

# Network Effects: Models and Analysis

**Q2: Why are Meta/Alphabet/ Apple valued so high?**

Alphabet Inc Class A



✓ Following

Share

\$138.84    ↑ 2.29%    +3.11 Today

After Hours: \$138.75 (↓ 0.065%) -0.090

Closed: Jan 8, 7:59:22 PM UTC-5 · USD · NASDAQ · Disclaimer

1D   5D   1M   6M   YTD   1Y   5Y   MAX

Key events >



Stock

Climate leader

US listed security

US headquartered

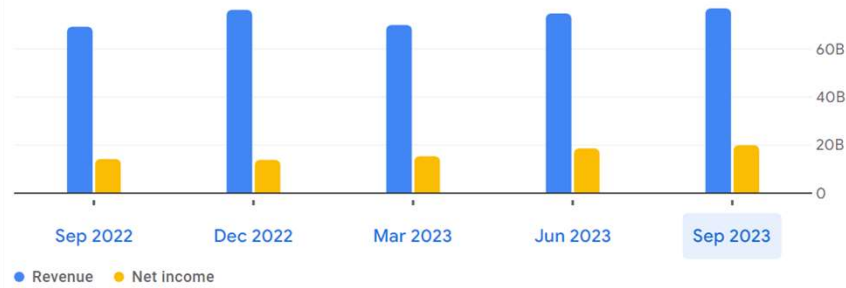
PREVIOUS CLOSE	\$135.73
DAY RANGE	\$136.26 - \$139.01
YEAR RANGE	\$85.83 - \$142.68
MARKET CAP	1.75T USD
AVG VOLUME	25.18M
P/E RATIO	26.61
DIVIDEND YIELD	-

## Financials

### Income Statement

Quarterly

Annual



(USD)	SEP 2023 ⓘ	Y/Y CHANGE
Revenue	76.69B	↑11.00%
Operating expense	22.04B	↑5.98%
Net income	19.69B	↑41.55%
Net profit margin	25.67	↑27.52%
Earnings per share	1.55	↑46.23%
EBITDA	25.25B	↑19.19%
Effective tax rate	7.11%	—

Balance Sheet

Cash Flow



# Airbnb Inc



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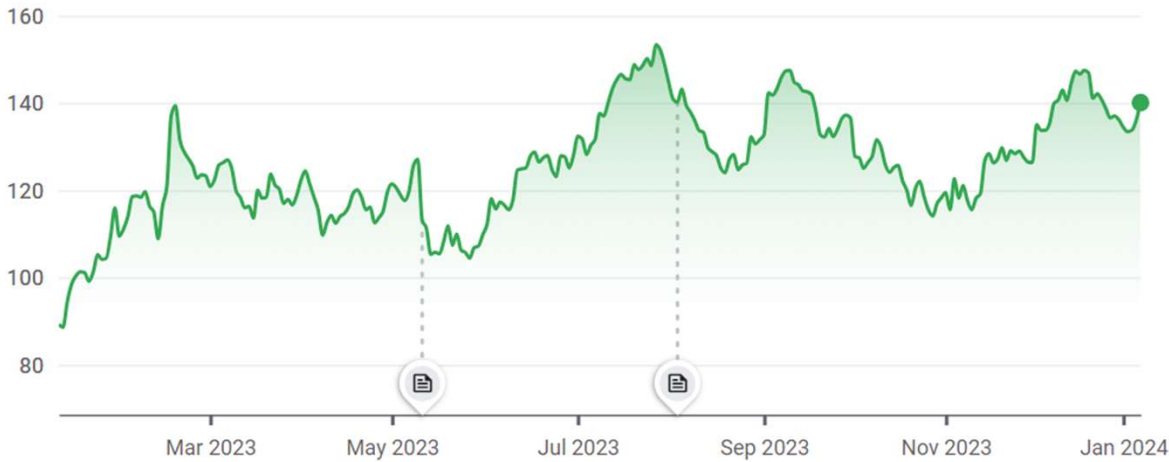
**\$140.08** ↑ 56.97% +50.84 1Y

After Hours: **\$139.90** (↓ 0.13%) -0.18

Closed: Jan 8, 7:58:32 PM UTC-5 · USD · NASDAQ · Disclaimer

1D 5D 1M 6M YTD 1Y 5Y MAX

Key events



Stock US listed security

US headquartered

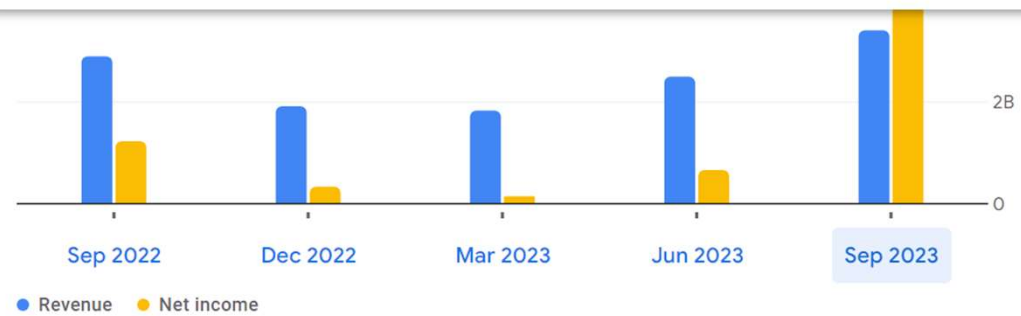
PREVIOUS CLOSE	\$135.98
DAY RANGE	\$136.61 - \$140.25
YEAR RANGE	\$86.75 - \$154.95
MARKET CAP	89.66B USD
AVG VOLUME	4.32M
P/E RATIO	16.94
DIVIDEND YIELD	-
PRIMARY EXCHANGE	NASDAQ

