Misunderstood Until Now, DAU MAU

Non-Financial Metrics, DAU, MAU, and DAU/MAU: An Integrative Framework and Analysis

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Abstract

This thesis proposes a framework for classifying various applications of daily active users (DAUs), monthly active users (MAUs), and their ratio (DAU/MAU) to evaluate company performance. The metrics are reported widely in financial filings across a number of industries, including social media and gaming, and are thus frequently cited in equity research. As a result, investors rely on these non-financial metrics to guide investment decisions, highlighting the importance of the metrics in investing and evaluating companies. However, there is a general lack of understanding regarding how to interpret such metrics, evidenced by the fact that there is very little published research about the topic. Perhaps due to the opaque definitions and interpretations of such metrics, there have been numerous litigations initiated by shareholders, arguing that omitting DAU and MAU metrics from financial filings is concealing material information. To address the discrepancy between the significance of DAUs, MAUs, and the DAU/MAU ratio in finance and the lack of understanding of the metrics, my thesis proposes an organizational framework that classifies various applications of DAU, MAU, and the DAU/MAU ratio to help improve investor understanding of the metrics, comment on potential ways to improve reporting standards for non-financial metrics, and clarify their role in litigation.

Abstract	1
Introduction	3
Institutional Background	5
Historical Background	5
Uses and Applications of DAU, MAU, and DAU/MAU	7
Reporting	8
Use Cases	9
Investor Reports / Equity Research	9
Litigation	11
Measurement	12
Measurement Discrepancies Across Companies and Industries	12
Measurement Manipulation	13
Methods: A Framework for Interpreting DAU, MAU, and DAU/MAU	15
I: Revenue Model	16
I.1: Subscription-based revenue model	16
I.2: Advertisement-based revenue model	17
I.3: Transaction-based revenue model	18
II: Seasonality	19
II.1: Constant Usage	19
II.2: Irregular usage	20
III: Intended Frequency of Use	21
III.1: Intended daily use	21
III.2: Less frequent usage pattern	22
IV: Product Life Cycle & Changing Consumer Cohorts Over Time	23
IV.1: Recent Launch and Growth	23
Intra-cohort dynamics	24
Cross-cohort dynamics	25
IV.2: Maturity and Stabilization	26
Discussion	26
Conclusion	27
Bibliography	29

Introduction

Many notable companies report a set of non-financial metrics, including daily active users (DAUs), monthly active users (MAUs), and their ratio (the DAU/MAU ratio) in various financial filings to provide a more holistic image of the company. Generally speaking, DAUs and MAUs represent the number of unique users who are active on an application or website platform each day and each month, respectively. DAUs, MAUs, and the DAU/MAU ratio are widely reported and cited by analysts across a number of industries, including: internet platforms (e.g. Autohome, Revolve, Baidu), software (e.g. Twilio, Uber, Netflix, Hulu, Amazon), and gaming platforms (e.g. Activision Blizzard, Zynga). These non-financial metrics are not audited and are not subject to standardized measurement, making the comparability of such metrics complex and difficult. Additionally, the interpretation of DAUs, MAUs, and the DAU/MAU ratio are opaque at best, but the definition and application of such non-financial metrics are extremely relevant as a number of astronomical valuations of many companies are supported by such metrics, rather than traditional profitability metrics.

To address the discrepancy between the significance of DAUs, MAUs, and the DAU/MAU ratio in finance and the lack of understanding of the metrics, my thesis will answer the research question: how should non-financial metrics, DAUs, MAUs, and the DAU/MAU ratio, be formally interpreted in various marketing and finance settings? My thesis proposes a framework that summarizes and synthesizes the existing literature, and classifies applications of DAUs, MAUs, and the DAU/MAU ratio along a few dimensions. The contribution of my thesis is twofold: 1) it provides investors with a better understanding of the meaning and limitations of DAUs, MAUs, and the DAU/MAU, and 2) it highlights issues in the current reporting of these non-financial metrics which could potentially help regulatory bodies improve reporting standards for financial filings and thus clarify the role of these metrics in litigations.

Despite the lack of consistent and robust research about the topic, the interpretation of DAUs, MAUs, and the DAU/MAU ratio is of interest to investors, who often rely on such metrics to guide investment decisions. Across equity research, analysts cite DAUs, MAUs, and DAU/MAU ratio trends to guide price targets, especially for early stage technology companies that may not have achieved profitability, tracing the metrics across time and drawing conclusions relating to user base growth and engagement. However, despite the casual use of the metrics, the definition is opaque and is rarely defined beyond company-specific financial filings. Ultimately, a deeper understanding of DAUs, MAUs, and the DAU/MAU ratio across businesses and industries will help investors better understand valuations of companies that report such non-financial metrics, which could help them choose higher return investments and deliver liquidity to high-quality companies with truly strong growth prospects.

