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The internet's contribution to progress and growth in Germany: The economic impact of the internet and the price structure of access

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REPORT

The Internet's Contribution to Progress and Growth in Germany: The Economic Impact of the Internet and the Price Structure of Access

Heidi Cigan

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Heidi Cigan

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Executive Summary

For a long time now, there has been intensive discussion in Germany, and other countries around the globe, amongst interested parties, about the need for “flat-rate” Internet pricing. Proponents of the provision of such a pricing scheme have argued that it is crucial to increasing use and access of the Internet, eliminating the “digital divide”, and, thus, to exploiting the full economic benefits the new technology brings. Although recognition of the benefits have led to the introduction of flat-rate Internet pricing in many countries, in Germany lack of competition in the market for local telephony (in particular, the monopoly position held by Deutsche Telekom and its imposition of metered charges on ISPs) has prevented it.

Therefore, the purpose of this paper is to analyse the need for flat-rate Internet pricing in the German economy, by answering two main questions: firstly, is increased diffusion of the Internet economically desirable; and secondly, if so, is the introduction of a flat-rate pricing structure the most effective way of achieving this? Parts 2 and 3 address the first question and part 4 the second.

In Part 2, about the effects of the Internet on efficiency and welfare, we find that the Internet makes the market, as a whole, more efficient and competitive and, thus, increases welfare. Characteristics of the Internet (*immediate access* and *interactivity*) reduce transactions costs between economic agents by easing communication between them and making them better informed about the market. As a result, the Internet transfers market power from the producer to the consumer leading to a new role of the consumer. The distribution channel is shortened, as consumers can deal directly with producers, causing “disintermediation” (the fall away of intermediaries). However, “re-intermediation” and the appearance of new intermediaries occurs in electronic markets, who add to transparency and reduce transactions costs further. The Internet allows a greater amount of outsourcing to be undertaken, encouraging firms to specialise on their core competencies, encouraging co-operation between firms and reducing the optimal size of the firm. In addition, reduced firm costs and global reach reduce barriers to entry. So that reduced transactions costs and barriers to entry increase competition.

In markets for “knowledge products”, which tend naturally to monopoly because of demand and supply-side economies-of-scale, we find that the Internet also generally increases efficiency and welfare. Whether knowledge markets “tip” in favour of monopoly depends upon the interplay of economies-of-scale and -scope. The Internet increases both. The result is that, in knowledge markets with “open standards”, where many firms compete within the market for producing system components, the Internet allows consumers to take advantage of increased “network effects”, as well as greater variety, thus, increasing welfare. In knowledge markets without accepted standards, and in which economies-of-scale are larger than demand for variety, the Internet may well encourage the market to tip in favour of one dominant firm. However, competition and innovation are strong and monopolies are only temporary: the minute a better product comes along the incumbent will lose their lead to the new competitor. Not only this, it would be welfare decreasing to restrict market share: firstly, consumers would lose out on network effects; and secondly, it would increase price (while traditional monopolists

restrict supply to increase price, in markets for knowledge products a firm faced with demand- and supply-side economies-of-scale will increase output and reduce price in order to gain market share). On the whole then, the Internet increases efficiency and welfare in traditional markets as well as in markets for knowledge products.

Part 3, on the effects of the Internet on the macro-economy, finds that the macro-economic gains derived from the Internet have been unevenly distributed between countries, largely due to differing levels of investment in, and therefore use of, information and communication technology (ICT). The amazing macroeconomic performance of the US in the 1990s has lead economists to ask whether it is due to the diffusion of ICT. The so-called “New-Economy” theory says that increased competition brought about by ICT puts downward pressure on inflation, encourages innovation and increased productivity, and reduces wage demands, therefore, leading to higher continued growth and lower unemployment. Empirical evidence shows that, despite the singularly phenomenal macroeconomic performance of the United States during the 1990s, it has not been the only country to have benefited from the New Economy. A number of observations can be made in this regard:

Evidence shows that the Internet and ICT reduces inflationary pressures, both as a result of falling prices for ICT goods but also because of increased price competition in electronic markets. Numerous studies show that prices are lower when buying goods through the Internet and that other forms of price competition are also increasing.

Productivity increases in a large number of countries during the 1990s were due to large investment in ICT in one set of countries, while, in an other set, they were largely due to falls in employment associated with a move towards the employment of the relatively more highly skilled. The first set includes the US, Australia, Canada, and a number of European countries (Denmark, Norway, and Portugal). The second set includes the countries: Finland, Germany, Italy, and Sweden. In those countries where increases in labour productivity growth were associated with increased or stable employment and better investment in ICT, growth rates of GDP also generally increased. The few countries that benefited from increased MFP growth were also members of the first group, the exceptions being Finland and Sweden (which also gained but are members of the second group). The contribution of ICT-producing industries to output and productivity growth during the 1990s was generally lower in other countries compared to the US, the major exception being Finland, who’s contribution far exceeds that of the US. It should be noted however that more recent data indicate increasing contributions from ICT in most countries.

Increased “job matching” is said to increase job-market efficiency and, therefore, reduce unemployment. Structural change should lead to both job losses in less efficient sectors and job gains in new, more efficient, ones. Finally, increased demand for skilled labour should increase relative employment of the more highly skilled. The evidence shows that, although strong employment effects have been achieved in a few countries (Canada, Finland, the Netherlands, the United Kingdom, and United States)(also those who have invested heavily in ICT), in the majority this is not the case. Also, although, in the US, the supply of skilled labour has increased in response to increased demand, evi-

dence of an increased wage gap between the relatively more highly skilled and the relatively less skilled shows that more investment in education is needed, even in the US.

In the case of Germany, rates of growth of GDP and Employment fell over the 1990s, productivity gains were mainly due to a relative move towards more skilled employment, and there was no apparent increase in MFP growth. A number of studies attribute poor macroeconomic performance in Germany to a lack of investment in ICT. It should also be noted that although Germany fares well in terms of skilled labour, this is based on past investment: current student numbers are low in international comparison.

Therefore, it can be seen that there is evidence of a New-Economy effect from ICT in a number of countries, not just the US. The New-Economy effect has, however, been unevenly distributed amongst industrialised countries. It is thus the case that, if it wants to share in the macroeconomic benefits from the New Economy, Germany has to invest more in ICT (i.e. the use of ICT should be encouraged). In addition, efforts should be made to increase the level of skills in the working population, by investing more in education and by encouraging use of foreign labour, where it can alleviate home market deficits (This refers to the “green card” issue for foreign specialists). Lastly, attention should be paid to providing the correct environment for businesses to expand into new areas of the ICT industries themselves. Otherwise, it faces the prospect of being left on the wrong side of the “digital divide”.

