

Internet Economics and Financial Technology - Notes

Dom Hutchinson

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1 The Big Picture

Remark 1.1 - *History of Commercial Computing*

1950-60 Mainframes - slow; size of rooms.

1960-70 Minicomputers - slow; couple per rooms.

1970-80 PCs - faster; one per desk.

1980-90 LANs - distributed networks.

1990-10 Internet - world wide distributed network.

2010-20 Cloud Computing

Where does IT go next? Has it peaked as IT is almost fully diffused?

2 Economic Principles

Definition 2.1 - *Externality*

The production or consumption of a good has an *externality* if it affects a third party who was not involved in the transaction. e.g. Pollution from production is a negative externality; education is a positive externality.

2.1 Micro-Economics

Definition 2.2 - *Microeconomics*

The study of the behaviour of individual economic actors (individuals & business) and how decisions are made based on the allocation of limited resources.

Definition 2.3 - *Production-Consumption Cycle*

Producers produce goods & services which consumers wish to buy. Consumers have a limited amount of money so have to choose what to & to-not buy at given prices. Similarly, producers have a limited number of resources (raw, labour & capital) so need to decide what goods & services, at what price, to produce. These lead to the idea of supply & demand curves.

Definition 2.4 - *Supply and Demand Equilibrium*

The *Equilibrium* of a supply-and-demand curve is a *price* where the quantity demanded by all consumers is equal to the quantity supplied by all producers.

When there is *excess demand* prices will rise due to scarcity of supply. The increase in supply will reduce demand as some consumers will not be happy to pay the higher price, meaning a new (higher) *equilibrium price* will be reached.

If there is *excess supply* prices will decrease as producers try to encourage customers to buy their product over others, this will in turn attract new customers and cause some producers out of business. A new lower *equilibrium price* will be reached.

Definition 2.5 - Consumer Demand Curve

A consumer's *Demand Curve* plots the quantity of a product a consumer is willing to buy for a given price-per-unit. These are typically downwards sloping as consumers prefer to pay lower prices. It is assumed a consumer will buy the quantity of units equal to the point where the *Demand Curve* intersects the market price.

The area under the curve, but above the *Market Price* is known as *Consumer Surplus*. This quantifies how much more a given consumer was willing to pay than the market price. The number of items a consumer is willing to buy at the *Market Price* multiplied by the *Market Price* gives the *Expenditure* for that consumer. Consumers want to maximise *Consumer Surplus*.

See Figure 2

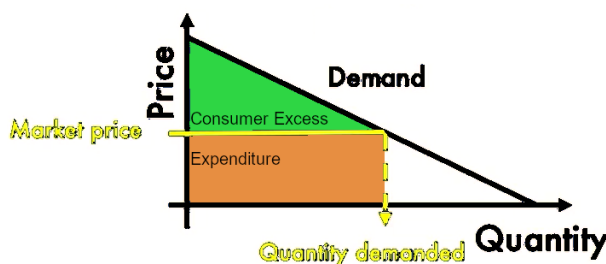


Figure 1: Consumer Surplus & Expenditure

Definition 2.6 - Production Costs

A producer will have costs they need to pay in order to stay in business. These costs can be categorised as

Fixed Costs A company must incur in order to operate, even before they start producing. (e.g. rent)

Variable Costs are costs which depend on the number of units produced. (e.g. equipment, raw materials)

Semi-Variable Costs Labour can be considered a variable cost as you can choose to pay overtime or to hire someone new in order to increase production.

The sum of these values will give you the *Total Cost* of production.

Definition 2.7 - Marginal Cost Curve

Marginal Cost is the cost of producing the last unit. It is equal to

$$\frac{\text{Change in Cost}}{\text{Change in Quantity Produced}}$$

We can plot a *Marginal Cost Curve* of marginal cost against quantity. Typically these are initially downwards sloping, then upwards sloping.

Definition 2.8 - Economies of Scale

When the *Marginal Cost Curve* is downwards sloping *Economies of Scale* are being experienced. *Economies of Scale* are the cost advantages a producer obtains by scaling their business. e.g.

By hiring a new staff member existing staff are able to specialise better on their task and thus production per staff member increases.

When the *Marginal Cost Curve* is upwards sloping *Diminishing Marginal Returns* are being experienced. This is common as it is unlikely that hiring 10 new staff will increase marginal production by 10 times that of a single new staff member.

Economies of scale & diminishing marginal returns affect the *Cost Curve* for a producer.