Moreover, my thesis highlights several issues about the inadequacy of existing reporting guidelines for non-financial metrics like DAUs, MAUs, and the DAU/MAU ratio, and thus the topic is of interest to regulatory bodies. Despite the large role of non-financial metrics in valuation, there is very little regulation with respect to the reporting of non-financial metrics, with the exception of ESG and sustainability accounting standards, which may be due to the nascent understanding of these metrics and the materiality to investors. The absence of regulation has given rise to a number of shareholder lawsuits, with investors arguing that the lack of disclosure of DAUs and MAUs, among many other non-financial metrics, conceals material information. My thesis project aids in the understanding of how the reporting of such

non-financial metrics fits in with the external reporting objectives defined by SEC, which will clarify the role of non-financial metrics in litigation.

The Institutional Background section of this paper provides an overview of the topic, including how DAUs, MAUs, and the DAU/MAU ratio became popularized, the metrics' use cases, and measurement issues. The Methods section details a proposed organizational framework for summarizing the literature and classifying various applications of the metrics. Based on the framework and literature review, I conclude by offering some observations and recommendations for future avenues of research.

Institutional Background

Historical Background

The concept of an active user is not new, as companies have always been concerned with measuring and understanding their consumer base, which is composed of their active customers. Since organizations were invented, they have kept lists that include their former "customers" (Schmittlein, Morrison, and Colombo 1987). For example, dentists and beauty salons keep files of their customers and churches keep directories of their attendees.

Active users in the context of the web were first discussed by Trueman and Wong in their paper, *The Eyeballs Have It: Searching for the Value in Internet Stocks*, published in January 2000. The paper focuses on the valuation of internet stocks, such as Yahoo!, eBay, and Amazon, and ties the value of an internet business with internet usage data from Media Matrix, which is a web rating company, including monthly unique users that interact with the website. Through a regression analysis, the authors find that "both unique visitors and pageviews... in general provide significant incremental explanatory power for stock prices." which shows the correlation between MAUs and company valuation (Trueman and Wong 2000).

However, the concept of *daily and monthly* active users did not take off in popularity until around 2004. From a search of "daily active users" and "monthly active users," the first reference to my knowledge of the concepts of DAUs and MAUs was in a TelevisionWeek article published in April 2004 about WeatherBug, a desktop temperature and weather application for AOL's instant messaging service (Whitney 2004). The article states:

"Of the 32 million who have downloaded the application, about 15 million are monthly active users, said Andy Jedynak, senior VP of WeatherBug, consumer division... [WeatherBug is] the top online weather property as measured by daily visitors... according to data from Com Score Media Metrix, the WeatherBug application averaged 4.9 million daily visitors in January."

This suggests that WeatherBug was using daily visitors (DAUs) and monthly active users as benchmarks of success, stating that the application was the top weather application by DAUs. However, because digital media measurement companies have been around for a while (Nielsen began television measurement in 1950), it is plausible that DAUs and MAUs were measured since the inception of such measurement companies, but were not formally published or discussed in the press until around the early 2000s.

Facebook was founded around the same time in February 2004, and the company published a "media kit" in April 2004, shown in *Figure 1* (Marshall 2017). The media kit cited Facebook's daily active users and monthly active users to show the "addictiveness" of the platform. However, other popular social media companies at the time, notably MySpace, did not publish or discuss their DAU and MAU metrics, suggesting that Facebook was one of the first companies to disclose and popularize such non-financial metrics.



Figure 1: Facebook's 2004 "Media Kit"

Moreover, the DAU/MAU ratio emerged with the increasing popularity of social-network games around 2009, which followed the increasing adoption of social media sites like MySpace and Facebook in the early 2000s. *Happy Farm*, one of Facebook's first social games developed by Five Minutes, was released in late 2008, reporting 23 million DAUs at the height of its popularity (Millward 2012). *Farmville*, one of Zynga's most well-known social games, launched on Facebook in 2009 and boasted 34.5 million DAUs at its peak (Takahashi 2011). With the increasing popularity of social games, the DAU/MAU ratio emerged as a key metric in determining the popularity and potential of a social game (Stark 2010). Since social games, other consumer apps began being judged by the DAU/MAU ratio, which is now known as a popular metric for "user engagement."

