



The Introduction of New Technology into the Household

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Abstract: Economic considerations should be fundamental to the design process. Modern economics provides a useful tool to analyse consumer demand for new technology. This paper sets out some basic economic concepts and then looks at the history of the introduction into the household of phones, TVs and VCRs, CDs and home computers and the Internet. It then takes the first tentative steps towards identifying the explanatory variables that should be included in a model of demand for new domestic technology.

Keywords: Consumer demand; Economic models; Technology in the home; Time budgets

1. Introduction

How fast will a new technology be adopted in the home? When new technology is introduced, the key question for producers, and social observers, is the rate and pattern of adoption across society. A host of factors will affect this, ranging from design, function, form, and so on. But surely the economic aspects will be fundamental, as Marx taught us long ago. Pearce [1] defines economics as “the study of the way in which mankind organises itself to tackle the basic problem of scarcity”. Hirschleifer [2] expands: “There is an economic problem whenever the constraint of resource scarcity impinges upon life.” Households have limited money and limited time available and they have to decide how to allocate them between competing desires and demands. The allocation of both are directly relevant to the adoption of new technology.

Curiously, there is very little express economic analysis in the literature reporting on new technologies in the home, particularly interactive ones. There has been greater emphasis on the interactive functions of technologies; what it is they do for users. This may, of course, be appropriate at a certain stage in the design process. It can be argued that one doesn't need to think about price while investigating what an interactive technology might do. The analysis and calculation of price would be dealt with later in the design process. However, I would argue that economic considerations should be treated as fundamental to the design process. Indeed, I would go further and argue that modern economics provides a useful tool that can be applied to new technology: the demand for a new

gadget in the home will be determined by the same general factors as the demand for any other item and is therefore susceptible to the same modelling techniques.

My purpose in this paper is a very limited one. It is to take the first tentative steps to identify the factors that are likely to be significant and amenable to statistical analysis. Section 2 summarises some basic concepts of economic theory. Then, as the starting point for building an economic model has to be what has happened in the past, in Sections 3 to 7 I look at some data on the use of time and money and, in particular, in relation to selected domestic technologies: phones, TVs and VCRs, CDs and, lastly, home computers and the Internet. Section 8 concludes by making a first attempt to identify potentially useful components of an economic model and setting out the next steps.

2. The Economics of Consumption

2.1. Utility and opportunity cost

The economic theory of consumer behaviour is based on the assumption that households want to maximise their “utility” subject to a “budget constraint”. “Utility” is widely construed as “welfare” [1]. The “budget constraint” is generally interpreted as money, but time can be taken into account too.

The theory says that households will buy goods only if by so doing they increase their overall level of utility and, in general, the more a household





consumes, the greater its utility. What gives utility to the household will be determined by the household's preferences or, more colloquially, tastes. Tastes are determined by all sorts of factors, including demographic, sociological and psychological.

How much the household can afford will depend on its income and the prices of the goods it desires. Given a limited budget, of money or time, it has to make choices. If it buys A, then it can't afford B. If you spend Saturday afternoon browsing the Internet, then you can't watch the football match live. In the economic jargon, this is the "opportunity cost", which Pearce [1] describes as "perhaps the most fundamental concept in economics". Formally, the opportunity cost of an action is the value of the foregone alternative action. It is the effects of prices and income on households' choices that economists have focussed on, often assuming "tastes" are given. Yet if we are to create a useful model of the demand for new technologies, we need to try to build a complete picture as possible of household behaviour.

2.2. Income

Economists use the concept of income elasticity to summarise the relationship between income and expenditure and classify goods accordingly. Income elasticity is a measure of the responsiveness to the quantity demanded of any good to a change in the level of income of the persons demanding the good [1]. If a rise in income of, say, 10% results in a less than 10% rise in the expenditure on the good, then the income elasticity of that good is said to be low and the good is described as a necessity. But if the opposite holds – a 10% rise in income results in a more than 10% rise in expenditure – then the good can be called a luxury. It is likely that new domestic technology, is, by this definition, a luxury [2,3].

Marshall [4] pointed out that

...the additional benefit which a person derives from a given increase in his stock of a thing diminishes with every increase in the stock that he already has.

In other words, the more a person has, the less he values it. This holds for money just the same as for other commodities, so:

...every increase in resources increases the price which he is willing to pay for any given benefit.

This means that the richer a person is, the more he is willing to pay for less benefit. Therefore, it is to be expected that the rich will be the early adopters of new technology. Then, over time, as

the economy grows and people become better off, things that were once only affordable by the rich will spread to the rest of society.

But why do the rich buy new technology? One answer is that new technology can be used to "buy" more free time. Douglas and Isherwood [5] present the idea of "periodicities". They argue that "between households of different income levels, to be poor is to be periodicity-constrained in the process of household management". In other words, the poor have to spend more time doing chores while the rich can afford new technology to free them. Consequently, a change in life-styles can be identified by a change in periodicities. Further, they propose that "...periodicities give a rough approximation to a major difference in the use between necessities and luxuries: future necessities in the present luxury class will be sets of goods with effective periodicity-relieving properties."

Becker [6] proposed a model of household behaviour that integrated both money and time constraints. He developed the concept of "full income" defined as "the sum of money income and that forgone by the use of time and goods to obtain utility". He expands:

This income could in general be obtained by devoting all the time and other resources of a household to earning income, with no regard for consumption. Of course, all the time would not usually be spent "at" a job: sleep, food, even leisure are required for efficiency and some time (and other resources) would have to be spent on these activities in order to maximise money income.

By taking into account the value of time in this way, Becker [6] argues that it is possible to gain a better understanding of households' consumption behaviour. He cites the observation that Americans – even back in the 1960s – are "wasteful" of material goods and yet "economical" with time and argues that this apparent paradox arises because "the market value of time is higher relative to the price of goods than elsewhere". This is particularly relevant to the demand for new technology.

Economic theory therefore predicts that the demand for a new technology that consumes time will be limited in societies with high productivity such as America while those that release time will be more popular, all other things being equal.

2.3. Prices

Prices determine how much people can buy with their given income and are therefore crucial in considering the effect of the budget constraint. The higher are prices in general, the less people can



afford, and the less “spare” income they have to spend on new technology. Of course, the higher the price of the new technology itself, the lower will be the demand for it.

The price of new technology may fall for a number of reasons. Technological improvements in production may lower the costs. Then, as demand expands, suppliers will start to benefit from economies of scale. To the extent that reductions in the cost of manufacture are passed on to consumers, demand will be increased. However, most importantly, prices will fall as a result of competition. New suppliers will enter the market, undercutting the original producers. Or, once the market among the rich is saturated, the original producers will cut their profit margins or produce a similar but simpler and cheaper product to sell to the mass market.