Part 4, involving an analysis of the factors influencing use of ICT, finds that there are significant differences in ICT penetration, between different individuals, households, and firms, due to socio-economic factors, as well as between different countries, due to differences in income and the availability of unmetered Internet access. At the level of the individual/household/firm we found that there are significant differences in ICT penetration dependent upon socio-economic factors (age, income, gender, education, and firm size) but that these differences are narrowing. The main factors preventing Internet access/use are financial. With regard to country differences, again those countries who were found to have invested in and benefited from ICT were also those who were the most “connected”. It was found in empirical studies that the main factors explaining this divide were income and the availability of unmetered Internet access (a flat rate)/ the amount of competition in the telecommunications market. Indeed, Haring et al. (2001) find that “...*unmetered pricing for ISP and telecoms services increases access and usage demand by 31 and 35%, respectively, compared to regimes with usage sensitive ISP and telecoms charges.*” It was also found that where unmetered Internet access was introduced it significantly increased both access to, and usage time of, the Internet.

As such we can conclude that if Germany wants to make the most of the numerous economic benefits brought about by the Internet it needs to encourage access to and use of the Internet. The most effective way to achieve this goal has been proven, on the basis of significant empirical and anecdotal evidence, to be the introduction of unmetered Internet access. Therefore, the dominant position of Deutsche Telekom in the market for local telephony and its refusal to allow ISPs to pay unmetered line rental charges is a significant barrier to gaining the wide spread economic benefits the Internet brings.

1 Introduction

For a long time now, there has been intensive discussion in Germany, and other countries around the globe, amongst interested parties, about the need for “flat-rate” Internet pricing. Proponents of the provision of such a pricing scheme argue that it is crucial to increasing use and access of the Internet, eliminating the “digital divide”, and, thus, to exploiting the full economic benefits the new technology brings.

Although recognition of the benefits have lead to the introduction of flat-rate Internet pricing in many countries, in Germany lack of competition in the market for local telephony has prevented it. Although some ISPs (Internet Service Providers) tried to offer a flat-rate pricing option to customers, they had to withdraw them again, almost immediately, because they were not economically feasible. The problem arises because of the line rental charges that ISPs have to pay to Deutsche Telekom (DT), which has a monopoly in the provision of local telephony. ISPs have to pay metered charges (a price per unit time) for use of the phone lines. With a flat rate, however, end consumers pay for unmetered Internet access to the ISP (i.e. they pay a fixed sum for unlimited Internet). A flat rate, therefore, enables consumers to use the Internet as much as they want, and they did. The flat-rate offers turned out to be uneconomical because users spent much more time online than the flat rate they paid covered in metered charges to DT. The only ISP apparently able to sustain the offer was T-online, a subsidiary of DT, because DT was able to subsidise its losses. As a result, DT was using its monopoly position to act anti-competitively.

This was also the conclusion the regulatory authority came to and, therefore, told DT to offer a wholesale flat rate to ISPs. Shortly after, however, this decision was overturned, after a complaint made by DT. By this time, DT had, instead of providing a wholesale flat rate to ISPs, withdrawn its flat rate to end customers. As a result, the authorities found that DT was no longer acting anti-competitively. The outcome is that ISPs are still unable to offer customers an economically feasible flat-rate pricing option.

To understand the economic consequences, two questions have to be answered: firstly, is increased diffusion of the Internet economically desirable and, secondly, if so, is the introduction of a flat-rate pricing structure the most effective way of achieving this? To this end, the following paper provides an overview of the current state of the literature on the economic effects of the Internet and the effects of the structure of price on access

to, and use of, the Internet. The paper is set out as follows: part 2 looks at literature on the effects of the Internet on efficiency and welfare; part 3 involves an analysis of the extent to which these effects have resulted in macro-economic gains in different countries; part 4 analyses the extent to which unmetered (flat-rate) Internet access effects the level of use/ access to the Internet; and part 5 concludes.

2 The Effects of the Internet at the Microeconomic Level

When analysing the effects of the Internet at the microeconomic level, a distinction needs to be made between its effects on markets for “traditional” goods and services and on those for “knowledge products”. By traditional goods and services we mean those that are physical in nature and thus have to be transported physically over space, and which incur a distance related cost in doing so. Knowledge products are however non-physical by nature and thus do not incur such costs. These differences in character mean that the Internet has additional effects on markets for knowledge products and, thus, we treat each separately.

2.1 Effects on Traditional Markets for Physical Goods and Services

2.1.1 Increased Competition

According to the literature, the Internet brings markets closer to the economist’s theory of perfect competition. Under perfect competition consumers are fully informed, transactions costs are zero, there are no barriers to entry or exit of firms, and there is a large number of firms in the market. As a result, firms have no power in setting prices, so that price equals marginal cost. In this way firms make no profits and consumer surplus is at a maximum. Therefore, under perfect competition welfare is maximised.

The Internet makes markets more like the text book notion of perfect competition¹ because: Firstly, it makes economic agents better informed, by reducing transactions costs. There are two main factors contributing to this: *immediate access* and *interactivity*. Immediate access means that economic agents have easier access to information irrespective of time and distance. Once a piece of information is “online” it can be accessed by users whatever the time of day and no matter how far away, as long as they have access. Increased Interactivity causes economic agents to be better informed about the market,

1 Wadhvani, S. B. (May 2000), The Impact of the Internet on UK Inflation, in Bank of England Quarterly Bulletin, p. 184.

by increasing ease of communication between them. Unlike other forms of communication, the Internet allows an individual to be both the receiver and sender of information at the same time. Thus making communication closer to that in face-to-face relations, although not entirely.

Secondly, the Internet reduces barriers to entry, partly as a result of global reach but also because the Internet reduces the costs necessary to set up a business in the first place. Global reach means that firms who were previously restricted to commerce in their local market can now reach customers and suppliers in distant places. Thus, combining previously separated markets to increase their overall size. Also, reduced costs of setting up a firm encourage an increased number of new entrants.

Thirdly, there is greater product market competition. As a result of lower transactions costs and lower barriers to entry, the market becomes more competitive. Better informed consumers and a larger number of suppliers means that prices tend towards marginal cost and profit margins shrink. This should have a dampening effect on inflation and also causes firms to innovate, so that productivity should be increased (I talk about the macroeconomic effects of the Internet in more detail in part 3).

2.1.2 New Role of the Customer

Reduced transactions costs are leading to greater consumer power and a new role of the customer in economic activity.^{2 3} In particular, interactivity enables consumers to give direct feedback to businesses, such as requested product characteristics and highest prices, and enables online auctioning. As a result of increased customer involvement in price setting and product design, some have said that the Internet leads to a “reverse economy”, reverse because, in part, the consumer and the producer are changing role. This new role of the customer is increasing the competitive pressure between firms and increasing the need for firms to individualise their products to customer needs. Although this can be expensive for traditional manufacturing firms, for firms providing digitalised knowledge products, individualisation can be relatively cheap and creates

2 Picot, A. and Neuberger, R. (2000), Prinzipien der Internet-Ökonomie, in Wirtschaftsdienst: Zeitschrift für Wirtschaftspolitik, Nr. 10, 80th year, Hamburg Institute of International Economics (HWWA), p.594-595.