## Financials

### Income Statement

Google Finance

Q NASDAQ: ABNB



(USD)	SEP 2023 ⓘ	Y/Y CHANGE
Revenue	3.40B	↑17.79%
Operating expense	1.44B	↑12.66%
Net income	4.37B	↑260.30%
Net profit margin	128.76	↑205.92%
Earnings per share	6.63	↑269.48%
EBITDA	1.50B	↑23.68%
Effective tax rate	-160.51%	—





HOME > INFY • NSE

## Infosys Ltd

✓ Following

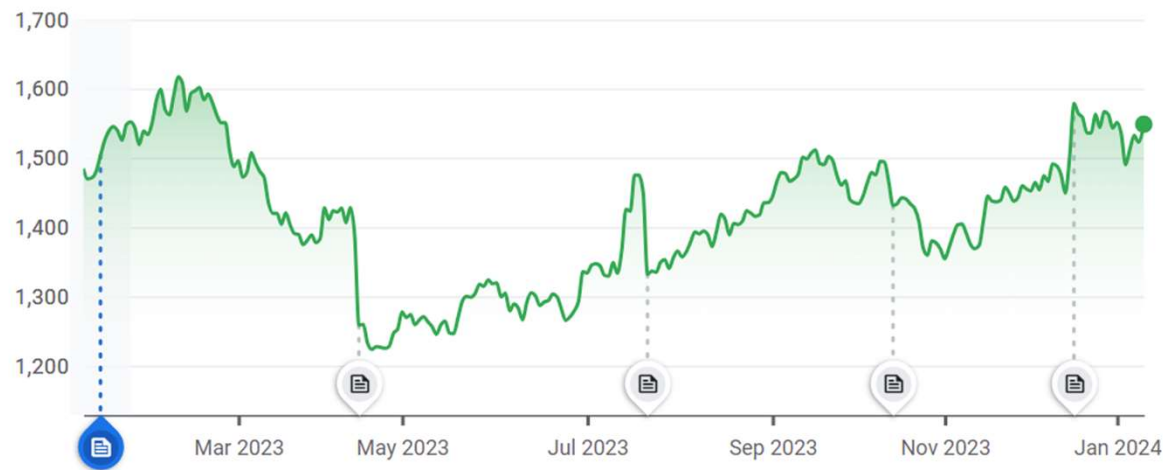
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₹1,549.40    ↑ 4.38%    +64.95 1Y

Jan 9, 1:04:25 PM UTC+5:30 · INR · NSE · Disclaimer

1D   5D   1M   6M   YTD   1Y   5Y   MAX

× Key events



Stock   Climate leader

IN listed security   IN headquartered

PREVIOUS CLOSE	₹1,522.80
DAY RANGE	₹1,536.95 - ₹1,553.00
YEAR RANGE	₹1,185.30 - ₹1,619.75
MARKET CAP	6.41T INR
P/E RATIO	25.90
DIVIDEND YIELD	2.29%
PRIMARY EXCHANGE	NSE

## Financials

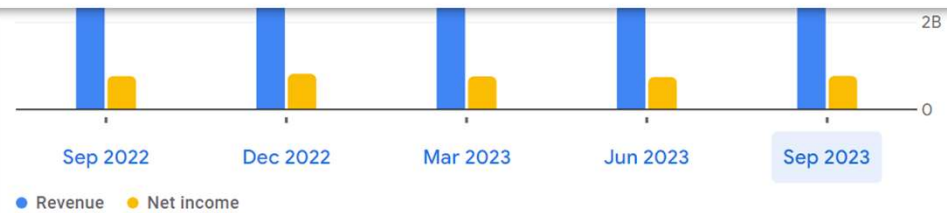
### Income Statement

Quarterly

Annual

Google Finance

Q NSE: INFY



(USD)	SEP 2023 ⓘ	Y/Y CHANGE
Revenue	4.72B	↑ 3.58%
Operating expense	417.00M	↑ 10.03%
Net income	751.00M	↑ 0.40%
Net profit margin	15.92	↓ -3.05%
Earnings per share	14.99	↑ 4.53%
EBITDA	1.09B	↑ 1.86%
Effective tax rate	29.15%	—





HOME > JUSTDIAL • NSE

## Just Dial Ltd

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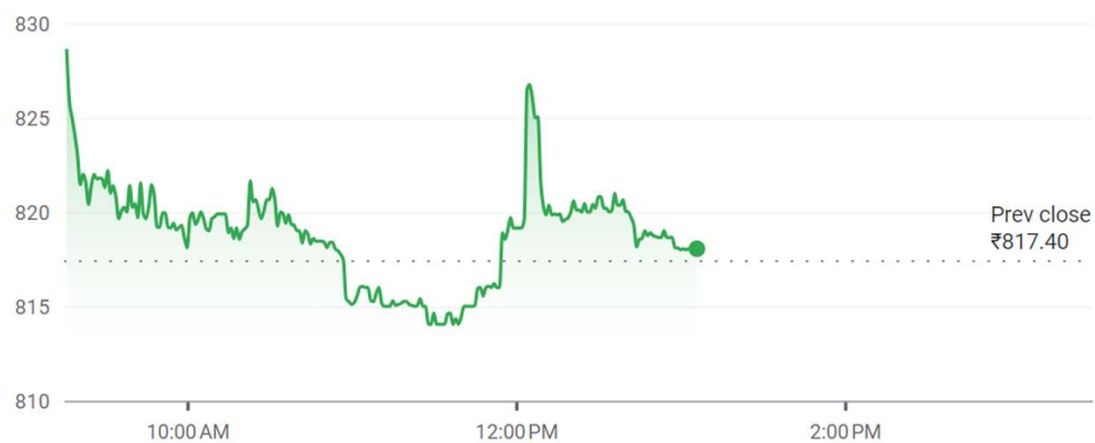
Google Finance