Howsoever caused, price reductions will stimulate demand:

A fall in the price of a commodity does actually affect the demand for that commodity in two different ways. On the one hand, it makes the consumer better off, it raises his “real income” and its effect along this channel is similar to that of an increase in income. On the other hand, it changes relative prices; and therefore apart from the changes in real income, there will be a tendency to substitute the commodity whose price has fallen for other commodities. [7]

The extent of this stimulation will depend on the price elasticity, the responsiveness to demand to changes in price. If a price fall of say, 10%, results

in a more than 10% rise in demand, then demand is said to be price elastic. If the opposite holds – a 10% fall in price results in a less than 10% rise in demand – then the demand is said to be inelastic. Basic needs tend to be price inelastic. The demand for new technology, particularly when it is first introduced, is likely to be very price elastic. However, as technology becomes absorbed into society, and widely regarded as a necessity, the price elasticity will fall.

3. Some Facts and Figures

3.1. About income and expenditure

In the 19th century, the German statistician Ernst Engel examined the relationship between income and the demand for certain types of commodities. Since then the relationship between income and expenditure has been summarised by Engel curves. Engel predicted that as income rises, the proportion of income spent on food would decline [2]. This is still the case today. Figure 1 shows that in the UK in 1997–98, as income rose, the proportion of expenditure accounted for by food fell. In contrast, the share of leisure services rose.

Between 1971 and 1995, expenditure on “recreation, entertainment and education” rose from £14 billion a year to £40 billion in 1990 prices [8]. In

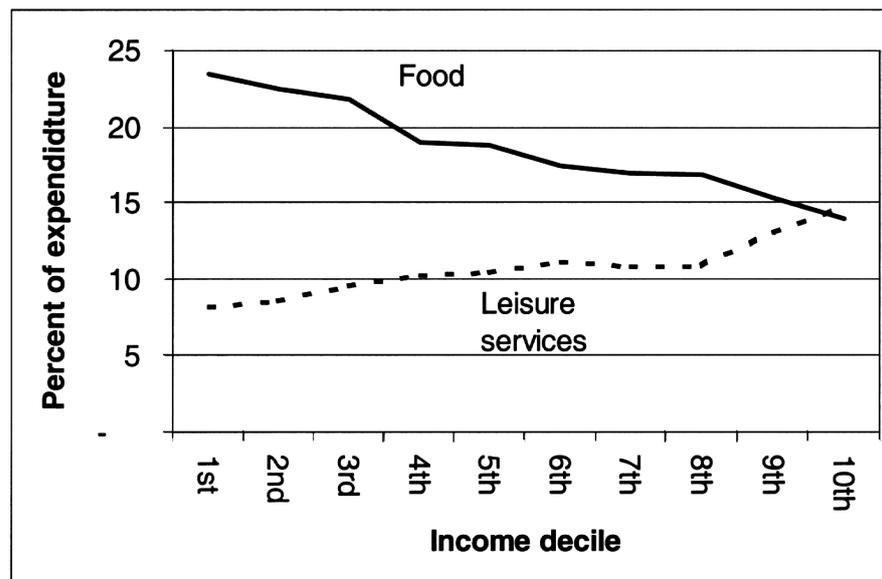


Fig. 1. Engel curves: budget share spend on (a) food and (b) leisure services, UK, 1997–98. Source: Family Spending: a Report on the 1997–98 Family Expenditure Survey. Office for National Statistics, 1998





other words, the market almost trebled in size. For the US, Dholakia and Dholakia [9] report that recent evidence “suggests an uptick in discretionary dollars allotted to entertainment from 7.7% in 1979 to 9.4% in 1993”.

In absolute terms the difference between the richest and poorest households are even more marked. In the UK in 1997–98, on average the richest households spent 12 times as much in absolute terms on “leisure goods and services” than the poorest households (Table 1).

In summary, while the budgets of individual households are fixed in the short-term, which limits their capacity to buy new technology, in the longer term, as societies become richer, they have more income to spend on goods that are not necessities.

3.2. About time budgets

The amount of time available is fixed: there are only 24 hours in the day. The amount of truly “free” time available, that is, time which is not required for work, sleep, preparing and eating food and such essential activities, is limited. Analysing the use of time is difficult because it is subjective. While people can only spend money on item X or item Y, they can spend time doing more than one activity. For example, if you are doing the ironing while watching TV is your main activity housework or leisure?

Comparison over time is very difficult but it appears that the amount of free time has increased in the longer term. A major multi-national study undertaken in the 1960s [10] found that on average people had about 31 hours of “free time” a week. A 1995 survey showed that on average British adults had 40 hours per week free time (Table 2).

However, the amount of free time does not seem to have changed significantly in recent years for full-time employed men in Britain: in both 1985 and 1995 they enjoyed 34 hours a week on average. Yet their female counterparts seem to have more: up from 25 in 1885 to 31 in 1995 [8,11]. Table 3 shows that watching TV and listening to the radio dominate free time.

Punie [12] reports that:

Even at the aggregate European level, there seems to be a relatively steady 60:40 split between leisure time spent in the home and outside the home.

Table 4, based on the May 1995 study in Great Britain, could be interpreted as confirming this, depending on how leisure time is defined. If

Table 1. Spending on “leisure goods and services”, UK, 1997–98.

	Average expenditure	Spending on “leisure goods and services”	
	£	£	As % of total expenditure
Bottom decile ¹	96	8	8
Top decile ¹	724	145	20
Average	329	39	12

¹By income

Source: Family Spending: a Report on the 1997–98 Family Expenditure Survey. Office for National Statistics 1998, Table 1.3

Table 2. Time use, British adults aged 15 and over, 1995.

Activity	Hours
Sleep	61
Work/study/travel	32
Housework, cooking and shopping	16
Eating, personal hygiene, caring	15
Household maintenance and pet care	4
Free time	40
Total	168

Source: Social Trends 26. 1996, Table 13.2

Table 3. Use of free time, Great Britain, 1995.

Activity	Hours per week
TV or radio	19
Socialising	11
Visiting friends	5
Talking/socialising and telephoning friends	3
Eating and drinking out	3
Activities	9
Reading	3
Walks and other recreation	2
Hobbies, games and computing	2
Sports participation	1
Religious, political and other meetings	1
Other	2
Total	42

Source: Social Trends 26, 1996, Table 13.4

travel and shopping are not counted as leisure, while gardening and DIY are, then the split between “home” leisure and “out-of-home” leisure is 62:38.

The amount of free time, like income, does not change significantly in the short term. However, even in the longer term, the scope for change is limited, in comparison with the scope for income



Table 4. Detailed analysis of time use in Great Britain, 1995.