Uses Cases of DAU, MAU, and DAU/MAU

Non-financial performance metrics, such as customer loyalty and employee satisfaction, are believed to reflect intangible value and contribute to overall profitability. As a result, DAUs, MAUs, and the DAU/MAU ratio are reported by a number of companies as a non-financial key performance indicator, and, as a result, the uses of such non-financial metrics span the press, investor reports, and litigations.

Reporting

Across financial filings, DAUs and MAUs are reported abundantly in a few industries, including internet, software, media, and gaming, showing that the metrics are highly relevant in such industries and investors use them in their analyses. Across internet platforms, such as Revolve Group, many companies rely on a transaction-based revenue structure to generate cash flows, and thus DAUs and MAUs are commonly reported metrics to capture high-level information about customer base size and market penetration, which translates to revenue generation. Internet platforms frequently cite MAUs as a key indicator of growth, as the number is directly tied to net sales. In the media space, both social media and traditional media companies, such as Twitter and NYTimes, report an active user metric to evaluate the scale and size of their audience, though the significance of such metrics varies based on revenue model. Many software and internet content companies, like Netflix and Twilio, report an active use metric as an indicator of market size and market penetration. Lastly, the active user metric is highly cited across a number of game developers to measure the size of their audience broadly. Across these industries, the relationship between DAUs and MAUs and revenue generation is a bit more ambiguous in some than others, and ultimately boils down to the company's interactions with the customers.

Use Cases

As a number of companies across various industries report DAUs and MAUs, the discussion and application of such metrics are cited across investor reports and litigations.

1) Investor Reports / Equity Research

Many companies rely on DAUs and MAUs as non-financial KPIs, and thus investors also use such metrics in their analyses of company performance. Companies that generate revenues from showing their consumers advertisements generally place the most emphasis on DAUs and MAUs, and hence many equity research reports also pay close attention to their active user trends. Equity research reports often compute a price target, which is an analyst's projection of a security's fair price, and offer a buy, sell, or hold recommendation for the security. In constructing a financial model for companies that report DAUs and MAUs, one possible starting place of an earnings model is the active user forecast, representing a "bottom-up" approach, shown in *Figure 2*. This particular earnings model that uses the active user count to forecast revenue is popular in social media companies. In sum, equity research integrates active user counts and trends when determining price targets and stock recommendations.

	2016A	2017E	2018E	2019E	2020E	2021E	2022E	2023E	2024E	2025E
Daily Active Users	158.0	191.7	223.8	252.2	281.2	307.5	331.8	356.8	382.6	404.7
Average Time Spent per Day, in minutes	26.3	28.8	29.5	30.3	31.0	31.8	32.6	33.4	34.2	35.1
Total Hours Spent	22023.9	30641.8	37142.0	43690.6	50183.6	56779.7	63202.3	69779.0	76808.1	83834.4
Implied Cost to Serve a Billion Hours	15.5	17.8	18.4	18.4	18.4	18.4	18.4	18.4	18.4	18.4
Total Infrastructure Costs	341.9	545.5	684.8	805.6	925.3	1046.9	1165.3	1286.6	1416.2	1545.8
Spectacles Cost of Goods Sold	5.2	48.6	35.8	38.7	39.9	39.2	36.5	33.4	29.8	26.6
Content Measurement and Creation Cost	43.3	93.8	166.1	235.5	321.8	408.8	501.9	594.2	680.4	756.1
Partner Revenue Share	57.8	124.7	223.9	332.4	466.6	609.5	739.7	864.1	974.3	1063.7
Stock Based Compensation	0.5	52.4	1.9	2.8	3.8	4.7	5.5	6.2	6.7	6.9
Depreciation and Amortization	2.9	4.9	5.7	6.8	6.2	7.7	9.4	11.1	12.9	14.7
Total Cost of Goods Sold	451.7	869.9	1118.2	1421.8	1763.6	2116.8	2458.3	2795.7	3120.3	3413.7

USD in millions, unless otherwise stated

Source: Company data, Credit Suisse estimates.

Figure 2: Credit Suisse Cost of Revenue Assumptions for Snap Inc.