Q NSE: JUSTDIAL



1D 5D 1M 6M YTD 1Y 5Y MAX

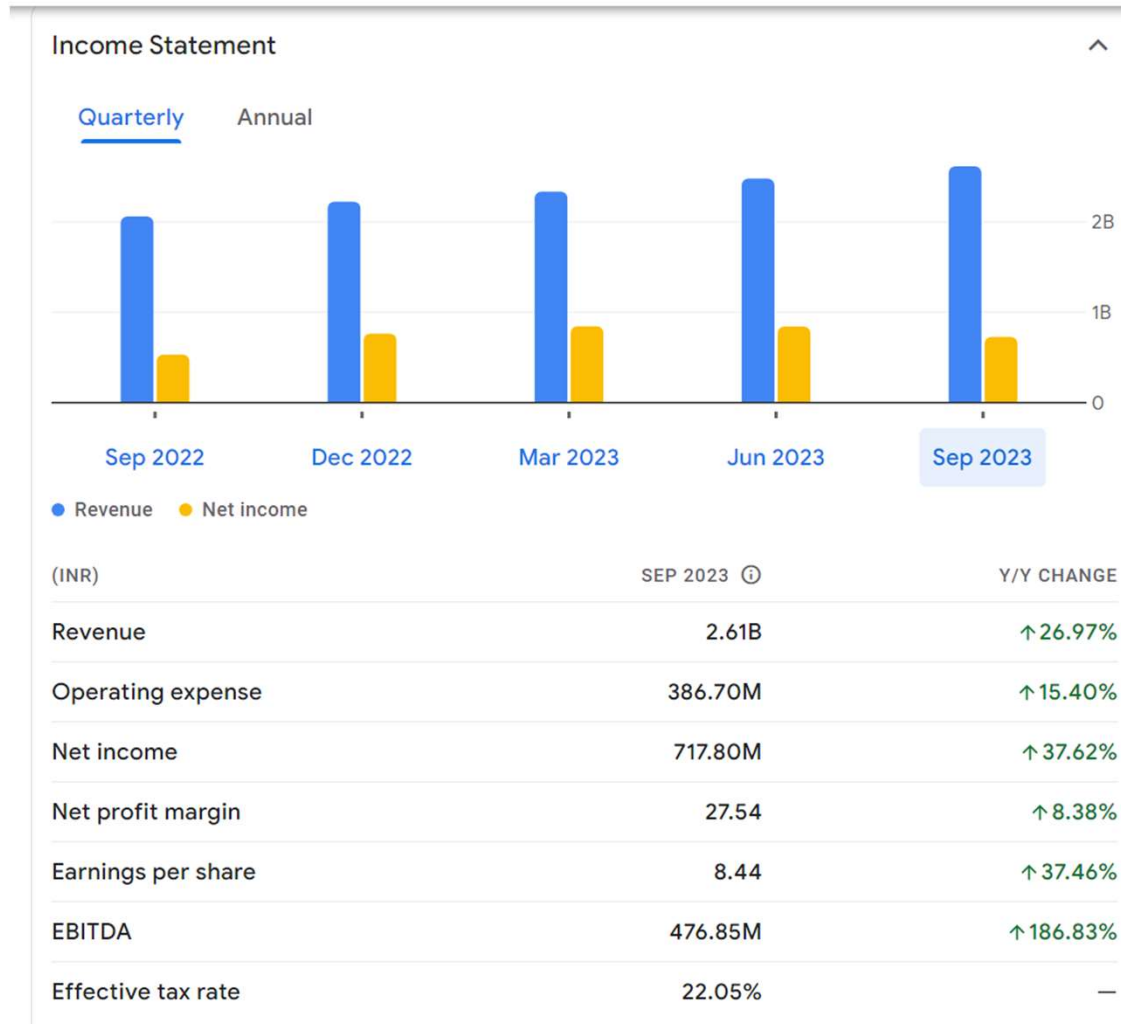
Key events >



IN headquartered

PREVIOUS CLOSE	₹817.40
DAY RANGE	₹814.05 - ₹828.65
YEAR RANGE	₹565.00 - ₹879.00
MARKET CAP	69.58B INR
P/E RATIO	22.16
DIVIDEND YIELD	-
PRIMARY EXCHANGE	NSE







HOME > AMZN • NASDAQ

## Amazon.com Inc

+ Follow

Share

**\$149.10** ↑ 70.67% +61.74 1Y

After Hours: **\$149.11** (↑ 0.0067%) +0.0100

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1D 5D 1M 6M YTD 1Y 5Y MAX

Key events



Stock

US listed security

US headquartered

PREVIOUS CLOSE	\$145.24
DAY RANGE	\$146.15 - \$149.40
YEAR RANGE	\$87.08 - \$155.63
MARKET CAP	1.54T USD
AVG VOLUME	40.08M
P/E RATIO	77.84
DIVIDEND YIELD	-
PRIMARY EXCHANGE	NASDAQ