“Essential” activities	Minutes per day	Leisure activities	Minutes per day
Sleep	522	Home leisure	
Paid work	181	Gardening/DIY	39
Cooking, eating, housework	156	TV and radio	153
Travel	46	Other home leisure	68
Personal care	44	Total home leisure	260
Shopping	36	“Out-of-home” leisure	
Care of children, etc	27	Socialising	63
		Eating/drinking out	31
		Other out-of-home leisure	63
Total “essentials”	1012	Total out-of-home leisure	157
		Total leisure	417

NB Total does not equal 1440 due to rounding and activities not stated.
Source: Social Trends. HMSO, 1998, Table 13.2

growth. This means that any new activity must by and large displace an existing activity. Given the apparent domination of TV and radio, it is these activities that are most likely to be negatively affected by the introduction of new activities related to new technology into the household.

4. Telephones:

4.1. Introduction

Fixed line phones: The telephone was invented in 1876. By 1900, nearly 10% of households in the US had phones. Ninety years later, the figure had

risen to 95%. Ownership of domestic telephones in the UK has lagged behind the US. In the UK the penetration rate did not reach 50% until the mid-1970s, a level reached by the late 1940s in the US. The UK probably just caught up with the US in the late 1990s: by 1997–98, 94% of households in the UK had telephones. Figure 2 shows that after reaching that 50% rate, phones spread rather faster in the UK than in the US, but the basic pattern was similar despite different time periods and countries.

Mobile phones: Data from the Family Expenditure Survey shown in Table 5 illustrate graphically the rate of increase in the use of mobile phones.

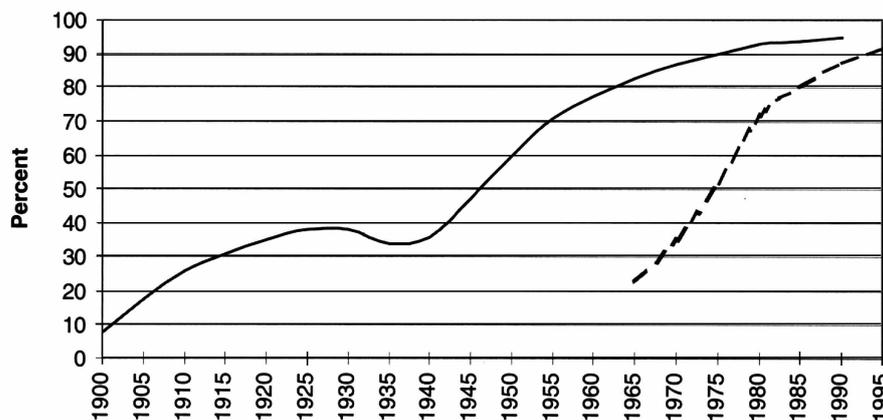


Fig. 2. Percent of households with phones: USA and UK.

Sources:

UK 1964–1993: Family Spending: a Report on the 1993 Family Expenditure Survey. CSO, HMSO, London, 1994, Table 9.3

1994 on: Family Spending 1997–98: a Report on the 1997–98 Family Expenditure Survey. ONS, Table 9.3

US to 1980: Based on US census data reproduced in [1/4]

1990: US Census: <http://www.census.gov/hhes/www/housing/historic/phone.html>





Only 1% of households reported expenditure on using mobile phones in 1994–95 but by 1997–98, this had risen to 15%. Another source [13] reported that a fifth of households had a mobile phone in 1997–98. The difference is probably due to the nature of the different surveys: the expenditure survey only records whether households had expenditure in a given period, not whether they had a phone.

4.2. Income

Fixed line phones: The phone was adopted by the richest households first. By 1903, 56% of top quartile “class of residence” in San Francisco had phones compared with 10% in the bottom quartile [14]. The same happened in the UK, though much later. Figure 3 shows that even in 1972, while over two-thirds of the richest households had phones, under a third of the poorest households had one. Between 1972 and 1990 the relationship between phone ownership and income in the UK had changed from being concave to becoming convex as saturation approached. Nevertheless, even by 1997–98, when 94% of households had a telephone, only 77% of the poorest decile of households had a phone compared to 100% of the top decile [15].

While the richest households spent more than three times as much as the poorest in absolute terms in the UK in 1997–98, it represented only 1.5% of their budget compared with 3% for the poorest (Fig. 4). This downwards – negatively – sloped Engel curve implies that telephones are now necessities rather than luxuries. This is to be expected given that they are now found in most households.

Mobile phones: It appears that mobile phones are following the same pattern. In the UK in 1997–98, a fifth of households owned at least

Table 5. Weekly expenditure on mobile phone services in the UK, 1994–98.

	Average weekly expenditure, all households (£)	% of respondents reporting expenditure ¹
1994–95	0.18	1
1995–96	0.23	3
1996–97	0.70	12
1997–98	1.00	15

¹Some 6500 respondents take part each year
Source: Family Spending reports 1994–95 to 1997–98. ONS, London

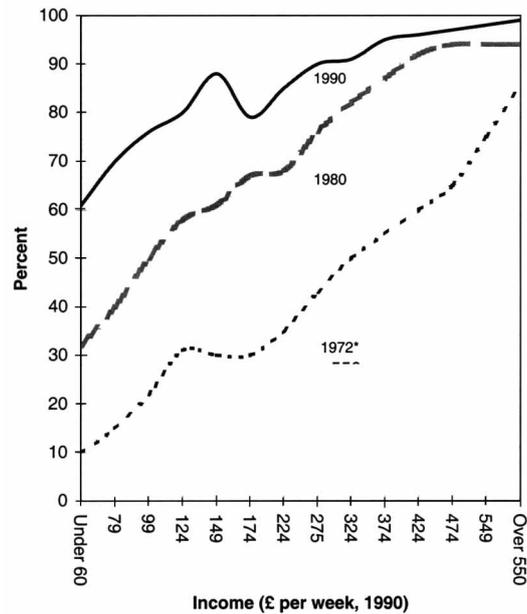


Fig. 3. Phones by household income, UK, 1972–1990.

Sources:
Family Spending: a Report on the 1990 Family Expenditure Survey. CSO, HMSO, London 1991, Table 3
Family Expenditure Survey 1980. Department of Employment, HMSO, London, 1982, Table 4
Family Expenditure Survey Report 1972. Department of Employment, HMSO, London, 1973, Table 50
*Best estimates, because of the problem of adjusting to 1990 income levels

one mobile phone, but 40% of “professional” households had one [13].

4.3. Prices

To have and use a telephone, it is necessary to buy a phone set, pay access charges, and pay for making calls. Access charges are charges for establishing the connection and periodic charges for staying connected. Charges for calls may vary according to time of day, distance and duration. The costs of using the phone far outweigh the cost of buying the equipment (Table 6).

