Internet Economics and Financial Technology

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Contents

1 The Big Picture

Based on past events, it is possible that we have reached the climax of the IT revolution. The migration to cloud technology is mirrored by the migration of electricity from home generators to power stations. From here, there have only been marginal improvements in this field, and this could be the same in the tech sector.

Similarly, this was seen in the explosion of the '.com boom' seen later. This rapid growth was due to people investing lots of money in the technology; a mania. Again, this has been seen before in history with the development of canals.

Another bubble popping phenomena was the collapse of the American housing market, where the stock market collapsed. Humans are really good at messing up financially, and also inventing tech that can revolutionise the world.

Essentially, what I'm getting at is that in the financial sector, trading is mostly done by computers. Obviously, these computer traders have no common sense, which worries a lot of the big companies, and investigations have been done into this.

1.1 Expanding the big picture

This section is the only section where we will discuss the history of finance, so bear with me here. Looking at the last 250 years of technology 'surges', we can possible gain insights about the current surge.

1. Industrial revolution (1770-1873)
2. Steam and railways (1829-1873)
3. Steel, electricity (1875-1918)
4. Oil, Car, Mass production (1908-1974)
5. IT and Telecoms (1971-??)

If the IT surge ends at the mean duration, then we can expect the surge to end in 2024. This end does not mean the end of the world, just that the time to make great fortunes has passed.

So, computer science is no longer *just* about computer science. Because of this surge, there is great interplay between this field and others, such as finance.

2 Big Money

2.1 Positive Feedback

Successful companies have won out for a whole host of factors, but history tends to focus on the winners. *Positive feedback* and *network externalities* can help to elevate a company or product to success, even if it has superior rivals.

2.2 The Long Tail

The long tail was named and popularised by Chris Anderson. In the old days, Retailers could make money on high-volume, low-margin goods or low-volume, high-margin goods. This is because shops had shelf volume that, if filled up by low-volume, low-margin goods, would be making a loss on these products, since physical space costs money. Thanks to the advent of online markets, 'shelf' space costs almost nothing, meaning that shops can now stock the low-volume, low-margin goods.

In examples such as the music industry, these less popular goods still have returns that would be beneficial for the vendor. In fact, no matter how far down the popularity graph you go, there is still money to be made. This tail is called the *long tail*.

2.2.1 Power-Law distribution of popularity

The power law appears a weirdly large amount in terms of popularity, which is of the form $P = cR^{-v}$. This makes the graph dip very sharply early on, but level off; never reaching zero.

As it turns out, the biggest money could be made in the smallest scales (if they are done large scale). The way to do it is:

1. Make everything available
2. Reduce prices
3. 'Help me find it'

2.2.2 Criticism of The Long Tail

Does the long-tail effect really exist? One observation is that the web actually *magnifies* the importance of 'blockbuster' hits. However, Anderson disagrees with this, stating that it is all about where you define the head and tail of the power-law curve and whether you use absolute values (since the criticism compares percentages).

Another criticism stated that music sales exhibited a log-normal distribution rather than a power-law curve. They reported that 80% of the music tracks they monitored sold NO copies at all over a one-year period. This was disputed poorly by Anderson.

2.2.3 Support for The Long Tail

The Long Tail has been proven to have grown longer over time. Niche books now account for around 37% of Amazon's sales. Additionally, a longer but also fatter tail has been observed on consumer software downloading patterns. However, this is only for software, which would behave differently than the entertainment sector.

2.3 Disruptive Technology

A technology company may have some form of technology and a projected performance. The company will also have an idea of the improvement required by the mainstream market. As long as the technology offered improves faster than the mainstream market's demands, the company is going to do fine. However, these are just predictions, and therefore this prediction must be monitored.

Some time into the future, a new technology appears with a much smaller performance and market than yours. However, it may have another benefit (smaller/cheaper/lighter), meaning that other companies invest in this. Because our company is already doing well, it is not a threat and we are not interested in it. The research team also conclude that the technology will not improve as fast as ours, therefore, our technology will always outperform the new one.

This prediction is true for a long time. At a certain point, the needs of the mainstream market are met by the new technology. Despite our technology being far above the needs of the consumer, the market is taken away from us, because our technology is far too advanced, and the new technology has other benefits that the mainstream market find more attractive, causing our company to be obsolete.

2.3.1 The Innovator's Dilemma

There are two different types of innovations:

- **Sustaining Innovations**: Incremental improvements on existing products or services that are attractive to existing customers and business models. Eventually, you offer more than the customer wants
- **Disruptive Innovations**: perform perform less well than existing products, perhaps being lower quality or less sophisticated, but they are also simpler, cheaper, or more user friendly.