Remark 2.1 - Minimum Sale Price

The *Marginal Cost* of a product is the minimum price a product must be sold at in order to make a profit.

A producer will go out of business if it cannot sell above its *Average Variable Cost* (per unit produced) in the short run; and if cannot cover its *Average Total Cost* (per unit produced) in the long run.

The point where these *AVC* & *ATC* curves intersect the *Marginal Cost Curve* define the minimum amount of units a business needs to sell to stay in business in the short and long term, respectively.

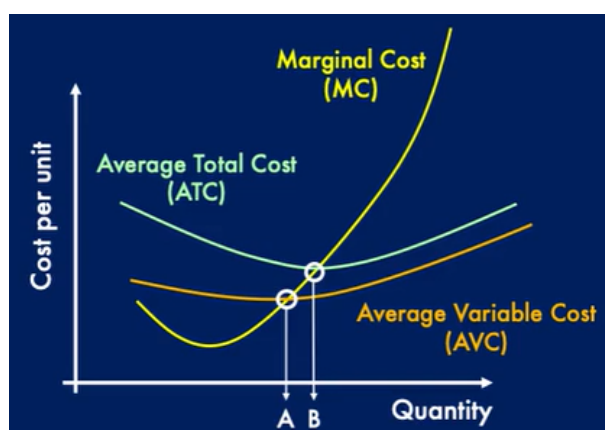


Figure 2: Cost Curve for a Product of a Physical Retailer

Definition 2.9 - Business Supply Curve

A business's *Supply Curve* is the minimum price-per-unit it is willing to sell each quantity of product at. It tends to be upwards sloping as marginal cost increases with quantity. The *Supply Curve* will be truncated and not have a value for small quantities (in practice) as the business would fail if it sold too few products.

Definition 2.10 - Market Supply Curve

The *Market Supply Curve* is the total number of units available, for a given price, across all producers in a market.

The area above the *Market Supply Curve* and below the *Market Price* is the *Producer Surplus*. This is the total additional income a producer receives after costs (i.e. total profit). Producers want to maximise *Producer Surplus*.

Definition 2.11 - Competitive Equilibrium

In a *Competitive Market* the *Market Equilibrium Price* will be that where the *Consumer Demand Curve* and *Market Supply Curve* intersect, as this is the price where quantity demanded and supplied are equal. The *Market Equilibrium Price* maximises total surplus for both consumers and producers.

Definition 2.12 - Shifts

Shifts can occur which move the whole of a supply or demand curve. These occur from non-price factors. e.g. a pandemic will cause a shift in the demand curve for face masks. These will cause a shift in *equilibrium price*.

Definition 2.13 - Monopoly Market

A market is considered a *Monopoly* if its structure is characterised by a single seller (The *Monopolist*). The *Monopolist* faces no competition and thus can be a price setter, rather than price taker. In the real world a firm with over 40% market share is considered to have a monopoly. Monopoly markets are not competitive.

2.2 Elasticity

Definition 2.14 - Price Elasticity of Demand

Price Elasticity is a measure of the how much the price of a product affects the quantity demanded. The more horizontal the demand curve, the greater the quantity demanded increases for a given decrease in price, (i.e. the more elastic the price is).

- A *Horizontal* demand curve has *Perfect Price Elasticity* as a change in quantity has no affect on price.
- A *Vertical* demand curve has *Perfect Price Inelasticity* as a fix quantity is demanded, at any price.
- A *45 degree* demand curve has *Unit Price Elasticity* as an $\Delta\%$ change in supply will produce an $\Delta\%$ change in demand.

Definition 2.15 - Price Elasticity of Supply

Supply Elasticity is a measure of how much a change in quantity supplied will affect the cost of production. The more horizontal the *Supply Curve* is the less the price of production increases for a given quantity.

- A *Horizontal* demand curve has *Perfect Price Elasticity* as a change in quantity has no affect on price.
- A *Vertical* demand curve has *Perfect Price Inelasticity* as a fix quantity is demanded, at any price.
- A *45 degree* demand curve has *Unit Price Elasticity* as an $\Delta\%$ change in supply will produce an $\Delta\%$ change in demand.

3 The Economics of The Internet

Definition 3.1 - Network Externalities

A *Network Externality* is an *Externality* that occurs when the act of buying a product/service has an indirect cost or benefit to those who already own the same product/service. Products with positive network externalities are often known as *Network Goods*.