Fixed line phones: In general, the cost of making phone calls has fallen. According to World Bank figures [16], the price of a three-minute call from New York to London fell from about \$250 in 1930 to under a dollar in 1995 (measured in 1990 dollars). In the UK, since privatisation in 1984, British Telecom has been required to keep its price increases on a basket of services for residential users below the general rate of inflation [17,18]. In fact, the cost of both local and long-distance calls in the UK fell in real terms (that



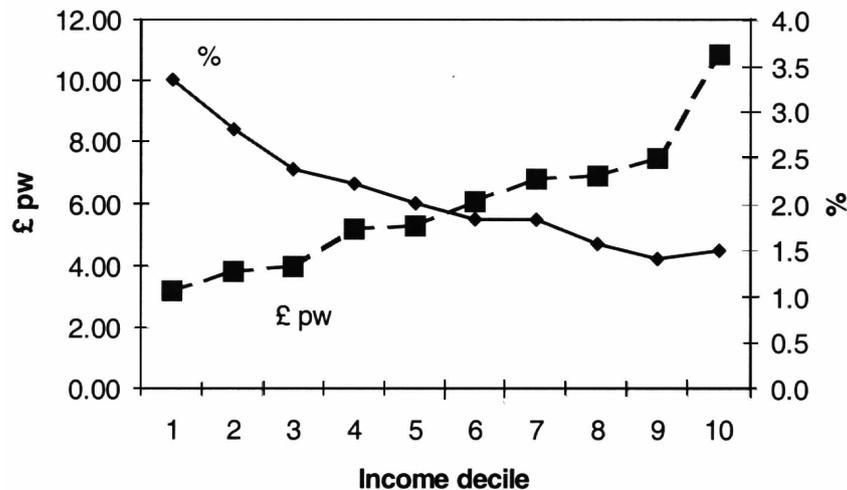


Fig. 4. Weekly expenditure telephones in £ and as percentage of household expenditure, UK, 1997–98. Source: Family spending: a report on the 1997–98 Family Expenditure Survey. The Stationery Office, London, 1998

Table 6. Average weekly household expenditure on phones, UK, 1997–98.

	Average weekly household expenditure	
	Purchase of goods (p)	Purchase of services (p)
Telephone	10	490
Mobile phone	10	100

Source: Family Spending: a Report on the 1997–98 Family Expenditure Survey. The Stationery Office, London, 1998, Table 7.1.

is, after allowing for inflation) from 1977 to 1994 [19,20].

Stehmann [19] reports that price elasticity for access is low, ranging between -0.05 and -0.15 . This means that if prices fall by 10%, demand will rise by between 0.5–1.5%. The income elasticity for access is low too, at around +0.5. He argues that this is because telephones are approaching saturation in industrialised countries and that “access to the telephone system has become a basic good for almost all income groups”. For calls, he reports elasticities of between -0.08 for local calls to over -0.5 for international calls.

Mobile phones: Access to the mobile network is obtained by buying a phone. OFTEL [21] reports that “most mobile phones when purchased are heavily subsidised... This subsidy is then reclaimed by the operator over the period the person uses the phone through higher call charges”. Charges are then based either on contract subscription or pre-pay [22].

Wood [23] argues that initially mobile phones were largely confined to the top business market owing to the high price but that, since 1992, their spread to the domestic market has been accelerated by the introduction of low-use tariffs. The prices are still falling and falling fast. NERA [22] has estimated that overall prices in the UK fell by 5% just between January and June 1999: for heavy users of pre-pay phones, the prices fell by 15%. Nevertheless, OFTEL [18] says that mobile phone prices are “falling but are still above those for fixed lines”. Furthermore, the Chief Executive of UK mobile phone operator Orange is reported as saying that “up to 30 percent of pre-pay phones bought from supermarkets were not being used because consumers had decided that they were too expensive to run” [24].

4.4. Time

In 1904 a US telephone company claimed:

While residential telephone service may not directly save money for the household, yet in an indirect way it accomplishes the same thing by saving time, labor and drudgery... [14]

Stehmann [19] points out that the demand for telephones differs from traditional demand because it does not only depend on personal income, access, and usage prices, but also on time. The latter influences demand in two ways: the usage of a telephone is time-consuming in itself; on the other hand, the telephone is a time-saving means of communication compared with its substitutes: personal contact, letters etc. Thus the higher opportunity cost of time the higher the demand for telephone services.





Anderson et al. [25] found “telephone usage in terms of hours increasing as income increases”. Figure 4 seems to confirm this.

Arguably, the introduction of mobile phones has increased the potential time available for using the phone. While it is widely held that the introduction of mobile phones has caused work to impinge on leisure, it may also be giving access to phones to people who usually have not had access at work. OFTEL [18] suggest that 20% of mobile calls are paid for by business “though they may also be used for personal calls”.

4.5. Summary

The story of telephones well illustrates the idea that the use of new technology is highly price and income sensitive when first introduced but that this sensitivity declines as the technology becomes more widely accepted and, eventually, a necessity. Phones also illustrate the importance of taking the value of time into consideration. First fixed line, and now mobile phones, reduce the “periodicity” of communications. Because, following Becker’s hypothesis, people in richer countries value their time more, we should find that the take-up of mobile phones is higher in the US, all other things being equal. This is also likely to be an important factor in explaining the high take-up of mobile phones in Scandanavia. There appears to be no research covering this, however.

5. Televisions and video cassette recorders

5.1. Introduction

The BBC started TV broadcasts in 1936. Then, there were just “a few thousand in the London area who could receive the transmissions. However, as transmission was stopped during the Second World War, it is probably more realistic to regard 1946 as the starting date¹. In 1948, only 0.3% of households had TV sets but by 1958, it was 52% [5]. By the 1970s, over 90% of UK households had TV sets and by 1996, 99% of households had them [26].

Douglas and Isherwood [5] argue that spread of television is a “good example of the infectious disease model”:

¹BBC website: <http://www.bbc.co.uk/info/history/>

Each household as it acquires a [TV] set becomes itself, as it were, immune, but its presence is likely to infect other households with the bug. People will usually buy what they see their friends using and enjoying.

This is perhaps a variation on the theme of “keep up with the Joneses”.

While TV ownership in the UK has now reached saturation levels, three changes have occurred:

- a switch to colour;
- the introduction of video recorders;
- the introduction of cable and satellite TV.

Colour TV: Colour television broadcasting started in the UK in 1967¹ and by 1979, 66% of UK households had colour TVs. This compares with 67% that had phones, despite phones having been available for very much longer. Interestingly, from 1979, the spread of phones was similar to the spread of colour TVs (Fig. 5).