## Financials





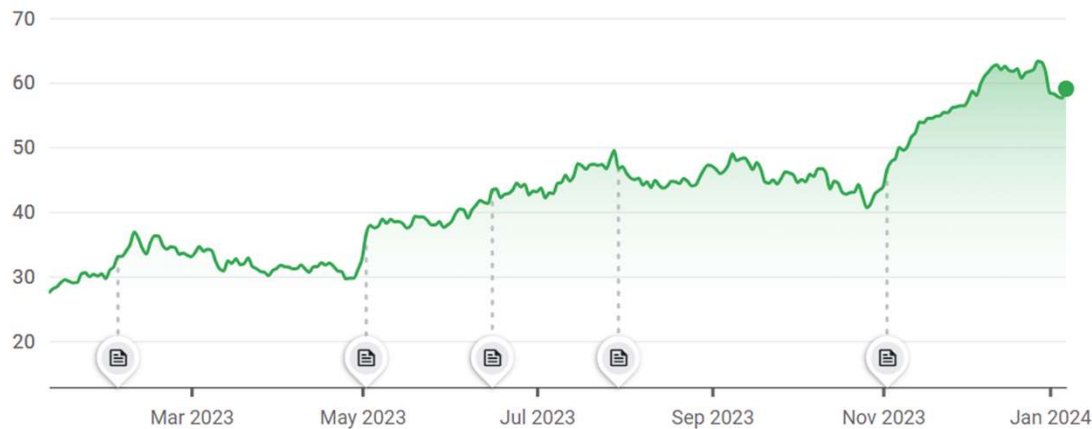
**\$59.01** ↑ 115.36% +31.61 1Y

After Hours: \$59.01 (0.00%) 0.00

Closed: Jan 8, 7:42:45 PM UTC-5 · USD · NYSE · Disclaimer

1D 5D 1M 6M YTD 1Y 5Y MAX

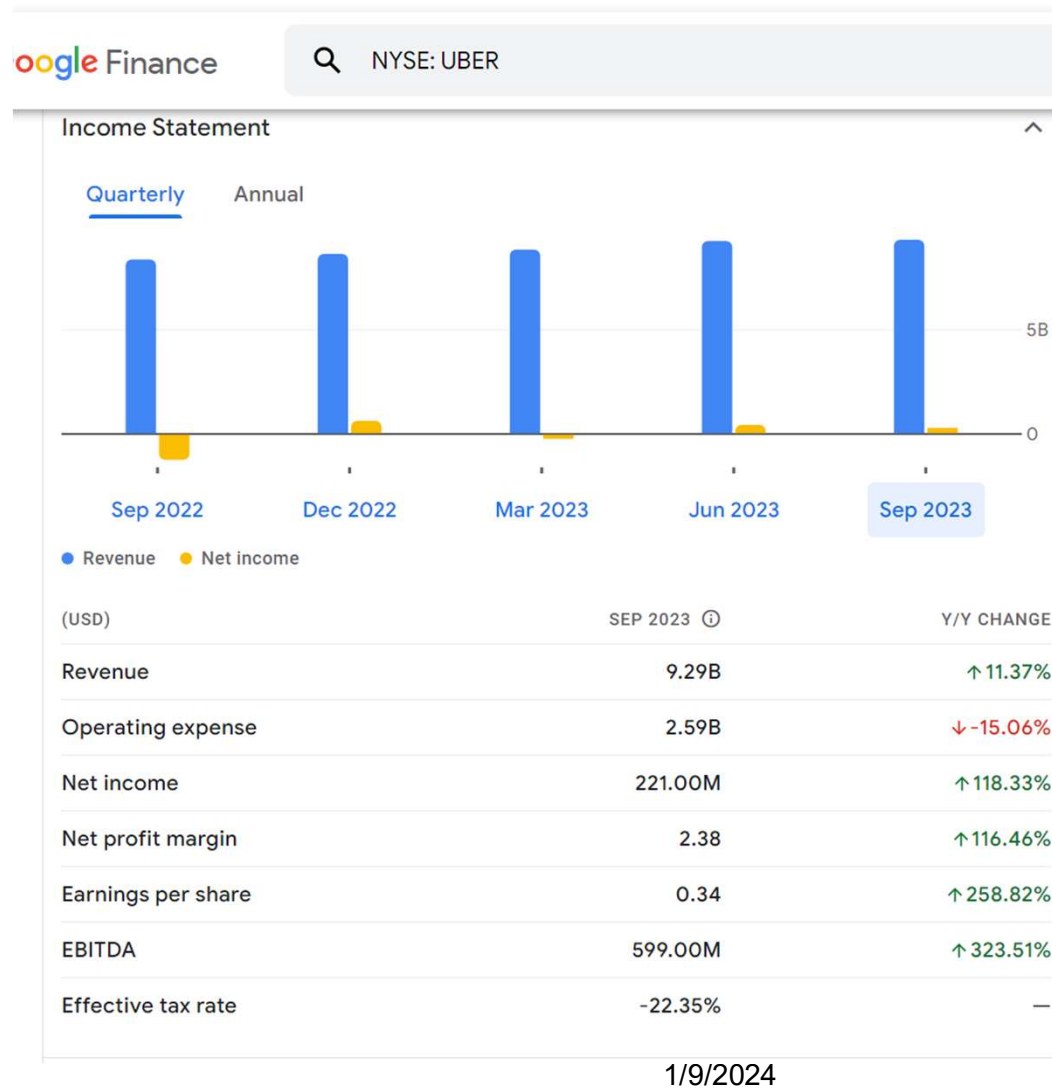
Key events



Stock US listed security

US headquartered

PREVIOUS CLOSE	\$57.58
DAY RANGE	\$57.85 - \$59.16
YEAR RANGE	\$27.15 - \$63.53
MARKET CAP	121.43B USD
AVG VOLUME	41.32M
P/E RATIO	115.09
DIVIDEND YIELD	-
PRIMARY EXCHANGE	NYSE