Owning a mobile phone has a positive network externality as you are increasing the number of contactable people. Owning a car has a negative network externality as you increase road traffic.

Positive network externalities can produce a *Positive Feedback Loop* where people buy products which are compatible with their friends, rather than necessarily the best product. This is part

of *Brand Value*.

Definition 3.2 - Network Effect Demand Curve

We can plot a *Network Effect Demand Curve* (Figure 3) of the price customers are willing to pay against network size. This is slope upwards initially as the marginal value of each extra user is higher; eventually it will slope downwards as these marginal gains diminish.

For any given price there are three equilibrium points q_0, q_1, q_2 for network size. q_1 is deemed unstable, the '*tipping point*', as once the network is larger than q_1 it will naturally grow to q_2 (as there is a consumer excess) but whilst it is smaller it will shrink to q_0 (as there is a consumer deficit). This means q_1 is the *Critical Mass* for the network to be sustainable.

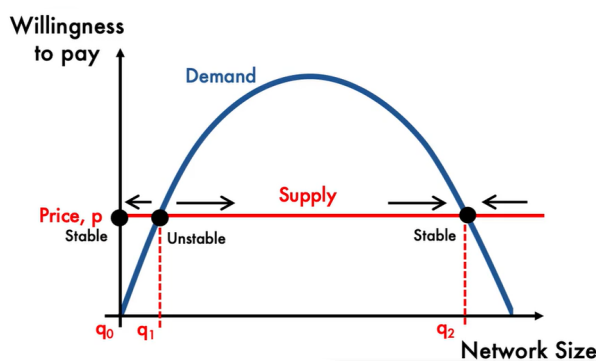


Figure 3: Network Effect Demand Curve

Proposition 3.1 - The Long Tail

Sales business typically sell either: high volume, low margin goods (e.g. burgers); Or, low volume, high margin goods (e.g. cars). Physical sales businesses are constrained by the physical shelf space they have and thus avoid low volume, low margin goods. This means that the sales distribution for products in a physical store will be a truncated *Pareto Distribution*.

Internet businesses have unlimited shelf space to advertise products, and since warehouse space is much cheaper (per sq ft) they can store a lot more products for the same cost, effectively increasing the margin of each product. Meaning there are more products which are profitable to stock and the sales distribution for products of an internet business will have a much longer tail. (See Figure 1).

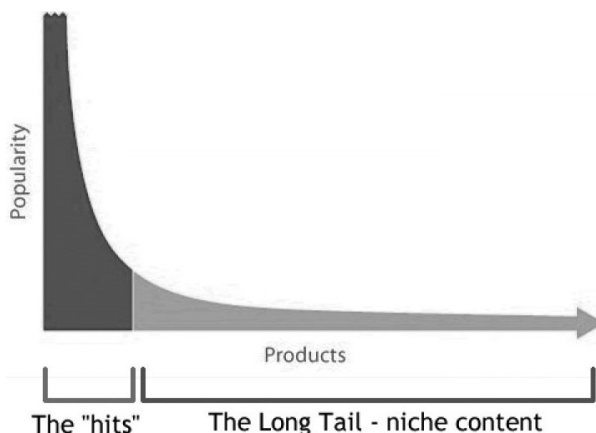


Figure 4: The Long Tail

Remark 3.1 - *How to take advantage of 'The Long Tail'*

- i). Make everything available.
- ii). Reduce prices (due to economies of scale & reduced costs).
- iii). Help customers find new products.

Remark 3.2 - *Sustaining v. Disruptive Innovations*

Sustaining Innovations are those that incrementally improve existing products on traditional performance metrics. Eventually these will supersede customer requirements.

Disruptive Innovations perform less well on traditional performance metrics but sufficiently better along other metrics in order to generate new markets.

Proposition 3.2 - *Disruptive Technology*

Established companies are often late to invest in new *disruptive* technologies. Typically this is due to the *disruptive* tech not reaching the requirements of their customers. However, the *disruptive* tech maybe better in other ways (lighter, more durable etc.) and so can establish a sufficient market for startups to invest in it. Once the *disruptive* tech does reach the requirements of mainstream customers, they are likely to jump to the new tech for these bonus features (lighter, more durable etc.) and the established company may fail.

The new tech may still be less powerful than the established tech, but it is sufficient for customers so it doesn't matter. The traditional performance metric for performance will vary by industry (e.g. mb/£ for hard drives).