3 European Communication Council (2000), E-economics: Strategies for the Digital Marketplace, p-150-151.

high value added. This has to do with low costs involved in reproducing knowledge products, especially those in digital form.⁴

2.1.3 Disintermediation

Increased consumer power is leading to a shortening of the supply chain and increased firm efficiency. In traditional production channels, end users buy their purchases from retailers, who get their products from producers through an extensive distribution chain. However, the Internet allows end users to bypass a lot of the supply chain by buying directly from the producer. De Prince et al. (1999) says that there are two main distribution channels used by companies distributing their goods with the aid of the Internet: “Amazonic” and “Dellphic” distribution.⁵ Under Amazonic distribution, consumers order products directly from a distributor who maintains an inventory of products. This method bypasses the retailer. Under Dellphic distribution the consumer is in direct contact to the producer, who has no inventories of finished goods at all. Instead, the customer orders products directly with the producer, which are then made to order and distributed to the buyer. This distribution method cuts out all intermediaries from the supply chain, leaving only the producer and end user. Again, these effects are greatest for firms producing digitalised knowledge products, who can also transport their goods via the Internet, cutting out the need for physical distribution.

These new forms of distribution increase firm efficiency by reducing the need for inventories, freeing resources for other uses, and result in “dis-intermediation” in the physical world, by reducing the role of middlemen in the supply chain.⁶

2.1.4 Re-intermediation and the Appearance of New Intermediaries

However, disintermediation in the physical world is countered by “re-intermediation” in electronic markets, as traditional firms begin to recognise the cost benefits of this method of commerce. In addition, the Internet is causing new intermediaries to emerge, such as Intelligent Agents and Shop-bots, which provide consumers with expert help in finding what they are searching for e.g. where to find the cheapest goods. These new

4 I talk more about this in part 2.2 The Effects of the Internet on markets for Knowledge Products.

5 De Prince Jr., A. E. and Ford, W. F. (1999), A Primer on Internet Economics, in *Business Economics*, October 1999, Vol. 34, Issue 4.

6 European Communication Council (2000), E-economics: Strategies for the Digital Marketplace, p. 148.

intermediaries will also help to reduce transactions costs by increasing market transparency.

2.1.5 Specialisation, Outsourcing and Reduced Firm Size

According to Picot and Neuberger (2000) the Internet allows firms to become more specialised.⁷ Previously, lack of information about the market meant that a lot of firm activities were undertaken “in-house”. However, easier access to information on the Internet, together with improved communication provided by the Internet (in terms of immediate access and interactivity) has made outsourcing a more viable option. Thus allowing firms to concentrate on their core competencies, increasing co-operation between firms, and reducing the optimal size of the firm.

2.1.6 New Forms of Co-operation

Increased specialisation and improved communication between firms is also leading to a distortion of the boundaries of the firm, as firms come together to form new kinds of co-operation.⁸ Such examples are Virtual Firms where a group of firms comes together on a temporary basis to work on a contract and once it is completed the co-operation is disbanded. Another example are so-called VPNs (Virtual Private Networks) where a group of separate firms are connected electronically, for example, to ease the flow of goods between firms and their suppliers. Such networks have enabled “just-in-time” processes to be introduced, reducing firms’ costs and increasing efficiency. Although firms had electronic links before the Internet, these were very expensive and, thus, generally only used by large firms. The Internet is much cheaper to use and, thus, opens new opportunities for small and medium sized firms.

2.2 The Effects of the Internet on Markets for Knowledge Products

2.2.1 Characteristics of Knowledge Products

According to Quah (1999) “knowledge products” are commodities whose physical properties resemble those of knowledge, regardless of whether the commodities themselves contain significant amounts of knowledge as traditionally understood.⁹ Knowl-

7 Picot, A. and Neuberger, R. (2000), Prinzipien der Internet-Ökonomie, p. 593.

8 Picot, A. and Neuberger, R. (2000), Prinzipien der Internet-Ökonomie, p. 593.

9 Quah, D. (1999), *The Weightless Economy in Growth*, p.2.

edge has special economic characteristics: it resembles a public good. Public goods have two defining characteristics: “non-rivalry” and “non-excludability”. Non-rivalry means that public goods do not abide by the basic economic law of scarcity, so that by increasing the number of consumers does not reduce the value of the good to other users. Non-excludability means that you can not exclude others from using the good. Traditional examples of public goods are air, street lighting, and national defence. Examples of knowledge products are computer software, music and videos. They exhibit non-rivalry because by listening to a CD or watching a video it does not prevent others from doing so. Non-rivalry of knowledge products also holds geographically.

2.2.2 Economies-of-Scale in Markets for Knowledge Products

2.2.2.1 Supply-side Economies-of-Scale

Non-rivalry means that the marginal cost of producing knowledge products is practically zero. Together with large first-copy costs, or sunk costs, therefore, large economies-of-scale can be achieved. However, zero marginal costs also means that firms may not be willing to invest in the large first copy costs. This could result in sub-optimal provision of knowledge products, unless these goods can be made excludable. While general knowledge is non-excludable, knowledge products can be seen to be partially excludable through contracts such as patents, copyright and trademarks etc.. So that inventors of new knowledge products can gain a price above marginal cost (or, as has been the recent case, other methods of achieving revenues are used e.g. advertising, sponsoring or “datamining”¹⁰). Once knowledge products are made excludable, then, the producers of knowledge products can take advantage of large economies-of-scale, and can thus dominate the market in the production of these goods.

2.2.2.2 Demand-side Economies-of-Scale

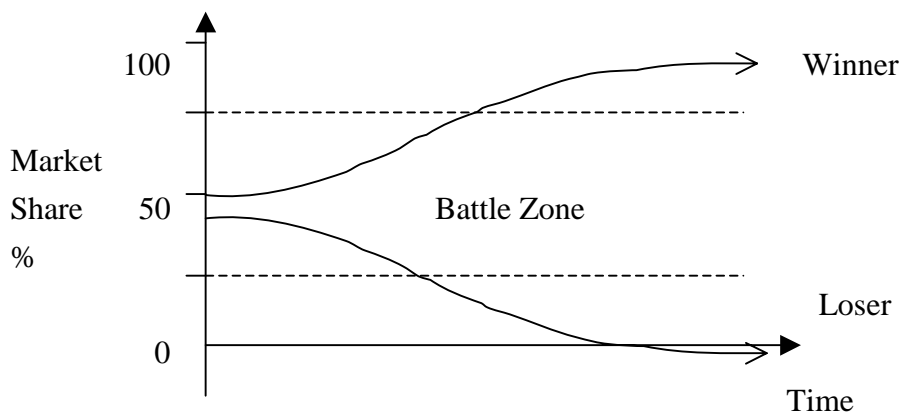
In addition to supply-side economies-of-scale, there are also large demand-side economies-of-scale, or “network effects”, in markets for knowledge products. In markets with network effects, the value of the network actually increases with the number of users. This can be seen nowhere more clearly than in communications markets such as the telephone system and the Internet itself. As more economic agents connect to the Internet its value to each increases. According to “Metcalfe’s Law” “...*the value of a net-*

10 European Communication Council (2000), E-economics: Strategies for the Digital Marketplace.

work goes up as a square of the number of users.”¹¹ The Internet and the telephone system are examples of “real” networks, however, network effects are also found in “virtual” networks such as the network of Microsoft windows users, or the network of CD users.¹² In these markets, then, consumers benefit the most from the largest number of users.