To understand the extent to which investors utilize DAUs and MAUs to make investment decisions, consider Facebook parent Meta's \$251bn equity wipeout in the beginning of 2022. The stock price drop was primarily in response to Facebook reporting that their DAU figure fell in 1Q2022 compared to 1Q2021, in addition to added costs due to Apple operating system changes that now prevent ad-tracking (Adinarayan and Barnet 2022). The sheer size of the stock's collapse illustrates how much weight investors place on DAU and MAU growth figures, as well as how much market power Facebook has been able to amass through strong active user growth trends over the past few years. However, Meta's sharp stock price decline calls into question whether or not Facebook's historical growth levels are truly sustainable. One could argue that it is not exactly surprising that DAUs stopped growing, as the number of people in the population with Internet and device access in developed countries is reaching a saturation point, which signals that Facebook may not be in its growth phase anymore (Weitz and Rosenthal 2022).

2) Litigation

Due to a lack of standardization with respect to reporting, there have been a number of lawsuits about the lack of reporting of DAUs and MAUs and the ambiguity of such metrics. In 2016, Twitter faced a class action lawsuit, *Twitter vs. Shenwick*, regarding Twitter's reporting of the platform's active user metrics, which highlights the uncertainty of what exactly these metrics imply about a company's finances and customer base health. The plaintiffs alleged that Twitter effectively misled investors by failing to report Twitter's DAUs and DAU/MAU ratio in the period leading up to Twitter's stock price decline in 2016 (Kellaher 2021). The plaintiffs stated that Twitter investors suffered economic losses when Twitter's stock price plummeted roughly 50% in 2016, revealing issues with user engagement and user growth, which the defendants had supposedly concealed by not reporting DAUs and the DAU/MAU ratio.

Twitter vs. Shenwick is part of a broader discussion about whether DAUs and the DAU/MAU ratio represent material information to investors, and whether or not there ought to be regulations in place regarding the mandatory disclosure of active user metrics. In September 2021, Twitter decided to use cash on hand to pay a settlement of \$809.5 million, showing the large monetary loss Twitter faced as a result of the ambiguities relating to DAU and MAU reporting (Ortutay 2021). Overall, because of the vague reporting standards regarding DAUs and MAUs and a general lack of understanding about what these metrics imply, a number of lawsuits have been filed against companies regarding the materiality of such information, often leading to significant company losses for settlements.

Measurement

There is a lack of standardization when it comes to the measurement of DAUs and MAUs, causing the comparability of such metrics across companies to be difficult and complex. This lack of standardization and comparability can arise from two sources: 1) discrepancies across industries and businesses regarding the definition of such metrics, and 2) the easy manipulation of such metrics.

Measurement Discrepancies Across Companies and Industries

One key discrepancy in the measurement of active user metrics stems from differences in industry and business models, which leads to variations in the definition of what constitutes a daily active user and monthly active user. For example, Revolve Group, a fashion retailer, calculates the number of active users to be those who have made a purchase in the last 12-months. In this case, the company's definition of an active user is simplistic and easy to measure due to the nature of the platform that is based on transactions which is an observable behavior. However, when considering a company like Twitter, a social media company that relies on customer interactions with advertisements to generate revenue, their definition and measurement of active users is very different. Rather than rooting the measurement in something directly related to revenues like transactions in the case of Revolve, Twitter bases its active user counts off of log-ins. Twitter reports a monetizable daily active user count, measured by "people, organizations, or other accounts who logged in or were otherwise authenticated and accessed Twitter on any given day through twitter.com or Twitter applications that are able to show ads" (Twitter 2020 10-K). Between Revolve Group and Twitter, there is a difference between the monetizability of Revolve's defined active user base and the monetizability of Twitter's defined

active user base. Specifically, every customer counted in Revolve Group's active user base definitively made a transaction on the platform, and thus contributed to the firm's revenue in the last 12 months, though not every user who signed into Twitter necessarily interacted with ads, implying that not every Twitter user contributed to generating revenue for the company. This example highlights the variations across industry and business models as a key source of discrepancy of the definitions and measurements of active users.

Measurement Manipulation

In addition to definition discrepancies, an active user count can be easily manipulated due to various interpretations of what "active" really means for a company. There are many notable "reforms" to the active user count measurement definitions reported by notable social media companies in response to investor skepticism:

- Prior to 2015, before Twitter reformed their active user count to include only *monetizable* users, they included Fast Follower users in their active user count (Truong 2015). Fast Follower users do not actually log into Twitter's platform, and instead receive Tweet notifications through text message. Thus, these Fast Followers have no opportunities to interact with or view advertisements and do not contribute to ad revenue.
- 2. In Twitter's Q4 2015 earnings call, Twitter was asked to explain why the social media platform had lost 4 million MAUs in the previous quarter. Twitter attributed the decline to the fact that the 4 million MAUs lost had not been using Twitter, but were mistakenly counted when applications automatically contacted Twitter servers for regular data pulls. For example, Apple's Safari web browser performs periodic automatic Twitter data pulls. The exclusion of such users caused the MAU figure to plummet (Twitter 2016 10K).