These disruptive innovations can cause strong incumbent companies to fall or falter, not due to weaknesses in these companies, but because they do the right think short-term; leaving the lower end of the market to others.

The *dilemma* is the choice between doing what made the company a success in the first place, or investing in a lower quality prospect, meaning that sometimes successful incumbents need to invest in the 'wrong thing'.

Very often, this is the sequence of events:

- The disruptive technology is developed by the incumbent company
- The existing customers are unimpressed
- Therefore, the company stops developing the disruptive technology and instead concentrates on sustaining innovations
- New companies form (sometimes from disgruntled ex-employees of said company) and develop a new market for the disruptive technology
- As the disruptive technology matures and improves, it moves 'up the chain'
- The company then realises that there is significant demand, and attempts to enter as a latecomer. It fails to do this due to the lead built already by these new companies.

3 Internet Economics

3.1 Micro Economics

Micronomics studies the behaviour of individuals and businesses and how decisions are made based on the allocation of limited resources. This income can then be used to make or provide other resources, giving us a cycle. Consumers have a finite amount of resources, so the price of the goods needs to be well placed so the consumers will buy. But also, consumers have a finite amount of resources, so the supply also needs to be carefully placed. These interactions can become quite complicated quite quickly.

Supply and demand is at the heart of this. On the one hand, we have the amount demanded by the consumers, and on the other, the amount supplied by the producers. The **equilibrium** of these two values is when they are the same.

Excess demand means that consumers are fighting over the finite goods, meaning that the price rises; perhaps above the equilibrium. Some consumers will be unlikely to buy at this inflated price, meaning that the equilibrium returns.

Excess supply causes prices to fall, and some producers are unlikely to want to continue creating these goods, returning the equilibrium.

Every individual has a different amount of a certain good that they demand. If we aggregate these demands, we get a *demand curve*. The law of diminishing marginal benefit means that the demand will have a downward slope as we go up in quantity. The *gradient* of the curve tells us the **price elasticity** of demand. If the gradient is small (i.e. small elasticity) a small change in price results in a large change in quantity demanded. Conversely, *inelastic* demand means that a large change in price results in a small change in quantity demanded.

How quantity demanded changes in relation to a price:

- Horizontal demand: **perfect elasticity** (a change in quantity has no effect on price)
- Vertical demand: **perfect inelasticity** (fixed quantity demanded, regardless of price
- 45-degrees: **unit elasticity** (percent change in price equals percent change in demand)

3.2 Production costs

Running a business has associated costs:

- **Fixed costs**: a company must incur fixed costs in order to operate. They are fixed during a short time period.
- **Variable costs**: these tend to rise with increased production
- **Semi-variable**: labour can be considered a variable cost, because if paying overtime hours, or if you decide to hire more people to cope with increased workload.

We can graph the costs against quantity produced. **Economies of scale** are increased profit when the company is first scaling. After this, we see **diminishing marginal returns**. The marginal cost

curve tends to be upwards sloping, and firms need to cover their marginal cost of each additional unit produced. Therefore, the minimum price they will supply their product is the MC. They also need to cover their AVC. The supply curve for a firm is the curve that appears above the production costs.

As with elastic price, there is also elastic supply. **Elastic supply** can accomodate a large chang ein supply for relatively small additional costs, while **inelastic supply** means an increase in suply requires high additional costs.

3.2.1 Competitive markets

A **competitive market** creates efficient allocation of resources at equilibrium where quantity generated matches the quantity demanded. If there is an excess of demand, the price will increase, and vice versa.

Supply and demand ccurves show the price-quantity relationship. A change in another factor can shift the demand/supply. This shift can be represented by a change in either line causing a new equilibrium.

3.2.2 Monopolistic Markets

Sometimes, as single firm grows to take over an entire market. This firm would be called a *monopolist*. In the real world, complete monopoly is rare, and so if a firm owns more than a quarter of the market, it is considered a monopoly. In a competitive market, firms ar eprice takers. Each firm supplies a very small proportion of the market so no matter how much they produce, there will only be demand at a price. Conversely, for a monopolist, they are the only provider, so the demand curve is the same as the market demand curve. They are able to set the price to whatever they like, since they have no competition.

3.3 Economics of the Internet

The internet has disrupted the business landscape:

- **Combinatorial innovation** — components can be combined and recombined to create new products or services — has accelerated due to the internet.
  - 1800s, standardised gears revolutionised manufacturing revolutionised manufacturing
  - Internet revolution — innovations are rapidly distributed globally, many innovations are open-source and standardisation is easierand more necessary.
- Economic laws have not fundamentally changed, but the caharacteristics of online business activities can result in different markets.