Network effects result in “positive feedback”. This means that as users join a network, increasing the value, this encourages more to join. As a result of positive feedback, these markets tend to be highly concentrated. As more users join, this encourages even more to join until, in the extreme case, one firm dominates the whole market. Thus, the market tends to monopoly, not just because of supply-side economies-of-scale but also as a result of positive feedback. As Shapiro and Varian (1999) put it, positive feedback makes “...*the strong grow stronger...*”. However, it is also true that “...*the weak grow weaker.*”¹³ Thus, the battle for market share in these markets is fierce. As can be seen in diagram 1 below, if there are two or more firms competing for market share in a market with strong positive feedback, only one firm may emerge as the winner. Economists say that such markets are “tippy” i.e. that it can tip in favour of one or the other player.

Diagram 1: Positive Feedback from Shapiro and Varian (1999)



11 Varian, H. R. and Shapiro, C. (1999), Information Rules: A Strategic Guide to the Network Economy. P.184.

12 Varian, H. R. and Shapiro, C. (1999), Information Rules: A Strategic Guide to the Network Economy, p. 174.

13 Varian, H. R. and Shapiro, C. (1999), Information Rules: A Strategic Guide to the Network Economy, p. 174.

Markets that undergo positive feedback, thus, follow a well known diffusion path. This is an S-shaped curve, where at low levels of adoption, new entrants are small, because the technology is not highly valued, and there are high uncertainty costs as to whether it will be successful. As a result, customers may delay their purchase until it becomes clear to them that this is the technology that everyone is using. Once the market reaches “critical mass”, uncertainty falls, value increases, positive feedback kicks in, and the market grows by itself.

In such markets, then, critical mass is crucial for success. This has led to companies in knowledge markets to follow strategies such as giving away products for free, to achieve critical mass as quickly as possible. An example of this is Netscape giving away of its Internet browser.

2.2.2.3 Switching Costs

A third element reinforcing concentration in markets for knowledge products are “switching costs” (the costs involved of switching from one system to another). Switching costs come about because of the learning necessary in switching products, the cost of replacing complementary products and also because of network effects. In the extreme case, when one firm or technology holds the industry standard, high switching costs can result in consumer “lock-in” (consumers tend to be locked in to the current system), which enables a monopolist to maintain its dominant position. Thus, in markets for knowledge products, “...*the natural market structure therefore becomes a monopoly*”.¹⁴

2.2.2.4 Open Standards

In this respect Shapiro and Varian (1999) say that “open standards” encourage competition and, thus, have generally positive effects on markets for knowledge products. When an open standard is formed, there is one system that is open to more than one firm. Firms then produce compatible system components. As a result, open standards benefit consumers and reduce the market power held by incumbents. Open standards increase network effects, reduce consumer uncertainty involved in buying knowledge products, because system components are compatible, reduce lock-in, reduce monopoly power

14 The Economist, 23rd-29th September 2000, *A Survey of the New Economy: Untangling e-economics*, p. 30.

and increase price competition within the market for system components. Thus, open standards increase competition and innovation within the market. A drawback of standards, however, emerges when an inefficient standard is set. On the whole, however, welfare is increased by the setting of open standards.

An example of this is that of Internet service provision. Before Internet access became commercial, a few firms tried to provide proprietary systems. However, you could not easily send e-mails etc. to people using other providers. As a result, consumers went to providers that provided the best access to other consumers. When the market for Internet access was commercialised, and the protocols for browsers were standardised, the advantage of being a large ISP was removed and thousands of smaller providers entered the market. Standardisation thus made the market for Internet access more competitive, while increasing positive network effects faced by consumers.

2.2.3 How the Internet Effects Markets for Knowledge Products

According to Shapiro and Varian (1999), whether a market tips (positive feedback kicks in resulting in monopoly), depends upon the interplay of economies-of-scale and -variety (scope). Markets where economies-of-scale are large and demand for variety is low are more likely to exhibit monopoly.

The Internet increases both potential economies-of-scale and -scope. The Internet makes it possible for all digitalised knowledge products to be produced at zero marginal cost and to be distributed around the world at a zero marginal cost over distance (i.e. the distance between sender and receiver is irrelevant, it does not matter whether a customer is in the same country or on the other side of the world from the sender, the cost is the same and only the connection to the Internet is necessary). Thus, it increases potential economies-of-scale in markets for knowledge products. Increased supply-side economies-of-scale mean that producers' production and distribution costs are lower which, *ceteris paribus*, encourages greater market concentration. Increased demand-side economies-of-scale also, *ceteris paribus*, encourage concentration, and allow consumers to take advantage of larger network effects. At the same time, the Internet also increases economies-of-scope in all markets by reducing firms' costs and barriers to entry. Reduced firms' costs and barriers to entry mean that more firms are able to enter the market, increasing competition.

The result will be that markets for knowledge products will continue to exhibit a few larger players but also lots of small ones. In markets with open standards, where many firms compete within the market for producing system components, the Internet allows consumers to take advantage of increased network effects, as well as greater variety, thus, increasing competition and welfare. In markets without accepted standards, and in which economies-of-scale are larger than the demand for variety, the Internet may well encourage the market to “tip” in favour of one dominant firm. Intensive competition, and thus innovation, means, however, that monopolies are only temporary. Market leaders will only remain so if their products are competitive: the minute a better product comes along they will lose their lead to this new competitor. Not only are monopolies temporary in nature, it would reduce consumer welfare to restrict market share because, firstly, consumers would lose out on network effects, and secondly, it would increase price (while traditional monopolists restrict supply to increase prices, in markets for knowledge products, a firm faced with demand- and supply-side economies-of-scale will increase output and reduce price in order to gain market share). So that, over all, the Internet increases efficiency and welfare in markets for knowledge products.

2.3 Summary and Conclusions of the Effects of the Internet at the Microeconomic Level

Characteristics of the Internet (*immediate access* and *interactivity*) reduce transactions costs between economic agents by easing communication between them and making them better informed about the market. As a result, the Internet transfers market power from the producer to the consumer leading to the new role of the consumer. The distribution channel is shortened, as consumers can deal directly with producers, causing “disintermediation” (the fall away of intermediaries). However, “re-intermediation” and the appearance of new intermediaries occurs in electronic markets, who add to transparency and reduce transactions costs further. The Internet allows a greater amount of outsourcing to be undertaken, encouraging firms to specialise on their core competencies, encouraging co-operation between firms and reducing the optimal size of the firm. In addition, reduced firm costs and global reach reduce barriers to entry. So that reduced transactions costs and barriers to entry increase competition and innovation.

