the competitive process.

(i) We do not consider some of the benchmarks used are correct such as comparing data centre utilisation rates with on-premises solutions. In particular, that public cloud data centres have higher utilisation rates than on-premises solutions does not show that competition is working well between public cloud providers.

Number and uptake of new cloud services and features of services

G.19 We requested data on the number of new services and features of services launched in each year since 2018 and the uptake or popularity of these new services and features.

G.20 We note that the absolute number of new services/features does not capture that new services/features will vary in their importance so there are limitations to any comparison and there is no clear benchmark for the number of new features/services that may be expected in well-functioning cloud services markets.

G.21 Five providers submitted data on the number of new services:

(a) Microsoft submitted data showing it had launched between [✂] new services each year between 2018 and 2022.[20]

(b) AWS submitted data showing it had launched [✂] new cloud services in 2018 and this had decreased over time to [✂] in 2022.[21]

(c) Google submitted data showing it had launched on average [✂] new services each year between 2018 and 2022.[22]

(d) Oracle submitted data showing the number of SKUs it launched was at a high of [✂] cloud services in 2019 and then between [✂] for each year between 2020 and 2023.[23]

(e) IBM submitted data that showed the number of cloud services launched per year decreased from [✂] in 2019 to [✂] in 2023.[24]

G.22 We took a cautious approach to comparing these numbers as the differences in the products and services introduced might make the figures presented above difficult to compare across providers.

G.23 Microsoft and AWS also submitted data on the uptake of new services. In both cases this showed a generally low uptake of most new services:

(a) Microsoft data shows that across all products launched over the period 2018 to 2022 on average [✂]% of customers were using them in 2022. For services that had been launched in 2020 or earlier, the average percentage of customers that used these in 2022 was still low at [✂]%. However, there are a small number of services [✂] for which usage has increased to more

[20] For the purposes of this submission, Microsoft defined newly launched products as [✂]. Microsoft response to the CMA's information request [✂].
[21] AWS' response to the CMA's information request [✂].
[22] Google's response to the CMA's information request [✂].
[23] Oracle's response to the CMA's information request [✂].
[24] IBM's response to the CMA's information request [✂].

than [✂]% of customers by 2022 and a small number of services [✂] that were among the top 50 services by revenue in 2022.[25]

(b) AWS data shows that across all products launched over the period 2018 to 2022 on average [✂] of customers were using them in 2022. For services that had been launched in 2020 or earlier, the average percentage of customers that used these in 2022 was still low at [✂]%. However, there are a small number of services [✂] for which usage has increased to more than [✂]% of customers by 2022 and a small number [✂] that were among the top [✂] services by revenue in 2022.[26]

G.24 Finally, four providers submitted data on the number of new features launched:

(a) Microsoft data showed that the total number of new features launched each year fluctuated between [✂] and [✂] between 2018 and 2021 before increasing significantly to [✂]in 2022.[27]

(b) AWS data showed an upward trend with the number of new features increasing from [✂] in 2018 to [✂] in 2022.[28]

(c) Google data showed an upward trend with the number of new features increasing from [✂] in 2018 to [✂] in 2022.[29]

(d) IBM data showed that number of new features launched increased from [✂] in 2019 to [✂] in 2021 before decreasing to [✂] in 2023.[30]

G.25 This data shows that generally providers are launching a varying number of new features each year. However, as noted above this is based on absolute numbers and therefore does not take into account the nature of the new features.

Patents and patent citations

G.26 We requested data on the number of patents and patent citations received in relation to new cloud services or features of services in each year since 2018.