 Prior to 2015, Facebook included users who interacted with third-party extensions, such as "liking" an article through a media platform like ESPN, in their active user count (Madhavan 2016). These users thus are not actually logging on to Facebook's platform.

While Twitter and Facebook have revised their active user counts in response to public skepticism regarding their measurements, these active user count definition reforms introduce the question: have other social media companies, and digital companies in general, made similar changes to ensure that their active user count captures the actual base of active users who drive revenues?

These examples illustrate how an "active" user can take on many forms, and in many cases, companies define "active users" by a minimal metric like logins or interacting with the platform through a third-party. Many of these "actions" that define an active user are low commitment and low friction, and thus do not reflect the true usage of the app and stickiness of an app or platform (Madhavan 2016).

In addition to lofty interpretations of what "active" means, a key flaw with these metrics is the lack of auditing. These figures are often reported within the Management Discussion & Analysis section of 10K financial filings, which are not audited, implying that there is no way to verify how companies ultimately obtain their DAU and MAU figures (Henry et al. 2014). The lack of auditing adds to other factors that hamper the interpretability of the metrics, introducing doubt into whether it makes sense to use DAUs and MAUs to compare companies.

Methods: A Framework for Interpreting DAU, MAU, and DAU/MAU

In this thesis, I focus on applications of DAU, MAU, and the DAU/MAU ratio in a marketing context. Broadly, active users is a measurement metric commonly used to quantify the number of active visits or interactions from users within a relevant range of time (daily and monthly). Despite the rather simplistic definition, applications of such metrics are difficult to generalize across business models and industries, and a centralized understanding of the metrics is rarely recognized. With this in mind, the goal of the following framework is to organize applications of DAUs, MAUs, and the DAU/MAU ratio and discuss how various dimensions affect the interpretation and analysis of such metrics.

In the following discussion, I outline four dimensions to classify applications of DAU, MAU, and the DAU/MAU ratio and discuss the specific subdimensions on which interpretations may differ.

I: Revenue Model

Revenue model defines the way in which businesses generate revenue. I characterize revenue models along three separate subdimensions: 1) subscription-based, 2) advertisement-based, and 3) transaction-based.

I.1: Subscription-based revenue model

In a subscription-based revenue model, customers are charged on a recurring basis in exchange for the delivery of a product or service. Examples of subscription-based revenue models include digital content entertainment subscriptions and newspaper subscriptions. The success of a subscription-based business relies on the volume of subscriptions sold, and the retention of subscribers, as these activities drive monetization. Thus, DAUs and MAUs to a webpage or platform do not necessarily contribute to the revenue of the business because revenue is solely dictated by the number of sold subscriptions in a given period.

However, measuring DAUs and MAUs shed light on growth potential and inform the *future expected* volume of subscriptions sold. Consider a simplified conversion funnel, which is a model that shows how a potential customer goes from company awareness to purchasing the good or service. The top of the funnel represents the number of people aware of the company, and the bottom of the funnel represents those customers who eventually become paying subscribers. DAUs and MAUs represent the top of the funnel, as having a significant base of active users at the top of the funnel ensures a wide enough audience from which the business can further identify users with a high propensity to pay and convert such users into paying subscribers (Petty 2022).

I.2: Advertisement-based revenue model

Online businesses and media companies often turn to advertisers as a key revenue stream. The premise of the business model is to present news, information, and content that attract users to the platform, and then sell advertising space to businesses that want to market to the platform's

audience. Examples of advertisement-based business models include most social media companies and select gaming platforms. Due to the complex relationship between advertising revenues and the active user base, two key considerations arise: 1) Do advertisers compensate platforms based on the sheer size of the audience base (display advertisements), or do they compensate platforms based on the "engagement" of users with the advertisements (engagement advertisements)? 2) Does the platform rely on an iterative data process to show targeted ads, where more customer information inherently makes the platform better?