In markets for “knowledge products”, which tend naturally to monopoly, because of demand- and supply-side economies-of-scale, the Internet increases both potential economies-of-scale and -scope. While increased economies-of-scale encourage market

concentration and allow consumers to take greater advantage of “network effects”, increased economies-of-scope encourage competition and increase variety. Whether knowledge markets “tip” in favour of monopoly depends upon the interplay of these opposing forces.

The result is that, in knowledge markets with “open standards”, where many firms compete within the market for producing system components, the Internet allows consumers to take advantage of increased network effects, as well as greater variety, leading to increased welfare. In knowledge markets without accepted standards, and in which economies-of-scale are larger than demand for variety, the Internet may well encourage the market to tip in favour of one dominant firm. However, competition and innovation are strong in knowledge markets and monopolies are only temporary: the minute a better product comes along, the incumbent will lose their lead to the new competitor. Not only this, it would be welfare decreasing to restrict market share, firstly, because consumers would lose out on network effects, and secondly, because it would increase price (while traditional monopolists restrict supply to increase price, in markets for knowledge products a firm faced with demand- and supply-side economies-of-scale will increase output and reduce price in order to gain market share). On the whole then, the Internet increases efficiency and welfare in traditional markets as well as in markets for knowledge products.

3 The Effects of the Internet at the Macroeconomic Level

3.1 A New Economy?

In connection with the efficiency and welfare enhancing effects of the Internet on the economy, discussed in chapter 2, there is growing evidence of a so-called “New Economy” in the US. During the 1990’s the US economy has undergone a period of sustained economic recovery with high rates of growth in output and productivity. At the same time, unemployment and inflation have also been favourable. A growing number of economists attribute this amazing economic performance to the diffusion of information and communication technology (ICT) and the Internet throughout the economy.

According to the New-Economy theory, greater market competition brought about by the diffusion of ICT and the Internet is having radical effects on the macro-economy. Competition has two effects: firstly, it forces economic actors to be more innovative; creating better, more efficient products and processes; and secondly, it has a dampening

effect on prices. More innovation encourages technological progress and increases productivity. Competition and low inflation hold wage demands at moderate levels. As a result of lower wage increases, as well as more efficient job matching¹⁵, unemployment is likely to fall. Finally, these events should lead to higher continued growth and, according to some proponents of this theory, bring an end to the ups-and-downs of the business cycle as we know it. However, this is rather an extreme view and, indeed, current data show that the US economy has started to slow down again. Despite this, however, the macroeconomic performance of the US over the past decade has been unparalleled.

In the light of these developments, it is the purpose of this chapter to analyse the degree to which evidence can be found of a New-Economy effect from ICT in the US and that for other countries, in particular for Germany. This chapter is laid out as follows. Part 3.2 looks at evidence of effects from the Internet/ICT on prices and inflation. Part 3.3 defines labour productivity and how ICT can affect it. Part 3.4 analyses the effects on growth and productivity. Part 3.4 looks at effect of ICT and the Internet on employment. Finally, part 3.5 concludes with a discussion of the evidence of the effects of ICT on different economies, highlighting the position of Germany in international comparison.

3.2 Prices and Inflation

Inflation is dampened by the diffusion of ICT and the Internet throughout the economy, both as a result of falling prices for ICT goods and as a result of the increased amount of competition.

As has been evidenced for some time now, computer power has increased at a very rapid pace, confirming a prediction made in 1965 by Gordon Moore, one of the founders of the microprocessor manufacturers Intel. What has now come to be known as “Moore’s Law” predicts that the complexity of microprocessors will double every 18 to 24 months. Though this law has its limits, this makes it “...*possible to achieve an exponential increase in the power of computer architectures and the software run on them.*”¹⁶ As a result of the rapid development in computer power, it has experienced a radical and continuous fall in prices. This trend can also be seen by looking at recent

15 See the section on employment effects in this chapter.

16 European Communication Council (2000), E-conomics: Strategies for the Digital Marketplace, p. 107.

figures on the price developments of personal computers. Tables 1 and 2 below show the evolution of average selling prices for PCs in Europe and the US.

As discussed in part 2, diffusion of the Internet results in a fall in prices and has a dampening effect on inflation, because of increased market competition. Smith et al. (2000) say that price competition is expressed in four different forms: price levels, price elasticity, menu costs, and price dispersion.¹⁷ This increased competitive pressure on markets brought about by the Internet will not only tend to reduce price levels, but should also: increase consumer price sensitivity, because of easier search costs; reduce menu costs (the costs of changing listed prices, such as on menus), because in an electronic market place they only involve the cost of one single price change in a database; and reduce price dispersion, because the Internet reduces search costs so that consumers are better informed.

Evidence generally confirms the first three effects on price levels, price elasticity and menu costs, but is more mixed with regard to price dispersion. Brynjolfsson and Smith (2000) comparing prices of books and CDs for the period 1998/99 find that prices were 9-16% cheaper in the Internet than in conventional markets. They also found evidence that menu

Table 1: Average Selling Prices, in Euro, for PC's, Europe (Euro exchange rates 1999), 1994-2002

	1994	1995	1996	1997	1998	1999	2000	2001	2002
86/88 & 286	583								
80386SX	1.284								
80386DX	1.162								
80486SX	1.545	1.340	1.219						
80486DX	2.064	1.822	1.691	841					
Pentium < 100 MHz	3.539	2.330	1.726	1.330	1.259				
Pentium 101-149 MHz		2.432	2.104	1.900	1.728				
Pentium 150+			2.555	1.923	1.654	1.350			
Pentium Pro		6.387	2.949	2.156	1.984	1.918	1.561		
Pentium II < 400 MHz				2.934	2.450	1.979	1.737	1.459	
Pentium II > 400 MHz					2.036	1.868	1.799	1.709	1.486
Pentium III							1.893	1.799	1.661

17 Smith, M., Bailey, J and Brynjolfsson, E. (2000), Understanding the digital divide: Review and Assessment, in Brynjolfsson, E. and Kahin, B. eds. (2000), Understanding the Digital Economy, p.100.

Table 2: Average Selling Prices, in Euro, for PC's, US (Euro exchange rates 1999), 1994-2002

	1994	1995	1996	1997	1998	1999	2000	2001	2002
86/88 & 286									
80386SX									
80386DX	1.064	849	686						
80486SX									
80486DX	2.130	2.495	1.997						
Pentium < 100 MHz	2.910	2.434	2.313	2.073	1.729				
Pentium 101-149 MHz	3.019	2.451	2.591	2.055	1.857				
Pentium 150+		2.962	2.732	2.096	1.842	1.528			
Pentium Pro		3.387	2.929	2.318	2.039	1.995	1.508		
Pentium II < 400 MHz				2.999	2.341	1.866	1.706	1.414	
Pentium II > 400 MHz					2.330	1.861	1.750	1.591	1.395
Pentium III							1.823	1.717	1.627

Source: European Information Technology Observatory (2001), p. 506 and 508.

costs were lower. However, they found that price dispersion was not lower.¹⁸ Bailey (1998a) looks at prices of books, CDs, and software over the period 1996/97. He gains similar results for menu costs and price dispersion but finds that prices were actually higher online.¹⁹ Smith et al. (2000) attributes this to market immaturity at the time the study was made. Brown and Goolsbee (2000), analysing the prices of life insurance policies, find that growth of the Internet reduced term life prices²⁰ by 8-15% and increased consumer surplus by \$115-215 million p.a. and could possibly be more. They also find that, although introduction of the Internet is initially associated with an increase in price dispersion, as the share of Internet users rises, dispersion falls.²¹ Finally Goolsbee (2000) finds a high sensitivity to local tax rates: people subject to high local sales tax are more likely to buy online.²²

18 Brynjolfsson, E. and Smith, M. (2000), Frictionless Commerce? A Comparison of Internet and Conventional Retailers, in Management Science (April).