VCRs: In 1990, the UK Central Statistical Office commented: “Since 1979 video has been transformed from a specialised branch of communications

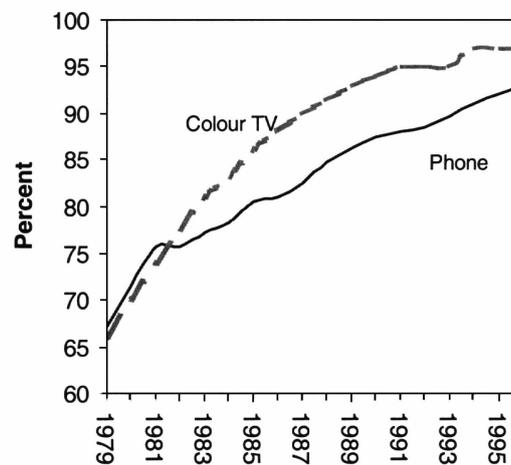


Fig. 5. UK households with (a) colour TV and (b) phone, 1979-95.

Sources:

Phones

UK 1964-1993: Family Spending: a Report on the 1993 Family Expenditure Survey. CSO, HMSO, London 1994, Table 9.3

1994 on: Family spending 1997-98: a Report on the 1997-98 Family Expenditure Survey. ONS, Table 9.3

Colour TVs

Social Trends 1997. ONS, The Stationery Office, London, Table 6.10

Living in Britain: preliminary results from the 1996 General Household Survey. ONS, The Stationery Office, Table A10

Living in Britain: results from the 1994 General Household Survey. OPCS, HMSO, Table A2.6

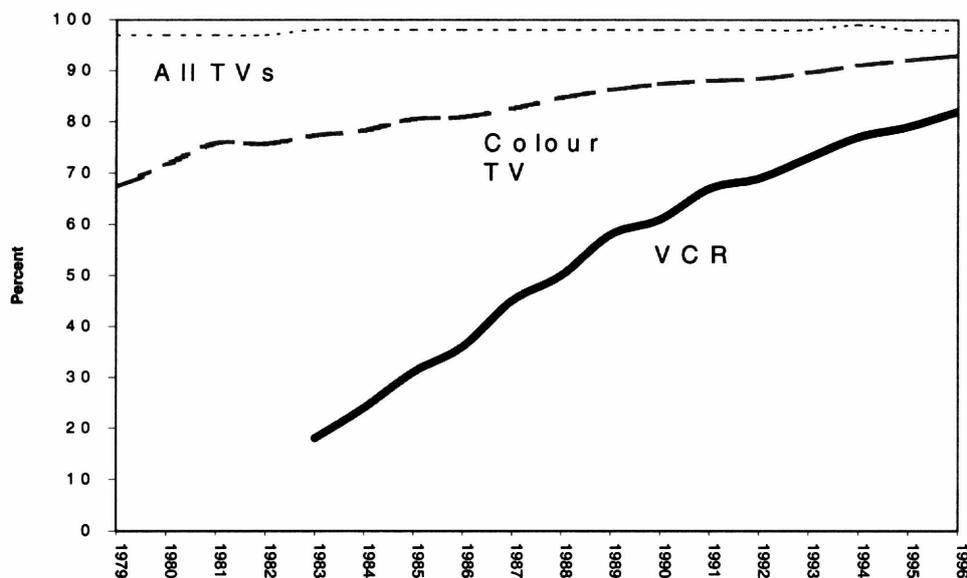


Fig. 6. UK households with (a) any TV (b) colour TV and (c) VCR, 1979-96.

Sources:

Social trends 27. ONS 1997, The Stationery Office, Table 6.10

Living in Britain: preliminary results from the 1996 General Household Survey. ONS, The Stationery Office: Table A10

Living in Britain: results from the 1994 General Household Survey. OPCS, HMSO, Table A2.6

technology to a mass domestic market” ([27]). At that time, about half the households in the UK had a VCR. By 1997-98, the ownership rate exceeded 84% (Fig. 6). This rapid growth occurred despite the fact that initially there were two formats available, which created an uncertainty that must have discouraged people from committing themselves to an expensive purchase.

Table 7 shows that average weekly expenditure on the purchase or rental of video cassettes has been stable in the UK recent years.

Cable and satellite TV: Cable TV is reported to have grown from 2.2 million in 1985 to 7 million by 1989 [27]. By 1997-98, it was estimated that 7% of households subscribed to cable TV. However,

Table 7. Weekly expenditure on purchase and rental of video cassettes in the UK, 1993 to 1997-98.

	Average weekly expenditure all households (£)	% of respondents reporting expenditure ¹
1993	0.73	17
1994-95	0.64	16
1995-96	0.76	16
1996-97	0.79	17
1997-98	0.80	16

¹Some 6500 respondents take part each year

Source: Family Spending Reports 1993 to 1997-98, ONS, London

by then, a quarter of UK households had a satellite TV dish and 13% subscribed to satellite TV [13;15]. Table 8 suggests that there was a significant expansion in the number of households with cable and satellite TV during 1996-97, but that this growth did not continue into 1997-98.

5.2. Income and prices

In the UK in 1997-98, on average households spent 1% of their budget on “TV, video and satellite rental, television licences”, excluding equipment. In absolute terms the richest households spent more than twice as much as the poorest, but the richest only spent about 0.5% of their budget compared to over 2% for the poorest (Fig. 7). As with telephones, this downwards – negatively – sloped Engel curve implies that TV and related services taken together are now necessities rather than luxuries. While that is to be expected for basic TV, which is almost universal, the situation for related services such as video tapes and cable and satellite TV services may not be the same.

VCRs are still more common in richer households than in poorer ones. But the relationship between income and ownership is quite flat across the richer half of households which suggests that, although VCRs are not yet “essentials”, they soon will be (Fig. 8).



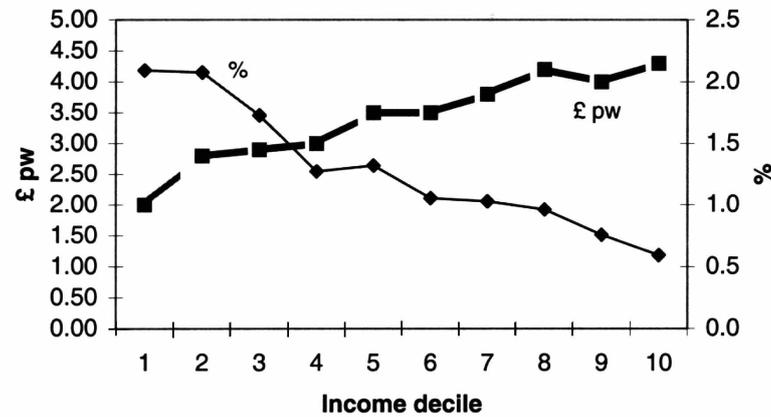


Fig. 7. Weekly expenditure on TV, video and satellite rental, television licences in £ and as percentage of household expenditure, UK, 1997-98. Source: Family Spending: a Report on the 1997-98 Family Expenditure Survey. The Stationery Office, London, 1998, Table 1.3

Table 8. Weekly expenditure on (a) satellite TV subscription to channels and (b) cable TV rental and subscription, UK, 1994-98.