Social media and traditional media companies like Twitter and NYTimes derive a significant portion of revenues through advertisements, which are determined by a combination of factors including the number of DAUs, ad pricing, number of ads shown, and the platform's clickthrough rate, which represents how frequently viewers of an ad end up clicking the ad. This suggests that DAUs and MAUs matter to a certain extent in determining revenues, but could vary based on the pricing model of advertisers. For engagement advertisers, which likely compensate platforms based on the number of impressions or click through rate, active user counts only matter to the extent that each of these active users are engaging and clicking on the advertisements, which suggests that having a wide, largely unengaged audience base does not contribute to revenue and that only the "power users," or those that frequently interact with ads, are driving advertisement revenues. On the other hand, DAUs and MAUs are directly proportional to revenues for companies that generate revenue through displaying advertisements, such as advertisements in free-for-play games, as more users indicates increased opportunities to display ads (Keoliya 2022).

Moreover, some media-based companies, like Pinterest, rely heavily on an iterative algorithm that uses customer data to improve their search engine and targeted advertisements. In this case,

one could argue that a larger active user base yields more customer data, and hence more effective targeted advertising, which drives advertising revenue (Petty 2022).

I.3: Transaction-based revenue model

Transaction-based revenue models encompass consumer and retail e-commerce platforms that rely on transaction volume to drive revenues. Examples include fashion e-commerce websites as well as ride-sharing platforms such as Uber and Lyft.

In the setting of transaction-based revenue models, businesses will often define the number of active customers as the number of unique customer accounts from which a purchase was made across the platform at least once in some preceding time range. Many transaction-based businesses report MAU as an indicator of future growth, the reach of the platform, and the continued desire of customers to transact on the platform. DAU, on the other hand, is typically not reported, which is likely a result of the fact that customers typically do not make transactions every day. While active users certainly drive net sales, the disentanglement between truly active users and those who made a purchase and never intend to transact again is difficult to observe. In sum, while active users need to continue to transact with significant basket sizes and with high frequency to actually contribute to revenue.

II: Seasonality

Many businesses are subject to seasonality, which means that interest in and demand for certain products and services may fluctuate based on a predictable schedule during the year due to

external factors. Within the idea of seasonality, I characterize products and services into two separate subdimensions: 1) constant usage, and 2) irregular usage.

II.1: Constant Usage

While most sales are affected by seasonality, some consumer products unaffected by seasonality include weather, work, productivity, and medical services. Naturally, due to consistent usage and ignoring customer acquisition and platform growth, the number of DAUs and MAUs to the platform will generally be stable. This implies the DAU/MAU ratio is also likely constant across the year.

As an example, consider Meet Group, a provider of interactive live-streaming products to offer consumers various mediums for forging social networks. By examination of Meet Group's website and app activity, the usage levels of the products and services offered, in aggregate, are relatively constant, evidenced by the largely flat DAU, MAU, and DAU/MAU ratio trend between March 2018 and June 2020, as displayed in Figure 3.



Figure 3: Meet Group Active User Trends

II.2: Irregular usage

The more interesting patterns of DAUs and MAUs arise in settings where consumers visit websites or apps irregularly, or according to some seasonality trend. Examples of irregular use products include video games, which are typically played more during vacation time, and tax softwares, which are used heavily during tax season. Based on the product or service of interest, seasonality takes on varying periods of time. Weekly seasonality involves usage irregularity that corresponds to different days of the week (weekdays versus weekends). Monthly seasonality involves usage changes across months (for example, Q4 is marked by more sales in general due to the holiday season, and local newspaper page views increase during high school football season). Both weekly and monthly seasonality can explain sharp variations in DAUs and MAUs over the period of a year.

DAU and MAU fluctuations naturally lead to variations in the DAU/MAU ratio. In the context of social and casual gaming, which are games typically played during down time during the day,

such as the commute to work, game play and the DAU/MAU ratio is low during the summer season due to vacations, but sharply increases in the winter season as people are home for the holidays (Keoliya 2022). Ideally, the DAU/MAU ratio would capture how well a platform or app retains its users, and how "engaged" users are in aggregate. However, as a result of seasonality, the true "retention" or "engagement" behind the DAU/MAU ratio is clouded, which hampers comparability across time and across companies.

III: Intended Frequency of Use

Different products and services are intended for different purposes, and thus have varying frequencies of use. Within this dimension, I have classified two subdimensions of products: 1) intended daily use, and 2) less frequent use.

III.1: Intended daily use

Many messaging and social media products are intended for daily use. For these types of products, due to the frequent use patterns, DAUs are often much closer to MAUs in terms of volume. Thus products that are intended for daily use typically experience high DAU/MAU ratios. Generally, for products that are intended to be used daily, DAU/MAU may be a good ratio to use to evaluate product market fit.