19 Bailey, J. (1998a), Intermediation and Electronic Markets: Aggregation and Pricing in Internet Commerce. Ph.D. dissertation, Program in Technology, Management and Policy, Massachusetts Institute of Technology.

20 Of the many types of life insurance policy, term life insurance is life insurance sold to individuals for a fixed period of time, say 1 year or 5 years. Term life insurance was chosen because these policies are relatively homogenous and, thus, are easier to compare.

21 Brown, J. and Goolsbee, A. (2000), Does the Internet Make Markets More Competitive? NBER Working Paper No. W7996.

22 Goolsbee, A. (2000), In a World with out Borders: The Impact of Taxes on Internet Commerce, in Quarterly Journal of Economics.

Evidence of price dispersion in the markets for some commodities has been attributed to: product heterogeneity; convenience shopping; awareness; retailer branching and trust; lock-in; and successful price discrimination.²³ However, it could be that this too is due to market immaturity.

So it can be seen that there is significant evidence to support the idea that the Internet puts downward pressure on prices, and, therefore, on inflation.

Though some economists have gone so far as to proclaim the “death” of inflation and an end to the business cycle. Visco (2000) says that it is more likely “...*simply that higher non-inflationary growth can be sustained over longer periods of time.*”²⁴ Also, Wadhvani (2000) refers to Buiter (1999) who re-emphasises that inflation is, ultimately, a monetary phenomenon. So a fall in the NAIRU (Non-Accelerating Inflation Rate of Unemployment) associated with the Internet would not reduce inflation in the long run, though there may be important short run effects. He also notes however that the short run in this example could, in practice, last several years.²⁵ Thus, even in this rather pessimistic view, the Internet is deemed to have a significant impact on reducing inflationary pressures.

3.3 Growth and Productivity

3.3.1 Definitions

3.3.1.1 Productivity Growth²⁶

Most empirical work on growth and productivity is based on the so-called “Growth Accounting” method. This method has its origins in traditional neoclassical growth theory, of the Solow type, where output (Y) is a function of Capital (K) and Labour (L). Thus:

$$Y = f(K, L)$$

where the production function is homogenous of degree one. If we replace this formula by the usual Cobb-Douglas production function, we have:

$$Y = K^\alpha + L^{(1-\alpha)}$$

23 See Smith et. al. (2000) for more detail.

24 Visco, I. (2000), The New Economy: fact or fiction?, OECD Observer.

25 Wadhvani, S. B. (May 2000), The Impact of the Internet on UK Inflation, in Bank of England Quarterly Bulletin.

26 Federal Reserve Bulletin (October 2000), Productivity Developments Abroad.

where $0 < \alpha < 1$. Putting this in logarithmic form and differentiating to get growth rates, we have:

$$y = \alpha k + (1 - \alpha)l$$

Here, α and $1 - \alpha$ are the marginal products of their representative factor inputs, which, under perfect competition, are equal to their relative factor returns. Thus, it is possible to estimate the growth contribution of the different factor inputs by setting GDP growth equal to the sum of the factor inputs, weighted by their relative factor returns. It should be noted that the number of factor inputs can be extended (for example, in the case of estimating the contribution of ICT to growth, we can differentiate between inputs from ICT and those from other industries).

The form of the estimated formula is thus:

$$y = \alpha k + (1 - \alpha)l + mfp$$

where the final term, mfp , is a residual. This formula can now easily be transformed to show growth in labour productivity ($lp = y - l$) i.e. growth in output per unit labour input:

$$y - l = \alpha(k - l) + mfp$$

Thus, growth of labour productivity can be attributed to two elements: “capital deepening”; and “multi-factor productivity” (MFP). Capital deepening is the growth in the capital-labour ratio and multi-factor productivity is a residual that captures increases in productivity due to technology advances or improvements in production arrangements, rather than increases in factor inputs. Thus, MFP is the element of productivity growth that would contain any “spillover effects” produced by the Internet. It should be noted, however, that because MFP is a residual it holds all factors influencing productivity not due to capital deepening, including measurement errors and the like. Thus, caution should be taken in interpreting its role.

3.3.1.2 How does ICT effect Growth and Productivity?

According to the literature, there are three ways in which ICT can influence growth and productivity: firstly, the ICT-producing industries directly contribute to growth from their own, increasingly efficient, output of ICT goods and services; secondly, ICT con-

tributes to growth in their role as capital investment goods in production in other industries; lastly, ICT also plays a role as a special capital input. This refers to spillover effects or network effects, that accrue from the use of ICT. These are assumed to be especially relevant for the Internet and e-commerce. In a “network economy”, spillovers occur because when a firm or individual connects to the network the benefit of their participation is not gained by them alone, but by all other participants too. Here we can refer to Metcalfe’s Law which says that the value of a network increases exponentially with the number of users. Thus, ICT and, in particular, the Internet (as the network of networks) are assumed to have large spillover effects on the growth and productivity of the economy at large.

3.3.2 The Historical Perspective: The Productivity “Paradox” of the 1970’s and 1980’s

Studies undertaken from the 1970’s to the mid-1990’s, with the goal of quantifying the contribution of ICT to growth and productivity, were generally concerned with the so-called “productivity paradox of computers”. Theoretically, it was believed that ICT would produce huge productivity gains that would spill over the economy and contribute to growth. However, these spillovers were not seen in the statistics. As often quoted, Solow remarked in the 1980’s that the impact of ICT could be seen “...*everywhere except in the productivity statistics.*”²⁷ Indeed, in many countries, productivity growth can be seen to have slowed during the 1970’s and 1980’s, despite theoretical predictions to the contrary.

Two pertinent explanations have been put forward to explain the productivity paradox: measurement errors and learning lags. Measurement errors refer to the inaccurate measurement of prices for ICT equipment. Traditional pricing methods do not take into account quality improvements in computing power. Thus, though the price of computers has fallen over time, when quality improvements are taken into account the “real” decline in prices has been much faster.²⁸ New pricing methods called “hedonic pricing” take quality improvements into account. However, it should be noted that, as yet, only a few countries have implemented them, in particular the US. Learning lags refer to the amount of time between the introduction of a new technology and its diffusion through

27 L’Hoest, R. (2001), The European Dimension of the Digital Economy, in *Intereconomics: Review of European Economic Policy*, Volume 36, p. 44-45.