G.27 AWS, Microsoft, Google and Oracle submitted data on the number of patents.[31] This data was not provided on a consistent basis with some providing just UK patents (not particularly relevant if innovation occurs at a more international level), some US patents and some all patents globally. More generally looking at the

[25] Microsoft response to the CMA's information request issued [✂].
[26] AWS' response to the CMA's information request [✂].
[27] The data was based on a web scrape of its updates blog to provide a proxy measure of the number of new features of cloud services that it introduced in each year since 2018.Microsoft's response to the CMA's information request [✂].
[28] AWS' response to the CMA's information request [✂].
[29] Google's response to the CMA's information request [✂].
[30] IBM's response to the CMA's information request [✂].
[31] [✂]. Responses to the CMA's information requests [✂].

absolute number of patents does not capture variations in importance between patents so there are limitations to any comparison and there is no clear benchmark for the number of patents that may be expected in a well-functioning market.

G.28 This data shows that:

(a) Between 2018 and 2023, AWS had [✂]. The number of patents per year fluctuated over time with no clear trend.[32]

(b) Between 2018 and 2022, Microsoft had 1,211 patent families[33] across the world relating to cloud services accounting for 21,313 patent citations. The number of patent families per year initially increased before declining. Overall there were 1,998 US patents relating to cloud services within the data provided.[34]

(c) Between 2018 and 2022, Google had 939 US patents relating to cloud services accounting for 1,984 patent citations. The number of patents per year fluctuated over time with no clear trend. In the UK, Google had 261 patents over this period.[35]

(d) Between 2018 and 2023, Oracle had eight UK patents relating to the OCI product group.[36]

G.29 We take a cautious approach to comparing these numbers as the differences in the underlying patents might make the figures presented above difficult to compare across providers.

R&D Investment

G.30 We requested data on the levels of investment in R&D aimed specifically at developing new cloud infrastructure, cloud services, features of services and other improvements to cloud services each year since 2018.

G.31 AWS and Microsoft were not able to provide data on R&D investment that was specific to their cloud services.

(a) Microsoft said that there have been some preliminary efforts within Microsoft to identify R&D costs for Azure on a standalone basis, but these have not

[32] There were [✂] patents in 2018, increasing to [✂] in 2019 and then varied between [✂] and [✂]. AWS' response to the CMA's information request [✂].
[33] Patent families are a group of patent applications covering similar technical content.
[34] There were [✂] patents in 2018 and increased to [✂] in 2019 before falling to [✂] in 2022. Microsoft's response to the CMA's information request [✂].
[35] The number of patents per year fluctuated between [✂] in 2021 and [✂] in 2022. Google's response to the CMA's information request issued [✂].
[36] Oracle's response to the CMA's information request [✂].

been fully finalised and are not reported to or used by the business to inform decisions.[37] We note that Microsoft did provide a separate submission on innovation which included figures on R&D, but these are not specific to its cloud services.[38]

(b) AWS said [✂].[39]

G.32 Google, Oracle and IBM provided data on R&D investment:

(a) Google submitted data showing it has increased its investment in R&D in Google Cloud from $[✂] in 2020 to $[✂] in 2022.[40]

(b) Oracle submitted data showing that its investment in R&D in cloud services has increased significantly from $[✂] in 2019 to $[✂] in 2020, before declining to $[✂] and $[✂] in 2021 and 2022 respectively.[41]

(c) IBM submitted data showing that its investment in R&D in cloud services has increased from $[✂] in 2019 to $[✂] in 2022.[42]

G.33 Across these three providers it can be seen that, in absolute terms, [✂] invests significantly more in R&D in cloud services than both [✂] and [✂], and [✂] also invests significantly more than [✂] in absolute terms. Nonetheless, we take a cautious approach to the interpretation of these data as we recognise that what is defined as R&D spend may differ across providers. Therefore, a direct comparison across providers may not be accurate.

[37] Microsoft response to the CMA's information request [✂].
[38] Microsoft response to the CMA's information request [✂].
[39] AWS' response to the CMA's information request [✂].
[40] Google said that this was done by aggregating all costs across [✂] teams and then classifying them into 'R&D costs' and 'other costs' based on the US GAAP accounting rules. Google said that these costs are reported for [✂] as a whole and not broken down into investment into infrastructure, services, features, etc. [✂] response to the CMA's information request [✂].
[41] Oracle's response to the CMA's information request [✂].
[42] IBM's response to the CMA's information request [✂].