	Satellite TV		Cable TV	
	Average weekly expenditure, all households (£)	% of respondents reporting expenditure ¹	Average weekly expenditure, all households (£)	% of respondents reporting expenditure ¹
1994-95	0.18	4	0.09	1
1995-96	0.23	4	0.17	2
1996-97	0.66	12	0.38	7
1997-98	0.70	13	0.40	7

¹Some 6500 respondents take part each year
Source: Family Spending Reports 1994-95 to 1997-98. ONS, London

In 1997-98, subscription to satellite TV was most common among the professional, managerial and skilled manual households; more than 15% of these households subscribed. This suggests that satellite TV is more common among the better off. However, skilled non-manual and manual and

unskilled households were rather more likely to have cable TV than other classes but, perhaps surprisingly for a relatively new technology, the variation across classes was not great [13].

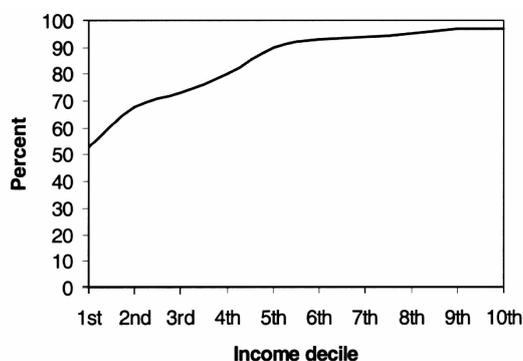


Fig. 8. UK ownership of video recorders by household income, 1997-98. Source: Family Spending: a Report on the 1997-98 Family Expenditure Survey. The Stationery Office, London, 1998, Table 9.4.

Prices: When first introduced in 1936, TV sets cost "as much as 100 guineas"², which is probably over £2500 today. Now they can be bought for under £100. This significant drop in the real price of the sets must have contributed significantly to the spread of TVs.

However, the use of a TV in the UK also requires a licence. The BBC² claims that there has been no increase in the licence fee in real terms (i.e. allowing for inflation) since 1985. The current fees are £101 a year for a colour licence and £33.50 for black and white. Thus the cost of the colour licence is comparable with the cost of a small set!

Purchase of a VCR alone is not sufficient to generate the benefits of owning the machine. What

²BBC website: http://www.bbc.co.uk/info/info/policy/b_policy.shtml#bbc5





Shapiro and Varain [28] term a “durable complementary asset” is required – namely video tapes, either blank or pre-recorded.

5.3. Time

Television watching accounts for a major part of leisure time, although it is not clear to what extent watching TV is combined with other activities. Commenting on the multinational 1960’s study, Sharp [10] says:

The very considerable amount of time allocated to TV watching is of interest... Since TV has only been developed on a large scale in the last 30 years, it is apparent that it has had a very considerable impact on the use of leisure time.

In 1967, school children and adults on average watched 16 hours per week in February and 13 hours in August. By 1979, these figures had increased to 20 and 16 respectively [29]. The upward trend has continued. In 1998, the Central Statistical Office reported that “The most common home-based activity for both men and women in the UK continues to be watching television” [30] and on average in 1997 they watched 25 hours a week [13].

Initially, the TV appears to have taken time from the cinema. Between 1956 and 1960 average weekly cinema admissions in Great Britain fell by more than a half from 21 million to 10 million. This was followed by a period of slower but steady decline and in 1984 reached just 1 million. But in 1985, attendance rose “in spite of the growing proportion of households with video recorders and the increased availability of films on video, which contributed to the fall in attendances during 1984” [11]. By 1986, 30% of households had hired a tape during the previous week [27]. Nevertheless:

The wide availability of video cassette recorders does not seem to have turned people away from the cinema in this country. The attendance rate has risen each year since 1984, when it stood at an all time low. [27]

Indeed, *The Times* [31] reported that cinema attendance in the UK in 1999 had reached the highest point since 1971.

VCRs can be used for “time shifting”, but Maguire and Butters [32] report that in 1990 “almost one third of video owners almost never programme their machines”, that “only 70% of VCR owners actually used them to time shift, resulting in only 30 minutes extra viewing per week”. The main use, therefore, seems to be viewing of pre-recorded tapes and the lack of impact on cinema-going is therefore all the more surprising.

6. Compact disks

6.1. Introduction

Although a new technology, compact disks provide the same basic service that record players have provided for many decades. Introduced in the early 1980s, by 1992 the CD “had revolutionised the way we listen to music” and, for the first time, more CDs were sold than cassettes [33].

Ownership of CD players has spread rapidly from 15% of UK households in 1989 to 63% in 1997–98. This rate of growth was similar to that seen for VCRs. Yet, unlike VCRs which provided a new service, the growth of CDs meant that households had to replace existing equipment. Shapiro and Varain [28] attribute this to the fact that “CDs offered significant improvement in convenience, durability and sound quality over LPs, so consumers were willing to replace their music libraries”.

In recent years, there appears to be little change in total expenditure on CDs and audio cassettes together (Table 9), but there may have been a shift between them.

6.2. Incomes and prices

By 1997–98, ownership of CD players was still quite strongly dependent on income, suggesting that CDs are still a luxury item (Fig. 9).

The growth in the use of CDs has been attributed to lower prices for both the players and the disks: “Lower priced CD players and the introduction of mid-price and budget discs have made the format much more widely accessible” [27].

6.3. Time

As the introduction of CDs did not represent a new service, the effect on time allocations can be expected to be minimal. However, it appears that

Table 9. Weekly expenditure on hire and purchase of CDs and audio cassettes in the UK, 1995–98.

	Average weekly expenditure, all households (£)	% of respondents reporting expenditure ¹
1995–96	0.95	13
1996–97	0.98	14
1997–98	1.00	14

¹Some 6500 respondents take part each year

Source: Family Spending Reports 1994-95 to 1997-98. ONS, London

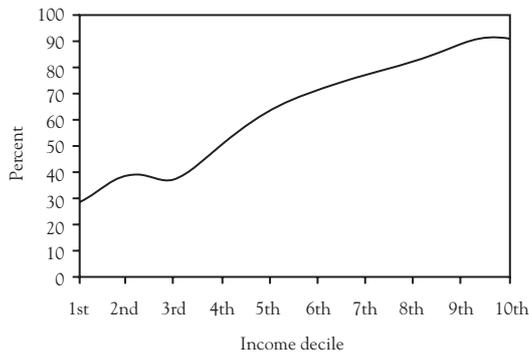


Fig. 9. UK ownership of CD players by household income, 1997-98. Source: Family Spending: a Report on the 1997-98 Family Expenditure Survey. The Stationery Office, London, 1998 Table 9.4.

listening to tapes or records has increased in popularity. In 1977, 64% of men reported listening to records or tapes during the previous four weeks and this had risen to 79% by 1993-94 (with similar figures for women) [8]. Since then the figures have stayed about the same [13]. Perhaps this increase in time spent listening was due to the increasing availability of mobile listening devices – both “personal” and “in car”? If so, then this may be explained as partly a function of how these technologies have provided “more time for listening”.