28 See Section 3.2 Prices and Inflation.

out the economy. Paul David has long argued that new technologies diffuse gradually because it takes time for companies to learn how to use the new resources efficiently. Also, there are acceptance barriers that need to be breached. In addition, it should be taken into account that, although computer hardware had advanced in leaps-and-bounds, software development was relatively slow until more recently. This is also likely to have put a restraint on the potential productivity contribution of ICT.

3.3.3 Empirical Evidence of a New-Economy Effect on Growth and Productivity for the US

Empirical work for the US shows a significant and rising contribution of ICT to growth and productivity during the 1990s (Bassanini, Scarpetta and Visco (2000), Jorgenson and Stiroh (2000), Oliner and Sichel (2000), Roegers (2001), Schreyer (2000), Whelan (2000), and Gordon (2000)).

3.3.3.1 Trends in Output and Productivity Growth in the US in the 1990s

Output growth in the US picked up from 2.8% p.a. in the first half of the 1990's to 4.8% p.a. in the latter half of the 1990's, also having been an average of 3% p.a. for the 1970's and 1980's (see table 3 below). Correspondingly, labour productivity growth picked up from 1.5% p.a. to 2.6% p.a. over the same period (see table 4 below).²⁹

3.3.3.2 Contribution from the Use of IT Capital

Oliner and Sichel (2000), calculating the contribution of ICT equipment, hardware and software together, find that results for the period 1996-99 "...put ICT at centerstage." They find a contribution of 0.6% p.a. from the use of IT hardware, and 1.1% from processing capital as a whole, a huge increase (see table 3, below). Other empirical studies find a contribution of between -0.27% p.a.³⁰ and 0.82% p.a.³¹ from the use of computer hardware to output growth (see table 5, below). The negative figure from Kiley (2000) was achieved because he assumed there to be very large adjustment costs, so large that

29 Oliner, S. D. and Sichel D. E. (2000), The Resurgence of Growth in the Late 1990's: Is Information Technology the Story?

30 Kiley, M. T. (1999), Computers and Growth with Cost Adjustment: Will the Future Look Like the Past? Federal Reserve Board, Finance and Economics Discussion Series Paper 1999-36.

31 Whelan, K. (2000), Computers, Obsolescence, and Productivity. Federal Reserve board, Finance and Economic Discussion Series Paper 2000-6.

they swamped any benefit to growth. The difference in the results of Whelan (2000) and Oliner and Sichel (2000) are due to the fact that the former assumed investment in IT equipment remained fully productive until retirement, whereas the latter assumed a degree of decay due to older computers not being as productive as more modern ones.

Table 3: Contributions to Growth of Real Non-farm Business Output, 1974-99

	1974-90	1991-95	1996-99
Growth rate of output	3.06	2.75	4.82
Contributions from:			
Information Technology capital	0.49	0.57	1.10
Hardware	0.27	0.25	0.63
Software	0.11	0.25	0.32
Communications equipment	0.11	0.07	0.15
Other capital	0.86	0.44	0.75
Labour hours	1.16	0.82	1.50
Labour quality	0.22	0.44	0.31
Multifactor productivity	0.33	0.48	1.16

Source: Oliner, S. D. and Sichel D. E. (2000), The Resurgence of Growth in the Late 1990's, Table 1, p. 24.

Table 4: Contribution to Labour Productivity in the Non-farm Business Sector, 1974-1999

	1974-90	1991-95	1996-99
Growth rate of labour productivity	1.37	1.53	2.57
Contributions (% p.a.) from:			
Capital deepening	0.81	0.62	1.10
Information Technology capital	0.44	0.51	0.96
Hardware	0.25	0.23	0.59
Software	0.09	0.23	0.27
Communications equipment	0.09	0.05	0.10
Other capital	0.37	0.11	0.14
Labour quality	0.22	0.44	0.31
Multifactor productivity	0.33	0.48	1.16

Source: Oliner, S. D. and Sichel D. E. (2000), The Resurgence of Growth in the Late 1990's, Table 2, p. 25.

Table 5: Contribution from Computer Hardware to Output Growth: Various Studies

Study	Previous Period		Current Period	
	Years covered	Contribution	Years covered	Contribution
Oliner-Sichel (2000)	1991-95	0.25	1996-99	0.62
			1996-98	0.59
Whelan (2000)	1990-95	0.33	1996-98	0.82
Jorgenson-Stiroh (2000)	1991-95	0.1	1996-99	0.49
Kiley (1999)	1974-84	-0.34	1985-98	-0.27

Source: Oliner, S. D. and Sichel D. E. (2000), *The Resurgence of Growth in the Late 1990s*, Table 3, p. 26.

3.3.3.3 Contribution from Growth in MFP

The growth rate of MFP more than doubled from 0.6% p.a. to 1.25% p.a. from 1991-95 to 1996-99.³² Oliner and Sichel (2000) find a contribution of 1.16% p.a. to labour productivity growth, from growth in MFP in the second half of the 1990s (see table 4, above). Thus, almost half of labour productivity growth, and a quarter of output growth, is due to growth in MFP.

An important question addressed in the literature is whether the rise in MFP growth is due to a rise in MFP growth in the ICT industry itself, or whether it reflects a more general pickup. If the latter were the case, it would support the idea of spillover effects from ICT and the Internet on the economy. The literature find that, although the ICT industry itself does contribute significantly to the increase in MFP, this is by no means the whole story. Oliner and Sichel (2000) find a contribution of 0.49% p.a. of the 1.16% p.a. increase in MFP from ICT-producing industries and the Council of Economic Advisers (2000) finds that 0.39% of the 1.04% increase in MFP is due to the ICT industry. Thus, a large part of the increase is unaccounted for. This bodes well for the spillovers argument, but the authors consider more research to be necessary before more concrete statements can be made. In particular, Gordon (2000) argues that the increase in labour productivity growth can be entirely explained by four factors: investment in ICT, in-

³² Oliner and Sichel (2000) and Jorgenson and Stiroh (2000).

creases in MFP in the ICT-producing sectors themselves, adoption of hedonic-pricing methods and through cyclical factors. However, it should be noted that the period of analysis is very short and it is probably too early to say to what extent cyclical factors have played a role in the recent macroeconomic performance of the US.

3.3.3.4 Evidence of the Individual Contribution of the Internet

Although the majority of the empirical work concentrates on estimating the contribution of ICT, as a whole, Oliner and Sichel (2000) also make an attempt at quantifying the contribution of the Internet (and e-commerce) on productivity growth in the US. They say that explosion of the Internet and e-commerce is assumed to have huge effects on productivity, as transactions and information costs fall. Though their analysis does not model this explicitly, they note that their results incorporate it. By using a “back of the hand” method, they calculate a cost saving from e-commerce of \$15bn for 1999, which represents 0.2% of the output of the non-farm business economy. By assuming that these savings accrued during the period 1996-99, they estimate that the impact of e-commerce on MFP growth would have been less than 0.1% p.a.. They conclude, therefore, that the efficiency gains from e-commerce have, so far, had a small effect on MFP.