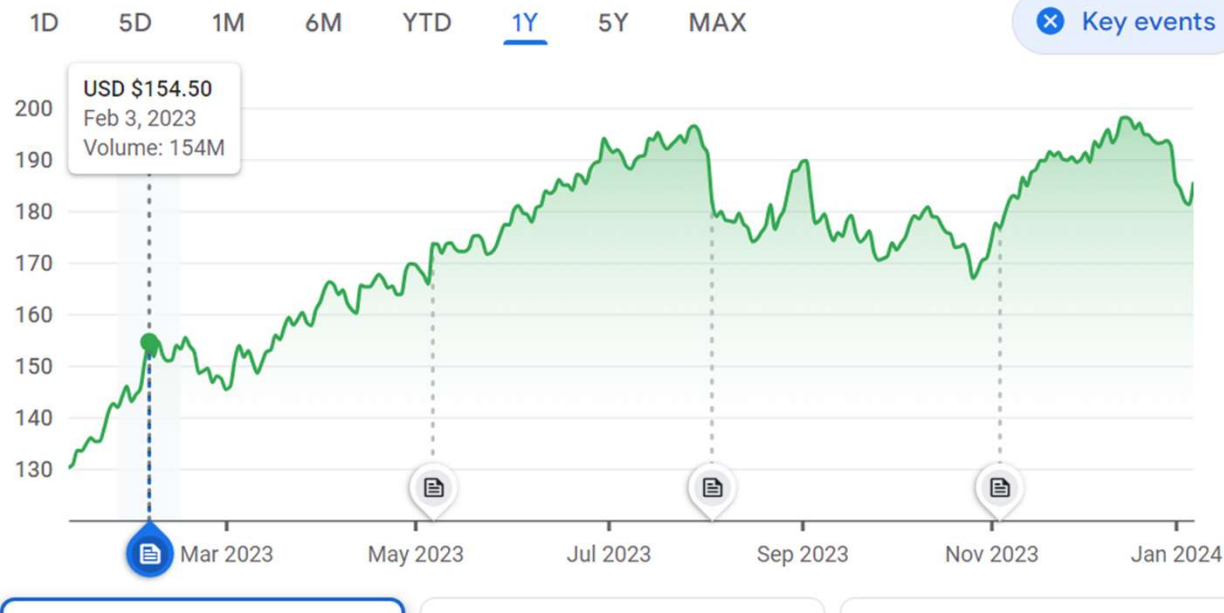
Following

Share

Apple Inc

\$185.56 ↑ 42.57% +55.41 1Y

After Hours: \$185.22 (↓ 0.18%) -0.34  
Closed: Jan 8, 7:59:49 PM UTC-5 · USD · NASDAQ · Disclaimer



Stock

US listed security

US headquartered

PREVIOUS CLOSE	\$181.18
DAY RANGE	\$181.50 - \$185.60
YEAR RANGE	\$128.12 - \$199.62
MARKET CAP	2.89T USD
AVG VOLUME	43.25M
P/E RATIO	30.25
DIVIDEND YIELD	0.52%
PRIMARY EXCHANGE	NASDAQ

## Financials

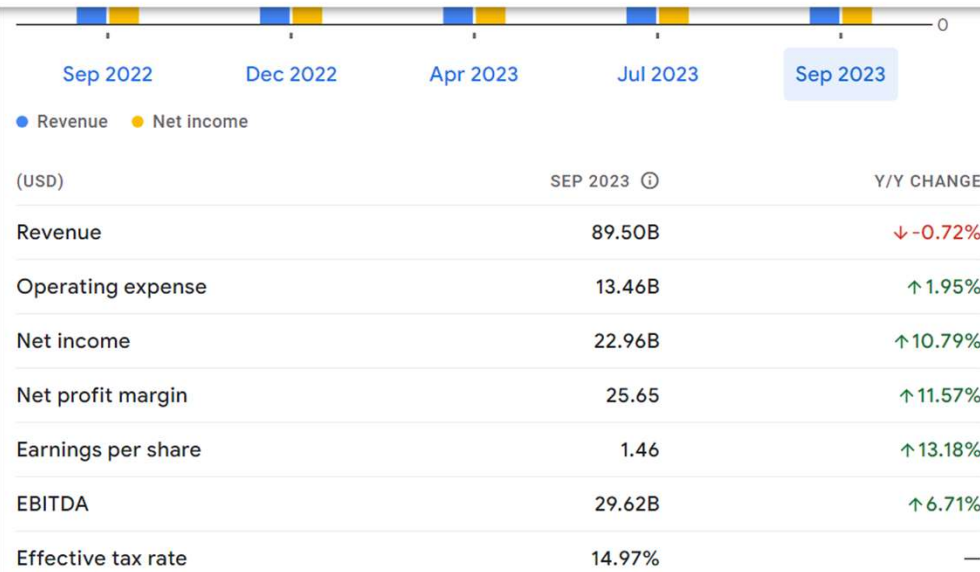
### Income Statement

Quarterly

Annual

google Finance

Q NASDAQ: AAPL



(USD)	SEP 2023 ⓘ	Y/Y CHANGE
Revenue	89.50B	↓ -0.72%
Operating expense	13.46B	↑ 1.95%
Net income	22.96B	↑ 10.79%
Net profit margin	25.65	↑ 11.57%
Earnings per share	1.46	↑ 13.18%
EBITDA	29.62B	↑ 6.71%
Effective tax rate	14.97%	—



# Network Effects



- **Direct: Direct effects of agents consuming the same product**
  - Value increases as the consumers or product/ service increase
  - Telephone was of little value to the first individual to have one
    - However with each additional telephone adopter, this innovation became more valuable to all of its users
- **Indirect: value of products increases as the number of, or a variety of, the complementary goods or services increases**
  - Computers as standalone machines are of little use unless installed with appropriate software
    - Computers and software complement each other and thus create network externality effects
  - Same holds good for Smartphones and Tablets