Proposition 3.3 - *Timeline of Disruptive Technology*

- i). *Disruptive Technology* is invented. Often by an established company.
- ii). The *disruptive technology* does not meet established the established company's requirements and so not focused on.
- iii). New companies form to pursue the *disruptive technology*. Often by ex employees of the established company.
- iv). *Disruptive Technology* improves & meets traditional performance metric requirements. The established company will likely try to enter the new market at this point but will be too late.
- v). *Disruptive Technology* becomes the main stream.

Proposition 3.4 - *How to spot Disruptive Technology*

- i). *Determine whether the technology is disruptive or sustaining*

3.1 Properties of Online Businesses

Remark 3.3 - *Economic Laws*

The *Economic Laws* are not fundamentally different between online & irl businesses, but the characteristics of online business activities can result in different markets.

Definition 3.3 - *Combinatorial Innovation*

Combinatorial Innovation describes a technology whose components can be combined & recombined to create new products and services. The Internet is a *Combinatorial Innovation* due to its standardised and open-source nature.

Proposition 3.5 - *Economic Differences between Digital & Physical Goods*

- Digital goods tend to be costly to produce; but *cheap to reproduce*. (i.e. Fixed costs are high but variable costs are low).
- Production costs for digital goods are sunk costs. (e.g. You can sell a building you don't need, but cannot get money back from a software developer).
- There are *no capacity constraints* limiting the number of times something can be reproduced.
- Digital goods are often *Experience Goods*. (i.e. a customer will not know whether they will like it before they try it, and thus cannot assign a value to it).
- *Search Costs* for a consumer are very low. It is easy for consumer to compare products and go with the best. IRL this is harder as it requires going to different stores.
- Digital goods have *strong positive network externalities*

Remark 3.4 - Switching Costs

A customer may incur a cost (inc. non-monetary) to switch services. This is more common (and costly) in the digital space than the physical. When switching costs are too high, consumers are *locked in*. Possible switching costs include:

- Training cost.
- Network effects.
- Setup costs.
- Reduced service quality due to new provider not having all your information (consider switching from Netflix).

Proposition 3.6 - Cost Curve for Digital Goods

Since digital goods have high fixed cost but low variable costs their *cost curves* are very different. The *Marginal Cost Curve* is effectively zero for all quantities; Average Variable Costs are effectively zero for all quantities; and, average total costs tend asymptotically towards zero. This means it is easy for an online business to survive in the short term and the minimum price they are willing to sell a product at is zero (due to v. low variable costs). Eventually the company will need to pay off its fixed costs.

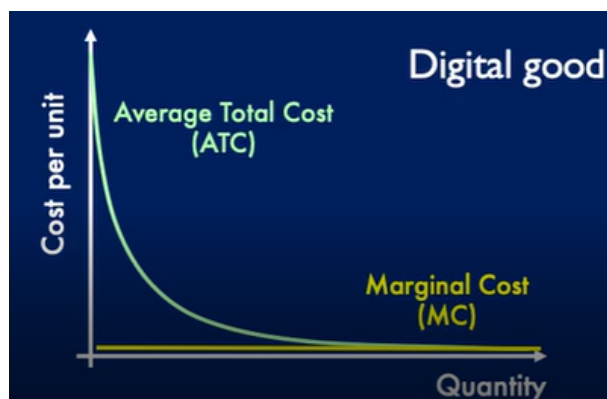


Figure 5: Consumer Surplus & Expenditure

Remark 3.5 - Competition between Digital Companies

- Due to low variable costs, companies with identical digital products will very quickly move prices to near-zero.
- New companies will struggle as fixed costs are high.
- Network effects & switching costs make it hard for new companies.

Due to these *barriers to entry* monopolies are common among digital companies. To succeed, a company needs to focus on product differentiation (i.e. innovation).

Remark 3.6 - *Formats*

Companies can make their software use *Proprietary Formats*, meaning the files cannot be used by other software. This increases switching costs for customers.

Using *Industry-Wide Standards* allow a user's files to be shared between providers. This can increase the network effect, potentially attracting new customers. Here companies have a trade-off between having a large part of a small pie, or a small part of a large pie.

Remark 3.7 - *How Standards Develop*

Industry-Wide Standards general develop in one of two ways

- i). A *single (major) player* sets a standard by opening up their proprietary format (e.g. PDF).
- ii). A *war* occurs between multiple standard setters. Generally detrimental to everyone involved.
- iii). A *negotiation* occurs between multiple standard setters. There is a risk that one party may pull out of the deal and use their own proprietary format.

3.2 Digital Monopolies