III.2: Less frequent usage pattern

However, as pointed out by Andrew Chen, consumer startup investor at Andreessen Horowitz, the DAU/MAU ratio may not be applicable to platforms that are not intended for daily use, which excludes mostly all consumer products except messaging and social media products (Chen n.d.). There are a number of platforms intended for less frequent use, including Slack, Microsoft Teams, and Airbnb, but these platforms still are highly profitable and valuable, which suggests that not all products should be evaluated by the DAU/MAU ratio. For Uber and Lyft, the most profitable rides are to airports and via Black Car for special nights out. Travel products, like Airbnb and Booking.com are used only a few times a year, but have managed to reach market capitalizations of over \$50bn. Customers of e-commerce platforms that sell mattresses or high-priced goods transact fairly infrequently. These all represent infrequent occurrences, which implies that there will be a sizable wedge between DAUs and MAUs and thus a lower DAU/MAU ratio compared to high frequency products.

This points to the idea that, even if a business is low frequency, if the company is able to monetize customer interactions, the platform can still be valuable. On the other end of the spectrum, high frequency products have a greater chance of growing virally and building a customer base that is suited to be monetized through advertisements. These forces give rise to, what Andrew Chen coined, nature vs nurture (Chen n.d.). Products have a "natural baseline DAU/MAU," or nature, and whether companies fall above or below this baseline is dependent on other factors, like market power and industry saturation, which are forces of nurture. In other words, if a product is meant to be used a few times a year, the product will never have as high of a DAU/MAU as Facebook, which is meant for daily use. However, low frequency products can sit on the higher range of DAU/MAU ratios for the particular product based on strategy and competition.

IV: Product Life Cycle & Changing Consumer Cohorts Over Time

Product life cycle refers to the length of time a product is introduced to consumers into the market until it is removed from the shelves. Throughout the life cycle of a product, there are many customer cohorts that engage with the product, with a cohort defined based on the time of customer acquisition. The life cycle includes: introduction, growth, shakeout, and decline phases that are marked by varying levels of customer acquisition. In the context of interpreting DAU, MAU, and the DAU/MAU ratio, two relevant subdimensions include: 1) the platform or app has launched recently and experiences strong customer acquisition trends, and 2) the platform or app is mature and customer acquisition and behavior is rather stable.

IV.1: Recent Launch and Growth

Across all products and services, worldwide launches are frequently met with significant attention that inevitably declines over time. Consider the case of games, whether it be free-to-play or titled. A worldwide launch brings in many new customers looking to try the game, which implies high DAUs and MAUs. However, as the game ages, more and more customer cohorts engage with the product or service, and the overall user base behavior variation increases. This product life cycle is not exclusive to games, but can be generalized to describe the evolving customer base of any app or platform. These dynamics can be isolated into: 1) intra-cohort dynamics, which describes changes in DAUs and MAUs within a given cohort of customers over time, and 2) cross-cohort dynamics, which describes aggregate customer base behavior as new cohorts enter and engage with the product.

1) Intra-cohort dynamics

Consider a new customer cohort that tries an app or platform for the first time. Here, we define a cohort to be a group of customers who are acquired at the same date, or begin using the platform for the first time at the same date. Due to natural customer heterogeneity, users log on to the platform with different frequencies and rates. Over time, the cohort undergoes a "shakeout" process (Fader 2019). Assuming that customers do not change their behavior and continue logging in with the same frequency as when initially acquired, those customers that use the platform extremely infrequently, perhaps logging in once every two months, are not counted in MAUs in the month following acquisition. As a result, the negative effect on the MAU count in subsequent months causes the DAU/MAU ratio to rise mechanically.

More generally, the decline in MAUs is not because of any change in customer behavior, but is merely due to the fact that all customers are counted in the first month following acquisition as MAUs, but those users who use the platform infrequently will not be counted in MAUs in *all* subsequent months. This causes the DAU/MAU ratio to increase following customer acquisition, and then stabilize in succeeding periods. In sum, the shakeout process will mechanically increase the DAU/MAU ratio, even if there are no substantial changes to the total number of logins and the overall level of customer engagement.



