The diffusion of innovations

Introduction

Projecting how the market for a new technology will grow is probably one of the most difficult questions in economics. Why is it so hard?

1. it is customary to assume that tomorrow's markets are just more developed versions of today's, but in fact new needs, applications, wants and sources of competitive advantage may be evident tomorrow that are not present today.
2. we often fail to recognise how 'path dependent' is the evolution of demand for a new technology
3. demand projections will depend on the evolution of this technology, but also of its rivals, and the latter is not always easy to foresee.
4. one of the regular features of competition in new technologies is that new rivals emerge from unexpected directions – especially when technologies are converging.

‘EPIDEMIC’ MODELS

These models recognise that there is a certain similarity between the diffusion of a new technology amongst a population of users and the spread of an infectious disease amongst a population of people who do not have resistance.

- The epidemic model assumes that each time the consumer is ‘exposed’ to the new product or service there is a certain probability that he will be ‘infected’.
- The epidemic model assumes that the rate of new cases of adoption is proportional to the product of the number infected and the number who are not infected, but could be the potential future adopters.

‘EPIDEMIC’ MODELS

The epidemic model makes some rather strong assumptions about ‘infection’ – i.e. how the adoption of the innovation will spread.

1. **Each exposure increases the buyer’s probability of purchase regardless of who conveys the message. But in practice, buyers tend to be more heavily influenced by those that they know and trust**
2. **Each exposure increases the buyer’s probability of purchase regardless of the quality of the pioneer’s experience. But in practice, this is too simplistic.**
   - The social process which spreads the use of a technology is taken to be the exchange of information amongst potential users, and the pioneer plays an important role as demonstrator and educator.
   - In more subtle models of this sort, it is not just the number of pioneers that count, but also how influential each one is.
   - Moreover, the effect that the pioneer has on subsequent adopters is also dependent on his experience with the technology: good experiences promote diffusion, while bad experiences retard diffusion.

‘EPIDEMIC’ MODELS

In the very long-term, the level of diffusion approaches a maximum.

- This technique is useful for projecting how fast the uptake will be, given a certain saturation level of diffusion, but it does not in itself help us to estimate the saturation level.
- The epidemic model remains relevant in a variety of settings.
  - It is relevant to the understanding of diffusion when price and quality are not an issue, and when consumers are not constrained by income or other factors.
  - Speeds of diffusion will vary enormously from one technology to another – for example compare the diffusion of the car and a particular pop record.

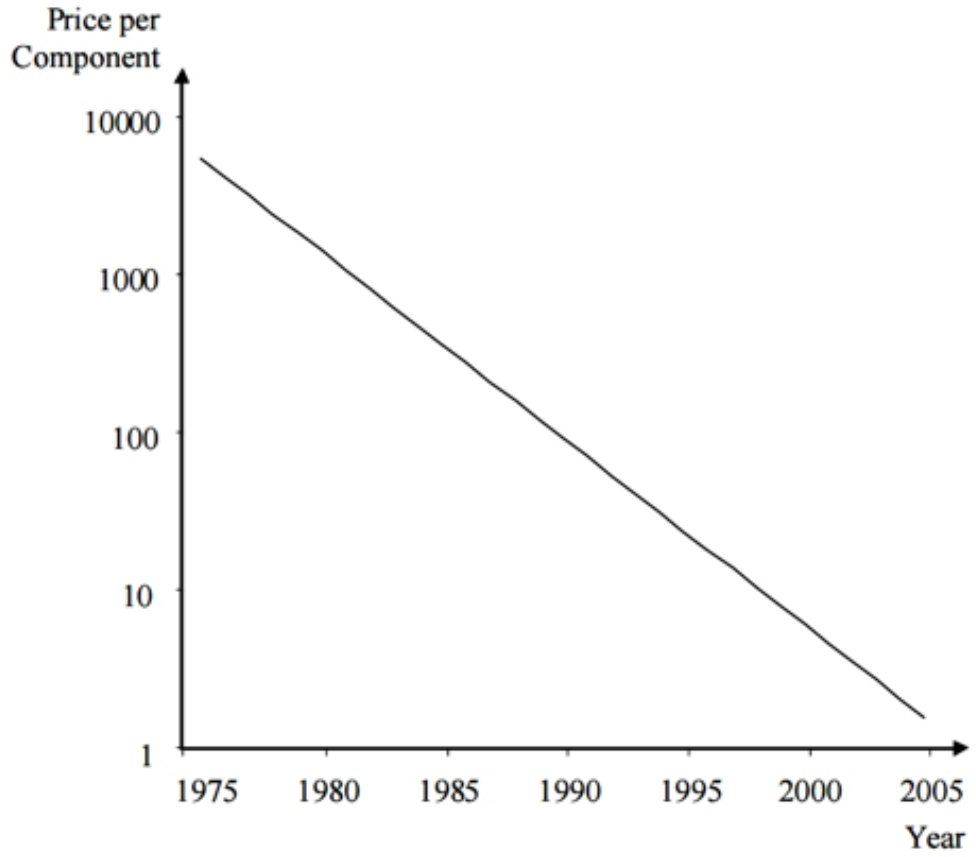
PRICE AND QUALITY EFFECTS

In this approach, as price falls and quality improves, more consumers enter the market.