7. Home computers and the Internet

7.1. Introduction

Ownership of home computers has risen much more slowly than ownership of VCRs and CD players. Between 1986 and 1996-97, the proportion of households with home computers rose from

16% to 26%. Table 10 shows that only a very small minority buy computer accessories, but that they do spend relatively large sums.

However, only a minority of PC owners had an Internet connection. Although domestic Internet connections became possible in the UK in around 1994, a survey carried out in Great Britain in spring 1997 found “one in twenty [households] had a home computer with an internet link” [30]. By September 1997, 9% of the population of the UK has access to the Internet and by December 1998 this had doubled to 18% [34], but it is not clear whether these figures include those with access from work.

7.2. Income

About a quarter of households in the UK own a home computer and ownership varies significantly by socio-economic group. Nearly two-thirds of British households headed by a professional had a home computer in 1996-97. This was “more than four times the proportion among households whose head was in the unskilled manual group” [13].

In the UK, income is “a strong indicator of Internet penetration rates, with the higher income groups disproportionately represented” [34].

Prices: Table 10 shows that expenditure on basic equipment exceeds what may be termed the “running costs” of owning a home computer. The high initial costs may be a factor explaining the lower rate of take-up of home computers compared with CDs and VCRs, for example.

Indeed, the UK Cabinet Office [34] considers that “The costs of buying a computer and modem can be a significant barrier for residential... users” and that this is a barrier to Internet connection. In a survey conducted in the UK in autumn 1998, when asked “which factor will encourage you to

Table 10. Weekly expenditure on (a) PCs, printers and calculators and (b) computer games, cartridges and computer software in the UK, 1994-98.

	PCs, printers and calculators		Computer games, cartridges and software	
	Average weekly expenditure, all households (£)	% of respondents reporting expenditure ¹	Average weekly expenditure, all households (£)	% of respondents reporting expenditure ¹
1994-95	0.57	1	na	na
1995-96	0.92	2	0.22	1
1996-97	1.23	2	0.37	2
1997-98	1.50	3	0.60	3

¹Some 6500 respondents take part each year. Source: Family Spending Reports 1994-95 to 1997-98. ONS, London





start using the Internet?” 9% of those who did not use it but intended to mentioned cheaper PCs [34].

In the UK, using the Internet generates both telecommunications and ISP charges. The impact of the launch of Freeserve in September 1998, the first provider of free access to the Internet in the UK, suggests that use of the Internet is particularly price sensitive. The Cabinet Office [34] reports “Freeserve (and numerous similar companies) have dramatically expanded the number of new Internet users”. Further “The free service providers are attracting a new type of Internet user – generally older and from C2DE social groups – where previously, users had been predominantly younger age groups and ABC1”. In the autumn 1998 survey referred to above, 12% of those who did not use it but intended to said that “lower cost of ISP subscription” was a factor [34].

Of course, in the UK and much of the rest of Europe, Internet users have to pay for their phones call too. This cost is often quoted as a reason for the lower take-up of the Internet in Europe compared to the US where the phone calls are free:

In the US, which often has zero usage charges for local calls (including calls to the Internet) – but higher charges for other types of call and line rental – the average time spent on an Internet call is two and a half hours. In the UK, which has time-based usage charges, it is 25 minutes. [34]

Thus both ownership of home computers and domestic access to the Internet still appear to be “luxuries”: they are closely correlated with income and are price sensitive.

7.3. Time

Vitalari, Venkatesh and Gonhaug [35] found that significant behaviour changes can occur when PCs first enter households. They found that time spent watching TV, leisure with family, sleeping and time spent alone were most affected by the introduction of a computer – all except the time spent alone being reduced. External activities were less affected.

Vitalari, Venkatesh and Gonhaug [35] also found that people with no previous experience would invest more time to learn than those with previous experience. In many cases, this experience was gained at work. Lack of knowledge and perceived lack of time are likely to be inhibitors to the take up of this type of technology. In a survey conducted in the UK in autumn 1998, when asked “Which factor will encourage you to start using the Internet?” 29% of those who did not use it but intended to mentioned the need to know more about it [34].

The spread of technology from work to home environments may help to explain why we find that so few elderly households have home computers. Haddon and Silverstone [36] point out that for “many of the elderly in particular, the social trend of automated offices from the 1980s had arrived too late in their working lives; for many of this generational cohort, computer technologies remained beyond their horizons”.

The Internet seems to be following the same trend: spreading from the office to the home. Access at work has often preceded access at home. A recent study by Pitney Bowes of messaging in large organisations discovered that email is the preferred communication by 40% of UK workers [37]. If the spread from work to home is important, then this should be the precursor to a major change in domestic communications.

While to the extent that computers and the Internet provide entertainment, the spread of the TV may provide a model on which to base future usage. But through email they also provide a communication channel, and so their spread may be more analogous to telephone usage.

8. Conclusion

8.1. Likely determinants of the demand for new domestic technology

Introduction: Douglas and Isherwood [5] asked “What is the direction and power that selects among modern luxuries and procures that shift in status, so that from first being unknown, then known but dispensable, some goods become indispensable?” Economics can help answer that question.

Economic forecasts are based on extrapolation of past trends. Historic statistical data are collected and analysed in such a way as to produce mathematical relationships. These relationships are then used to generate an image of a possible future. The demand for a good depends on its price, the price of other goods, income and a whole range of other factors. To see what such a model for the demand for new technologies might look like, we will now look at these factors.

Income, prices and time: The possession of older technology, like phones and TVs, does not vary with income. These have, in effect, become necessities of modern life. However, the possession of new technology is closely related to income. Household income is clearly an important factor



in determining the demand for new technology. It is well established that the early adopters of new technology are the wealthy. It is also clear that technology seeps down the income scale over time and goods that once were luxuries become necessities. This is hardly new. What is required here is to develop Becker's "full income" concept to take into account the value of time.