Table 1: Single cohort 2 months post-acquisition, assuming user log-in heterogeneity

As a simplified example, shown in Table 1, where we consider 10 days in a "month," consider the case where there are 4 users with heterogeneous behavior, given in the second column. In the first month, the DAU/MAU ratio is 45%. However, in month 2, User 3 does not log in, because of the users' infrequent use patterns. As a result, the DAU/MAU ratio in month 2 is around 57%. Mechanically, there is no change in behavior in any of the users, but the DAU/MAU ratio mechanically falls because User 3 is no longer included in month 2's MAU calculation, while the DAU count doesn't decline significantly.

While the simplified example assumes that individual-level behavior is stationary, there could be intrapersonal dynamics over time, as users increase or decrease their usage as they familiarize themselves with the product. However, these changes will, on net, wash each other out (one users' increase in usage is offset by anothers' decrease in usage), and will be small in comparison

to the broader cohort-level heterogeneity that affects the DAU/MAU ratio. Moreover, to the extent that there is user churn, it is more likely that the initially casual users, or those that use the platform relatively infrequently, are more likely to drop out of the customer base, which further accelerates the DAU/MAU ratio increase following acquisition.

2) Cross-cohort dynamics

In addition to intra-cohort dynamics, cross-cohort dynamics also affect the overall DAU/MAU ratio of the platform. Consider the first cohort of customers who join a platform who initially had a DAU/MAU ratio of 40%, and the shakeout process results in a stable 60% DAU/MAU ratio. If an identical cohort of customers, who, on average, access the platform 40% of the days in a month, join the platform after the first cohort's shakeout, the cohort contributes to lowering the DAU/MAU ratio for the platform even though there is no decrease in DAU/MAU in the initial cohort. In other words, the acquisition of another cohort "punishes" the overall DAU/MAU ratio, when, in reality, the cohort has yet to undergo its shakeout process to identify the most valuable customers. As a result of this "dilution effect" by new cohorts of customers, the overall platform DAU/MAU declines.

As a result, the DAU/MAU ratio in particular is fogged by both intra-cohort and cross-cohort dynamics that makes it hard to tease out the true underlying "engagement" and retention of the customer base.

IV.2: Maturity and Stabilization

After cohorts have matured, and the most valuable customers have been retained, DAU, MAU and the DAU/MAU ratio will remain rather stable. This is because, after all of the shakeouts and

customer acquisition dilutions, the heterogeneity of the customer base theoretically should not change significantly. However, this state of the world is extremely rare, as businesses are always seeking to acquire new customers and will very rarely have an extremely stable and stagnant customer base, suggesting that the DAU/MAU ratio is constantly affected by the intra-cohort and cross-cohort dynamics discussed above.

Discussion

Due to the various nuances with regards to the interpretation of DAU, MAU, and the DAU/MAU ratio, there is significant discussion about reporting standards. While I believe there are many industries in which DAU and MAU are minimally relevant to revenue generation, I would argue that certain industries ought to implement a standard with regards to DAU and MAU measurement, definitions, and reporting. For example, for industries that create products intended for daily use that generate revenues from showing their customers ads, such as messaging services, social media, and free-to-play casual games, reporting DAUs and MAUs can give investors a strong starting point for projecting and evaluating revenues. However, it may be useful to report these in conjunction with other non-financial metrics, like the number of advertisers a company works with, to holistically evaluate company performance.

In my discussion with Professor Weitz and Professor Rosenthal at Seton Hall University, they proposed that certain industries, such as social media, ought to follow similar reporting standards as those enforced for oil and gas companies. Namely, O&G companies are required to report existing reserves, which are used to generate revenues. While counting the number of reserves is

a simplistic exercise, a similar standardized method of reporting non-financial metrics, like customer metrics, ought to be put in place for social media companies.

In terms of avenues for future research, there is still much to explore with regards to what an adequate reporting standard would look like for DAUs and MAUs, and specifically how these metrics ought to be measured. Moverover, there is a lot of research to be done regarding the actual relationship between DAU and MAU and profitability from a more quantitative data-driven methodology.

Conclusion

The main objective of my thesis is to motivate and clarify research issues related to DAU, MAU, and the DAU/MAU ratio in various business settings. DAU and MAU have emerged as key non-financial metrics reported by a number of companies to provide a more holistic image of financial health, and are thus very important to understand. My thesis offered an integrative framework of various applications of DAU and MAU, utilizing existing literature and a series of interviews with academics and industry professionals. Ultimately, when applying DAU, MAU, and the DAU/MAU ratio to evaluate company performance, it is important to keep in mind revenue model, seasonality, intended frequency of use, and customer cohort dynamics affect such measures. These active user counts are merely a quantitative assessment of the user base and thus should not be applied qualitatively.

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