- This approach is most relevant for products subject to rapid technological change, so that their price falls or their quality improves.
- This approach is based on the underlying assumption that we have an economic consumer.
- As a result, we can analyse the way the consumer responds to price reductions and quality improvements using the product map and territory map.
    - The territory map describes the sorts of consumers that buy a particular product. Any price reductions and quality improvements in a particular product extend the territory of that product.

Rapidly declining prices per component

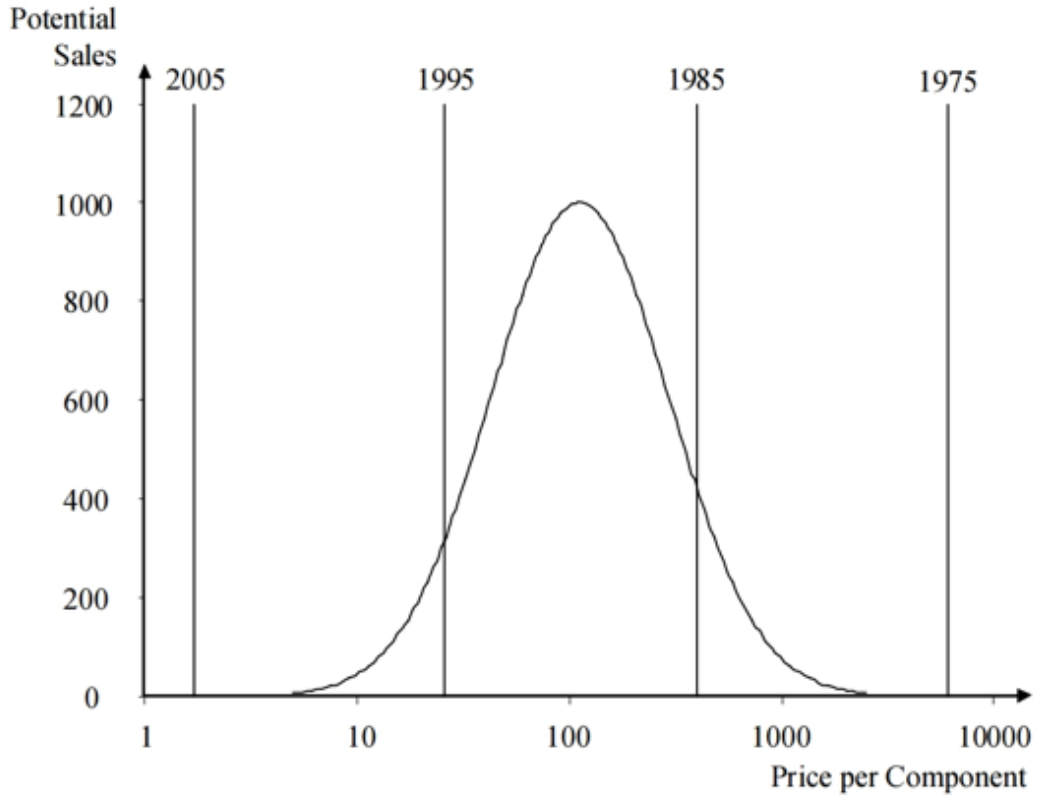
The graph summarises the trend in one of the simplest measures of improvement in a technology: the cost per component. The line drawn here is related to Moore's Law: as originally stated, this observed that the rate of increase in the number of components per semiconductor chip was doubling every year, though the rate of advance started to tail off as the technology matured.
This also implies an exponential decline in the price per component.



Distribution of willingness to pay

The graph draws out the implications for buyer demand. It shows the numbers of buyers that are prepared to pay different prices per component.
As the price per component falls over time, so the cut-off point sweeps leftward thus drawing ever more users into the market.

The speed of diffusion here depends on the speed of price decline and the variance of the willingness-to-pay of different buyers. As drawn, the variance is very large, but so also is the rate of price decline.