Online economic activities consist of:

- Digital goods
- Information goods

- Online purchasing of physical goods
- Online provision of services

Digital differences between digital and physical goods:

1. Digital goods tend to be costly to produce, but cheap to reproduce. Fixed costs are high, but variable costs are low
2. Most of the production costs are *sunk* (cannot be recovered) unlike a factory, for example, which can be resold after
3. There are no capacity constraints limiting the number of times something can be reproduced.
4. Digital goods are often *experience goods* (customer downt know the value without using them)
5. Searching online is easy, so search costs for the customer is very low
6. *Positive network externalities* are often strong — the value to you increases as more people use it.

3.3.1 Consumers

If the production and consumption of a good or service affects the third party who was not involved, then they are a *externality*. A **negative externality** imposes costs on the others (such as pollution). **Positive externality** has benefits (such as spending on education).

Network externalities is a kind of externality that occurs when the act of buying a product confers indirect cost or value on all those who already own the same product or service. A **Negative network externality** imposes costs on others who also own the product (such as car purchase increasing road congestion). **Positive network externality** provides benefit to others who also own the product or service (such as telephone that makes you available for others to call). The term *network effect* is often used in a positive way.

The network efect is a very powerful effect. The demand curve of this is initially upward sloping, meaning that the initial marginal cost is very large. This is because the network is growing, and so is of more benefit to the consumer. After a while, this tapers off, and the demand curve ends up looking hyperbolic. The midway point in the upward curve is the *critical mass*. This is the quantity of users that must be reached for the network to be viable.

Switching from one product from one product or service to another can have additional cost. When this cost becomes very high, a user is said to be *locked in*. In the digital domain:

- The consumer would have to retrain to learn another service or software
- The consumer would have to convince their friends/peers to switch too
- The sotftware needs to be set up again
- There will be reduced quality of service in the short term because of the information that is stored by one company that will not be transferred to the other.

3.3.2 Producers

For the competitive markets:

- Short term: supply curve is MC above AVC (average variable cost)
- Long term: supply curve is MC above ATC (average total cost)

If two companies are competeing with identical digital products as their varaible costs are near zero, copetition will drive the price down to near-zero. A new company won't want to rist competing with an existing company because the set up costs are high compared with the possible profits. The risk is further enhanced by the newtwork effect as any new product must reach the critical mass or it will fail. Additionally, switching costs and lock in mean htat users are less likely to swap to the new product. Therefore, for commodity digital ogods, there is a tendency towards monopoly. To succeed, companies must therefore focus on product differentiation or competing for emerging future monopolies.

For digital products with a strong network effect and high switching costs, we expect to see monopolies occuring.

Producers greatly gain from having a monopoly and therefore will try to retain this. *Proprietary formats* are a powerful means of enforcing monopoly, such as the *.doc* format of Word. OpenOffice reverse engineered this, reducing lock-in, but switching costs meant that it was not widely uptaken. As a result, Word is still dominant, but OpenOffice is making inroads.

Standards help to stop this. Adopting industry-wider standards allows a user network to be shared between providers. This seems detrimental, but the network value is greatly increased. There are multiple ways a standard can be introduced:

1. Standards have a *leader*, that sets the standard for the industry
2. A *standard war*, where two or more producers compete to dominate
3. A *standards negotiation*, where two or more producers negotiate a standard collectively

3.4 Pricing Strategies

There are three degrees of **price discrimination**

- **First-degree**: Perfect price discrimination. The business charges the maximum possible price for each unit sold. It is hard to know everyones individual spending habits, so is not often used anymore
- **Second-degree**: When a company charges a different quantities consumed, such as quantity disounts on bulk purchases, or versioning (premium, standard, free tiers). This means buyers self-select and reveal their type via their selection. Much easier to employ this in the digital world.
- **Third-degree**: Grouping a product by a certain group, such as cinema tickets with students, adults, children, etc. Buyers cannot choose their group.

For price discriminatino to take place, a seller must satisfy three conditions:

- Distinguish between customers
- Have enough market power
- Resale must be impractival, costly, or forbidden

Price discrimination can also be controversial for a variety of reasons, and sometimes against the law.

Bundling is another form of versioning and is the practice of selling several goods together for a single price, such as Microsoft Office. It's used to sell to customers who would otherwise not buy. Can help to keep a monopoly.