# Where does the value come from?

- **Exchange**
  - Every product or service subject to network effects fosters some kind of exchange
- **Staying power**
  - Networks with greater number of users suggest *Staying Power*
  - Related to *switching cost and lock-in*
    - Switching costs strengthen the value of network effects as a strategic asset
- **Complementary benefits are those products or services that add additional value to the network**
  - Products and services that encourage others to offer complementary goods are sometimes referred to as *platforms*

# Complementary and Compatibility



- Some network goods are immediately combinable because of their inherent properties
  - However for many complex products, actual complementarity can be achieved only through the adherence to specific technical *compatibility* standards
- Providers have the options of making their products fully or partially compatible with components produced by other firms
  - Proprietary designs; refusal to interconnect

1/9/2024

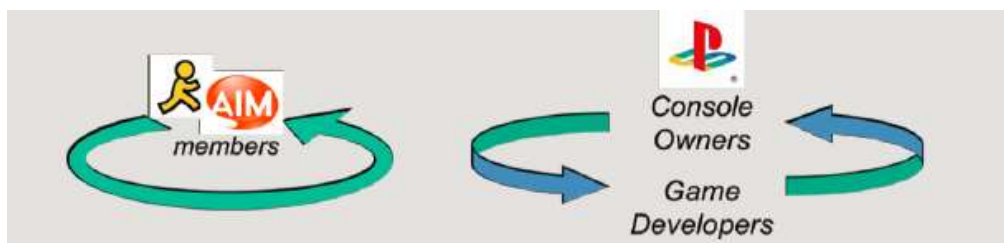
# One-Sided or Two-Sided Markets

- **One-Sided Market**

- Networks derive most of their value from a single class of users
- *Same-Side Exchange Benefits*

- **Two-Sided Market**

- Markets comprises of two distinct categories of network participants
- When an increase in the number of users on one side of the market creates a rise in the other-side of the market, then it is referred to as *Cross-Side Exchange Benefits*



# Models for Network Externalities

— — —

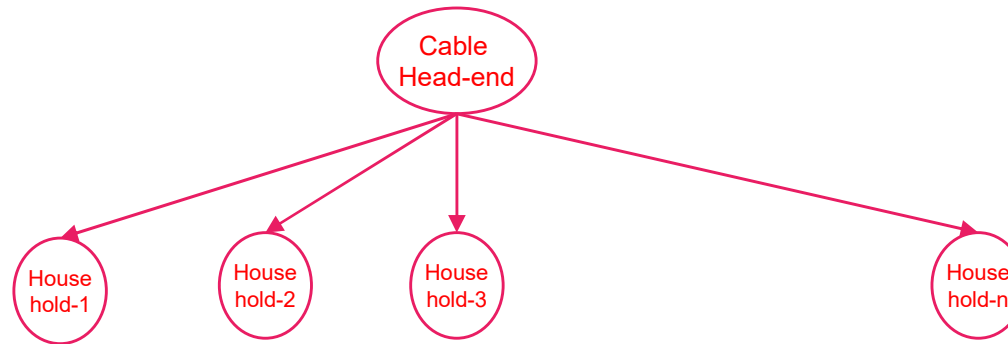


Sarnoff's Law:  $V \propto N$   
Metcalf's Law:  $V \propto N^2$   
Reed's Law:  $V \propto 2^N$   
Widely used:  $V \propto N \log N$

# Value of a Network: Broadcasting Networks



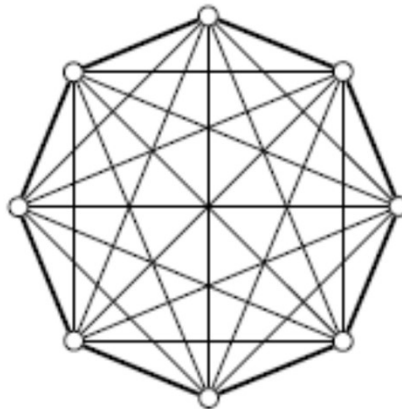
- Sarnoff's Law: Value of a network  $\propto N$
- Value just depends on connecting to receive broadcasts



# Value of a Network: Connecting Peers

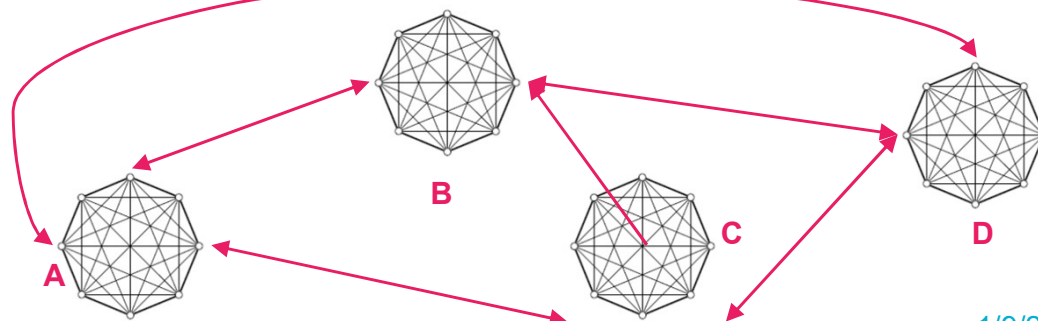


- Fully Connected Network: No of links:  $N \times (N-1) / 2$
- If A  $\rightarrow$  B is not the same as B  $\rightarrow$  A, then number of potential connections:  $N \times (N-1) = N^2 - 1$
- Metcalf's Law: Value  $\propto N^2$
- Holds good for Telecommunication Networks, Email, Unicasting