Like money, time is strictly limited. Although the time available is relatively fixed, time allocations can shift very quickly to accommodate a new demand (e.g. TV came to dominate leisure time in a relatively short period). Further, unlike income, which can continue to grow indefinitely, the availability of free time is constrained. This changes the way people view the value of their time. The richer they become, the higher the value they place on it and the more they will be willing to buy new technology that allows them to use their time more efficiently. However, while some new technologies will save time, some use time, particularly in the short-run (e.g. home computers) and this can be expected to dampen demand for them. The use of time is a key factor in the use of new domestic technology. Douglas and Isherwood's [5] concept of periodicities, and Becker's [6] concept of "full income" could be useful starting points for developing explanatory variables.

As with income, it appears that in the early life of new technology, price is an important issue. This phenomenon has been noted for mobile phones, CDs, and Internet access. For older technologies that have become necessities, such as fixed line telephones, prices are not very important.

However, it is not just the price of the device itself that is relevant. There are also ongoing costs, or running costs, of owning and using the new technology. Some new technology requires "durable complementary assets". Shapiro and Varian [28] quote the CD as an example. VCRs are another example.

Then there are the straightforward running costs. A phone, once connected quite cheaply, can generate large bills. The same holds in the UK for connection to the Internet: connection will be cheap if a modem is built into the PC, but the resulting phone bill in the UK can be very large, and there may be ISP charges in addition.

The discussion so far has focussed on complementary goods and services. However, substitutes are also important. The marginal cost of watching a film on TV is negligible: once the set is bought and the licence paid, the only cost is the electricity.

In contrast, renting a video or going to the cinema imposes costs. Similarly, the marginal cost of listening to the radio is negligible, but buying a CD or going to a concert is not. In building an economic model of the demand for new technology in the household, the prices and income must be key variables. However, it is not only the price of the new device that must be taken into account, but the price of related goods and services, both complements and substitutes. These need to be identified and this, in turn, requires an understanding of people's domestic behaviour, and how it may not be the economic factor but may be down to behaviour drawing on ideas identified by other social sciences. More importantly, in addition to the traditional economic determinants of consumer demand – income and prices – for new technology, the effect on households' use of time must also be taken into account.

The degree of innovation: There is a learning curve associated with new technology and the steepness of this curve will depend on familiarity with the technology. Technology incorporating Freeman's [38] "incremental innovations" will be familiar and should be adopted faster than "radical innovations" that represent "a discontinuity" – new technology that cannot be related easily to people's everyday experience. According to this view, colour TVs were an incremental improvement of an existing technology. People knew how they used a TV and could readily identify the benefits of owning a colour set. In contrast, while the benefits to business of the phone were obvious from the start, much of the early marketing of domestic phones in the US was designed to explain its uses.

Nelson [39] pointed out that "Consumers are continually making choices among products, the consequences of which they are but dimly aware". He considered the costs of obtaining information about proposed purchases and looked at the wider economic implications of this problem. In doing so, he identified an "experience good" as something which consumers must experience in order to value. By this definition, as Shapiro and Varian [28] point out, virtually any new product is an "experience good". The sale of experience goods requires marketing techniques that will help to overcome this problem, such as free samples. Furthermore, as people become more familiar with new technology the use and perceived benefits will change. This change could increase demand as a result of upgrading equipment and affect the likely life-span of new technology, a factor that needs to



be considered in market forecasts. Thus measures for both the degree of innovation and the difficulties of overcoming the “experience good” problem should be taken into account in making forecasts.

Positive feedback: The spread of some types of new technology will depend on “network economics”. While the effect appears under a variety of guises such as “network externalities” and “demand-side economies of scale”, the key point according to Shapiro and Varian [28] is that “the value of connecting to a network depends on the number of other people connected to it”. It is this phenomenon that gives rise to positive feedback – the bigger the network gets, the greater the benefit of being connected to it. Clearly, the telephone is the classic example and the Internet, particularly the use of email, is following the same course. The adoption of these kinds of new technologies follows the S-shaped curve in Fig. 2: a slow take-off, followed by a rapid expansion until saturation is approached.

Furthermore, positive feedback can occur for non-networked technology too. Two types of domestic feedback have been identified. First, Shapiro and Varian [28] point out that

In consumer electronics, buyers are wary of products that are not yet popular, fearing they will pick a loser and be stranded with marginally valuable equipment.

The two types of early VCR are an example. Second, there is the powerful force of wanting things one’s friends and relations have. The “infectious disease model” [5] is one way of modelling this effect.

There is also a form of positive feedback from work to home. Cronberg [40] reports finding a “domestic technology trajectory”, by which technology introduced into the workplace reached households some 5–10 years later. Although this conclusion was based on mechanisation in the middle of the century, it could well be applicable for electronic appliances in the early 21st century. For example, Fischer [14] says, “The telephone began as novelty, became business’s substitute for the telegraph and then evolved into a mass product”. Furthermore, the advent of teleworking may have accelerated the migration of technology from work to home. Haddon and Silverstone [41] found that teleworking “can act as a catalyst for purchasing [information and communication technologies] already desired”. Alternatively, teleworking can introduce devices into home that are then “retired” into domestic use [36]. This implies that a relationship between work technology and home technology needs to be built into the economic model.

The economic model needs to include one or more variables to reflect positive feedback from other households and, where appropriate, from work. The former might be reflected by the percentage of households already owning the item in question; the latter, by a measure reflecting use of technology in the workplace.

8.2. Next steps and conclusion

Clearly, further work needs to be done to identify likely determinants of the demand for new technology in the home and, in particular, how to take account of the issue of time.

Data need to be collected, the issues tested. It has to be recognised, however, that by definition the data available on the latest technologies will always be very limited and data are only readily available for technologies that have been fairly widely adopted. However, I do not think that these constraints prevent us from doing work that can improve our understanding of the behaviour of households. Broadly, two types of data are available: at the macro level as provided in national accounts, or at the household budget level. The former are by definition limited to time series analysis and fairly broad categories of expenditure. The latter, however, are cross-sectional, but have now been collected for many years, thereby providing time series too.

Finally, we will need to identify the most appropriate mathematical models. While linear models have been used in the past, a case is now being made for more mathematical sophistication [42]. In this paper, my concern has not been to elaborate over what these more advanced models might be: it has been rather to introduce and sketch out what an economic analysis of the take up and use of new technology in the home would look like. Two main factors have been focused on: money – an obvious economic entity – and time. The latter is, in many respects, an increasingly valuable commodity at the end of the millenium.

The key lessons I have wanted to convey are that both money and time are limited and households have to decide how to allocate these scarce resources between competing demands. Economic analysis provides a way of analysing the allocation of such scarce resources and can therefore provide useful insight to the adoption of new technologies in the household. This view complements the different perspectives afforded by other social sciences. It is my view that more research on the introduction of new



technologies into the domestic situation in the past, using an economic framework, will produce useful insights and tools that can be applied to understanding how new technologies become domesticated now and in the future.

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