4 Auctions

4.1 Auction Theory

There are four common auction types:

- Open Ascending-Price (English)
- Open Descending-price (Dutch)
- First-price sealed bid
- Second-price sealed bid (Vickrey)

Auctions are not new, and have been used since the era of the Babylonians. Auctions are used because the *seller is unsure* about the values that bidders attach to the object being sold. If the seller knew bidder values, he could just offer the object to the bidder with the highest value v, or just below.

4.1.1 Terminology

Private values:

- Each bidder knows the value of the object to themself at the time of the bidding
- No bidder knows with certainty the values attached by *other* bidders, and knowledge of the other bidders' values have no effect

This assumption is most plausible when the value of the object to a bidder is derived from its consumption or use alone, such as a pizza or a bicycle.

Interdependence is when the object worth may be *unknown* at the time of the auction to the bidder.

- Bidder may have only an *estimate* or some private signal that is correlated with the true value.
- Other bidders may possess *information* that, if known, would affect the value that a particular bidder attaches to the object.

We call this specification **interdependent values** which are values that are unknown at the time of the auction and may be affected by the information available to other bidders.

This assumption is most plausible for situations in which the object being sold that can possible be resold after the auction, such as a Harry Potter first edition book.

4.1.2 Equivalent Auctions

- **First-price sealed-bid auction**:
  - The bidder's strategy maps private information to a bid
  - No information about other bidders is available as the auction is sealed
  - The bidder needs to consider what the bid, as they have no idea what other people might bid
- **Dutch auction**:
  - Conducted in the open, but offers no useful information to bidders
  - The only information available is that some bidder has agreed to buy at the current price, but that causes the auction to end.

These two are equivalent because bidding a certain amount in the FPSB auction is equivalent to offering to buy at that amount in a Dutch auction. Therefore, Dutch open descending price auction is strategically equivalent to the first-price sealed-bid auction.

strategic Equivalence: for every strategy in one game, a player has a strategy in another game that results in the same outcomes

- **English auction**
  - Offers information when other bidders drop out. By observing this, it may be possible to infer something about their privately known information
  - with *private values*, however, this information is of no use
- **English Auction Strategy**
  - It cannot be optimal to:
    - Stay in after the price, p exceeds the value v (incurring a loss)
    - Drop out before the price reaches the value (losing out on potential gains)
  - Therefore, the optimal strategy is to bid up to the value $p = v$

the strategy for a **Second-price sealed-bid auction** is also the same:

- Bidder B with private value v bids a price p.
- The highest competing bid has price c

So, the optimal bidding strategy for this auction is:

- If B bids at $p = v$:
  - B wins if $v = c$ (making profit $v - c$) and does not win if $v < c$.
  - If $v = c$, assume B is indifferent between winning and losing
- Alternatively, if B bids p lower than v (i.e. $p < v$):
  - If $v > p > c$, then B still wins and profit is still $v - c$
  - If $c > v > p$, then B still loses, so also no change, BUT
  - If $v > c > p$, the B now loses, so makes less profit
  - Therefore, bidding $p < v$ can never increase profit for B but can decrease profit.

We say that these auctions are **weakly equivalent** because the two auctions are not strategically equivalent, but the optimal strategies are the same if the values are private.

With interdependent values, the information available to others in the open auction is relevant to a

bidder's evaluation of worth. Seeing some other bidder drop out early may make the bidder realise that his own estimate is too great. Therefore, if the values are interdependent, the two auctions may not be equivalent from the perspective of the bidders.

An auction is said to be *incentive compatible* if it encourages bidders to bid their *true value of the good*

Both English and Vickrey are incentive compatible, since when values are private, the optimal strategy is to bid $p = v$.

However, Dutch and FPSB are not, since we want to bid lower than the true value; attempting to stop the auction just below the price of what other bidders value the good at.

Incentive compatible auctions stop game-playing between bidders.

4.1.3 Revenue Equivalence Theorem (RET)

- In English/Vickrey auctions, bidders bid price $p = v$.
- In Dutch/FPSB, bidders price $p < v$.
- However, the expected revenue in a first-price auction is the same as the expected revenue in a second-price auction.

The revenue equivalence theorem states that if the values are private, and bidders are risk neutral, any standard auction will yield the **same expected revenue** to the seller.

The revenue equivalence theorem requires *risk neutral* bidders, meaning that they have no emotional attachment to the bids and they only seek to maximise expected profits. However, in reality, bidders are normally *risk averse*, meaning that they will bid higher, as they will buy *insurance* against the possibility of losing. When we take risk aversion into account, we get the result that the expected equivalence in the first-price auction is greater than that in a second-price auction.

The RET also requires private values, but in reality, the values are often interdependent, since we often change our valuations based on valuations from others. When we take interdependence into account, ordinary ascending auctions are more profitable than standard (first-price) auctions.