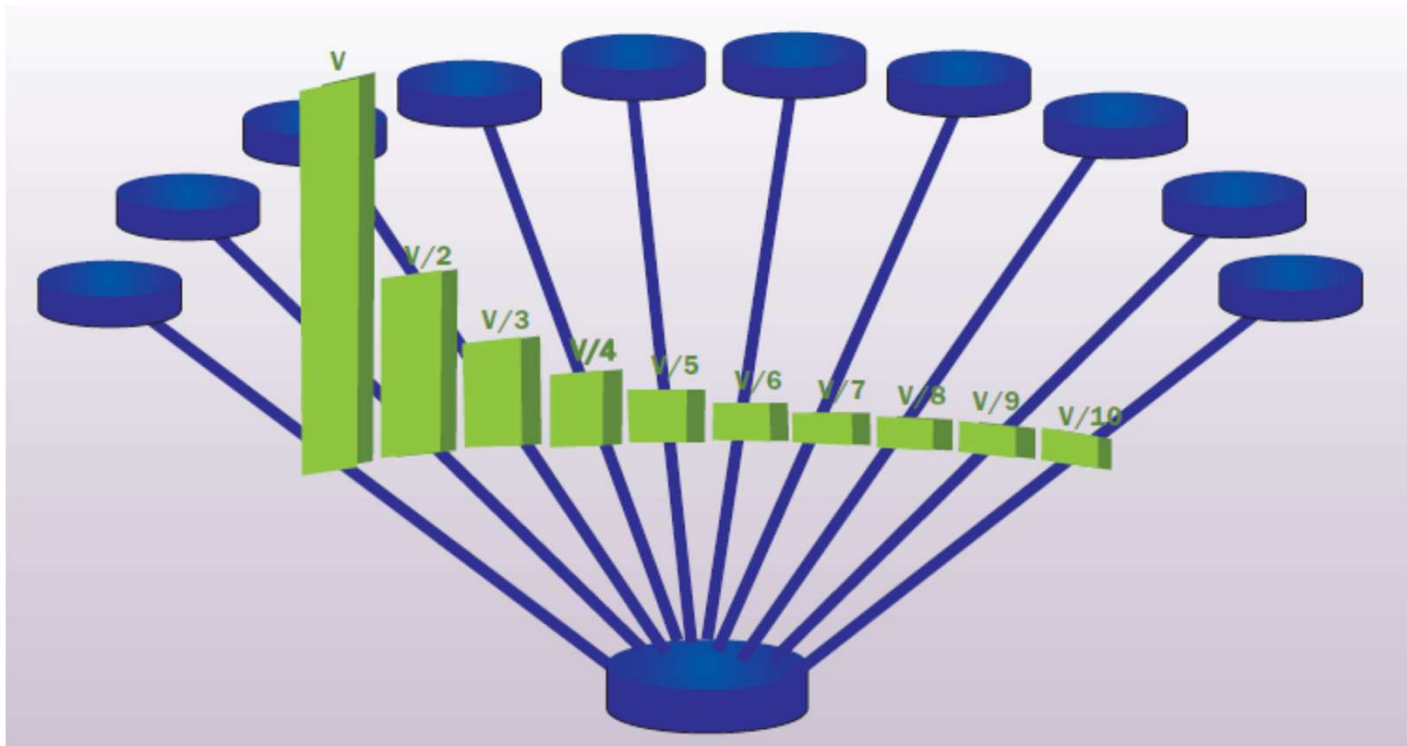
# Value of Networks: Group Forming Networks (GFN)

- Groups in which peers interact
  - Collaboration value is more important than connectivity value
- In a network of  $n$  nodes, the number of subgroups (1,2,3,..n member groups) that can be formed (an individual is in the group or not) is in the order of: Reed's Law: Value  $\propto 2^n$ 
  - Subtract the singletons and the empty set  $\rightarrow 2^n - n - 1$
- Examples: Peer-to-peer networks such as Facebook, Group based auction site eBay, Chats, On-line groups, Multicasting
- Internet: Network of Networks; value of the Internet much higher compared to broadcast or telephone networks



1/9/2024

# Harmonic Value of Connections





# Strategies for Competing in Markets with Network Effects



- Move Early
- Seed the Market
- Subsidize Adoption
- Expand by refining the Market
- Alliances and Partnerships
- Encourage development of complimentary goods
- Rivals: Be compatible with leading network
- Incumbents: Close off rival access and constantly innovate

# Too much Network Effect



- **Creates congestion effect**
  - **Affects Qos -> customers drop out**
  - **Free Internet Service, IPO of FaceBook!**

# Network Effect Promotes Standards



- Sony's Betamax vs. JVC's VHS video format
  - VHS introduced one year later and is technologically inferior
  - Reason for Betamax failure: Less adoption due to stringent licensing rules of Sony
- Sony's Blue Ray vs Toshiba's HD-DVD
  - BlueRay won due to better adoption by product manufacturers
- ITU's H.323 and IETF's Session Initiation Protocol (SIP)
  - SIP – easy to implement; lesser code base; better integrated with variants of H.323
  - ITU banded as a controller of technology and an operator and equipment maker lobbyist
- WiMax vs Long Term Evolution (LTE)
  - WiMax is incompatible with other networks though technically superior and had a 4 years early mover advantage
- Open XML of Microsoft vs. Open Document Format of IBM/Sun