INCOME, SIZE AND OTHER DRIVERS

- Another force leading to diffusion is related to **growing income**, turnover or other characteristics of the buyer.
- As income per capita rises gradually over time then consumption of some products will rise.
  - At an early stage, buyers may be limited to those on relatively high incomes, but as the average level of incomes rises, more and more buyers enter the market.
- The same principles can be applied to the diffusion of new technologies amongst firms.
  - For some expensive new technologies, early buyers may be the larger firms, but as the smaller firms grow, they too would be potential buyers.
- This basic approach can also be used with other consumer or firm characteristics: as consumers become educated they are more likely to buy certain products; as firms become more concerned to seek new sources of competitive advantage in an ever more competitive market, they may be more likely to buy into some new technologies.

INCOME, SIZE AND OTHER DRIVERS

- This process generates an S-shaped diffusion curve.
- Diffusion promoted by growth in incomes, revenues or other buyer characteristics tends to be a slower process than diffusion attributable to other effects. The reason for this is simply that the rate of growth of incomes is typically quite a small percentage rate.
- GDP per head rises at perhaps 3% per annum on average, and most consumers' incomes rise no faster than that.
  - Large companies do well to grow any faster than that.
  - Some smaller companies of course can grow a good deal faster, but they are outnumbered by companies that don't.

STRATEGIC INCENTIVES FOR ADOPTION

- The models of diffusion described contain no element of strategic interaction.
- Game theory models of diffusion, however, suggest that such strategic interaction between players may be an important factor in explaining the rate of diffusion.
- For example, some adoption decisions may be driven by a desire to forge ahead of competitors in order to achieve a cost, quality or performance advantage.
- Equally, some adoption decisions may be driven by a need to catch up with competitors and thus to make good a cost, quality or performance disadvantage.
- Interestingly, the former incentive may be strongest when diffusion has not progressed far in the market:
  - in that case, there is still scope to forge ahead. But the latter incentive may be strongest when diffusion is quite well progressed: in that case, the need to catch up is most pressing.
- The rates of diffusion generated in these models can be very rapid.

BANDWAGON EFFECTS

https://www.youtube.com/watch?app=desktop&v=SiYxq62RxoA

- The **bandwagon effect** is the tendency for people to adopt certain behaviors, styles, or attitudes simply because others are doing so.
- More specifically, it is a cognitive bias by which public opinion or behaviours can alter due to particular actions and beliefs rallying amongst the public.
- It is a psychological phenomenon whereby the rate of uptake of beliefs, ideas, fads and trends increases with respect to the proportion of others who have already done so.
- As more people come to believe in something, others also "hop on the bandwagon" regardless of the underlying evidence.
- We start with the case where customer A's adoption of an innovation makes customer B more likely to adopt. This could be the result of strategic interaction as just described or a result of network effects. It may be that there are direct network benefits from adopting a technology which has a large installed base of users.

BANDWAGON EFFECTS

- This is sometimes called a penguin effect.
- The reason for this metaphor is that penguins often line up along the edge of the ice waiting to jump in to catch fish. But they know there is a risk of being the first to jump in because there is a danger from predators.
- If one penguin, wisely or otherwise, has the nerve to jump in first and is not attacked by predators, then the rest will soon follow as the perceived risk has fallen.

BANDWAGON EFFECTS

- This feature of rapid take-off can also arise where firm B faces competitive pressure to adopt a new technology because their rival firm A is using it with good effect to take market share away from B. While firm B may not be especially interested in adopting the technology on its own merits, they may become so if firm A exploits the technology for competitive advantage. This can lead to a ‘me too’ attitude to adoption, and a very rapid rate of diffusion.
- This process of diffusion as a result of competitive pressure, operating in addition to those can further accelerate the process of diffusion.
- One major feature of technological change noted above is that firms tend to find new competitors emerging from new and unexpected directions.
- That means the technology adoption decisions of an ever greater number of firms can impinge on the decision faced by one particular firm.
- This proliferation of competitors can make diffusion resulting from competitive pressure a very rapid process, and will continue to raise the level at which the market reaches saturation.

DISTINCTION EFFECTS

- Now we turn to the case where customer A's adoption of an innovation makes customer B less likely to adopt.
- Perhaps the customer has a desire for distinction or the value of adoption may actually fall if too many others have already adopted.
- These effects can also arise in the context of industrial buying if a group of pioneering buyers is seen as a 'distinction group' by another large set of industrial buyers. This could happen if early applications in some sectors were generally thought to be unsuccessful, and if other companies seek to distinguish themselves from the geekish early users.
- This emphasises again how important it can be that early applications of a technology are successful to maximise its ultimate diffusion

CONCLUSION

- In most practical cases, actual diffusion patterns will exhibit a mix of the different phenomena described.
- Moreover, it is often the case that several of the different consumer types described will play a distinctive role in the observed pattern of diffusion.
- Marshall consumers (and perhaps also Veblen/Bourdieu consumers) may be essential as pioneers at an early stage, while Douglas consumers become more important later on, and Galbraith consumers are most important as the market approaches maturity.