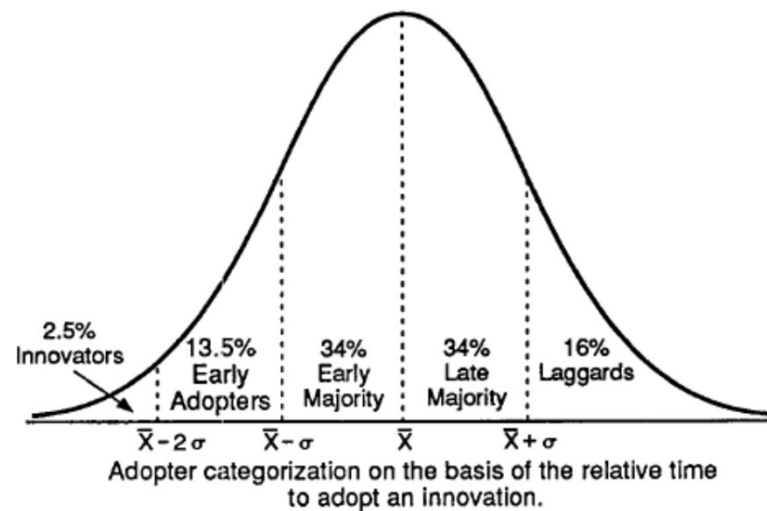


# Diffusion Theory: Bass Model

# Segmentation of Adopters



- Different categories of adopters differ by, for example, social, economic status -- particularly resources, affinity for risk, knowledge, Collateral assets, interest in the product



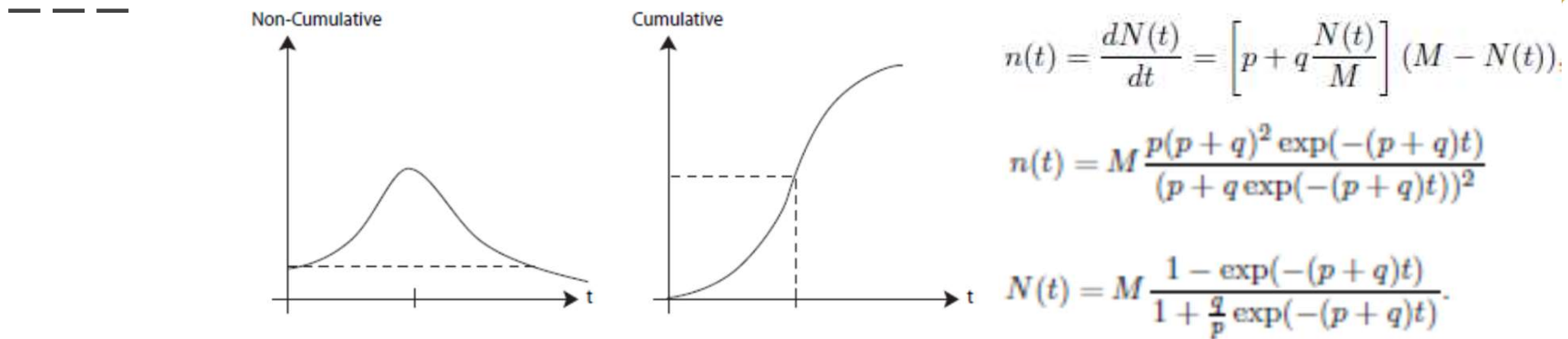
# Diffusion Effects



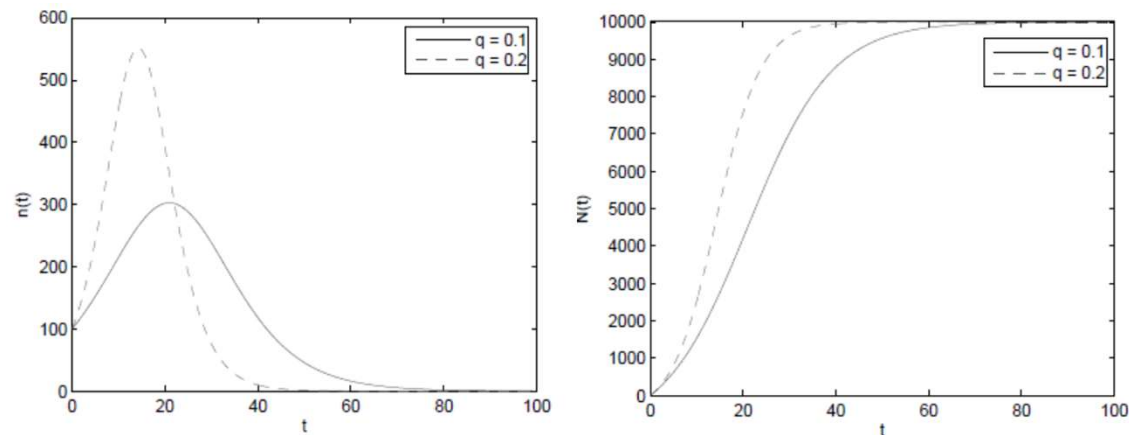
- How do users adopt a product/ service?
- Something intrinsic about the product itself attracts them to use it
  - Called as the *intrinsic factor* ( $p$ ).
  - which is *independent* of how many other people have adopted it.
- The network effect: either because more adopters change the value of the product itself, or because of the *information-cascade effect*
  - Referred to this as the *imitation factor* ( $q$ )
- *Bass model of diffusion*
  - The number of adopters at any time  $t$ : ( $n(t)$ )
  - Depends on  $p$  (the *intrinsic factor*),  $q$  (the *imitating factor*),  $M$  (the *finite population*): and  $N(t)$ : Cumulative number of adopters until  $t$ 
    - *Ratio of Imitator component and network component*

# Bass Diffusion Model

Bass, F. M. (1969). A new product growth for model consumer durables. *Management science*, 15(5), 215-227.



$N(t)$ : Cumulative no of users at time  $t$   
 $n(t)$ : no of users at time  $t$   
 $M$ : Maximum potential number of users  
 $p$ : Intrinsic factor  
 $q$ : imitation factor



Source: Chiang, M. (2012). *Networked Life: 20 Questions and Answers*. Cambridge University Press.