Despite this result, they are optimistic that, in the future, the effects will be much larger. They point to predictions of rapid growth in the field of e-commerce in the coming years, which raises the possibility of future gains. They also point to a recent study by Brooks and Wahhaj (2000) who argue that “...*business-to-business e-commerce will make a considerable contribution to economic growth over the next ten years.*” An added argument is that of David’s learning lags. As we can see, the growth and productivity effects from computers have only just started to come through, after having the personal computer for more than twenty years. Going by this, we still have quite some time to go before the full effects of the “Internet Economy” will be seen, even in the United States. After all the Internet has only been in commercial use since 1995. Also, as more economic activity moves to services, measurement difficulties are increasing. Indeed, that the availability and quality of data on e-commerce is very bad at this stage. This is mainly due the difficulties of measuring output in these sectors. Thus, it is difficult to know the true size of its contribution.

3.3.4 Empirical Evidence of a New-Economy Effect on Growth and Productivity for Germany and Other OECD Countries

Though international comparison is complicated by the differing price measurement practices of different countries, the evidence from comparative studies show that, although ICT has had an increasingly important impact on growth and productivity in a number of countries, it has not been to the same extent as that witnessed in the USA during the 1990s (see table 6, below).

3.3.4.1 Trends in Output and Productivity Growth in the OECD in the 1990s

In general, growth rates in the 1990s differed widely amongst OECD countries. In many countries, including Germany, a significant slowdown can be witnessed. The major exceptions to this, in addition to the USA, are the cases of Australia, Canada, New Zealand, and the smaller European countries: the Netherlands, Ireland, Norway, Finland, and Denmark.³³

In contrast to the heterogeneous pattern of output growth amongst OECD countries, labour productivity growth rates have been more stable during the 1990s. Labour productivity growth picked up in a number of countries. Bassanini et al. (2000) explain this seeming contradiction, between varied growth rates and stable productivity growth, as the result of varying labour utilisation rates in different countries: where as in some countries (USA, Australia, Canada, Denmark, Norway and Portugal) increased labour productivity growth was associated with stable or rising employment rates, in others (Finland, Germany, Italy and Sweden) it is associated with falling employment. In the latter case then, it can be assumed that measured labour productivity increases were due to a fall in the employment of the low skilled (i.e. to the large amount of “up-skilling” that is taking place in EU countries) rather than to more productive capital. A number of other countries (Austria, France, Ireland, Japan, the Netherlands, New Zealand, and Spain) experienced falls in productivity.

33 Bassanini, A., Sarpetta, S., and Visco, I. (2000), Knowledge, Technology and Economic Growth: Recent Evidence from OECD Countries

Table 6: Business sector GDP Growth and its components, 1980-98 (% change at annual rate, trend series)															
	GDP			Employment			Labour productivity			Capital deepening			MFP		
	1980-90	1990-98	1995-98	1980-90	1990-98	1995-98	1980-90	1990-98	1995-98	1980-90	1990-98	1995-98	1980-90	1990-98	1995-98
US	3.1	3.3	3.8	2.0	1.9	2.2	1.1	1.4	1.6	1.1	0.6	1.0	0.8	1.1	1.1
Japan	4.0	2.5	2.2	1.3	0.6	0.3	2.7	1.8	1.9	4.9	4.7	4.4	1.6	0.7	0.8
Germany	2.3	1.6	1.7	0.5	-0.5	-0.3	1.8	2.1	2.0	2.9	3.7	3.1	1.1	1.0	1.1
France	2.3	1.7	1.8	-0.2	0.0	0.2	2.4	1.7	1.6	2.3	2.3	2.3	1.6	0.9	0.8
Italy	2.5	1.7	1.7	0.5	-0.6	-0.6	2.0	2.3	2.3	2.7	3.5	3.4	1.2	1.1	0.9
UK	3.0	2.1	2.3	0.6	0.6	0.7	2.3	1.5	1.6	1.8	1.2	1.0	...	1.2	1.3
Canada	2.8	2.5	3.1	1.7	1.4	2.0	1.1	1.1	1.1	1.8	0.9	1.4	0.3	0.7	0.7
Australia	3.5	4.1	4.6	2.1	1.8	2.1	1.4	2.2	2.5	1.5	0.1	0.9	0.8	2.1	2.1
Austria	2.3	2.4	2.2	0.0	0.4	0.1	2.4	2.0	2.1	4.0	4.7	5.0	1.0	0.6	0.6
Belgium	2.1	2.0	1.9	0.0	0.4	0.5	2.1	1.5	1.4	3.1	3.0	2.7	1.1	0.7	0.6
Denmark	2.0	2.9	3.4	0.3	0.0	0.6	1.7	2.9	2.8	3.4	2.8	2.6	0.6	1.8	1.7
Finland	2.6	2.1	3.6	-0.7	-1.9	-0.4	3.4	4.0	3.9	4.1	2.8	1.2	2.2	3.1	3.5
Greece	1.6	1.8	2.2	0.5	0.7	0.8	1.1	1.1	1.4	2.7	1.8	1.6	0.6	0.3	0.6
Ireland	4.0	6.6	7.4	-0.1	3.4	4.5	4.2	3.2	2.8	2.4	-0.1	-0.4	3.4	3.5	3.2
Netherlands	2.2	3.0	3.0	0.7	1.7	1.8	1.4	1.3	1.2	2.7	1.6	1.6	1.1	1.0	0.8
New Zealand	1.6	3.0	3.6	0.4	2.3	2.8	1.2	0.6	0.7	1.7	-1.1	...	0.6	1.1	...
Norway	1.4	2.6	3.4	0.0	0.4	1.5	1.4	2.2	1.9	3.4	1.6	1.7	0.7	1.9	1.6
Portugal	2.7	2.4	...	0.8	0.2	...	1.9	2.2	...	2.9	1.7	1.8	...
Spain	2.4	2.3	2.5	-0.3	0.5	1.1	2.7	1.8	1.4	4.8	3.8	2.8	1.6	0.6	0.4
Sweden	2.0	1.6	2.0	0.2	-1.2	...	1.8	2.8	3.0	2.6	2.4	2.7	0.9	1.7	1.7
Switzerland	2.2	0.8	...	1.3	-0.1	...	0.9	0.9	3.5	...	0.1	-0.1	-0.1
Variability of Growth Rates:															
EU15	0.6	1.3	1.5	0.4	1.3	1.4	0.8	0.8	0.8	0.8	1.3	1.3	0.8	1.0	1.0
OECD24	0.7	1.2	1.4	0.8	1.2	1.3	0.8	0.8	0.8	1.1	1.6	1.3	0.7	0.9	0.9

Source: Scarpetta et. al. (2000), Economic Growth in the OECD Area, OECD Economics Department Working Paper No. 248, Table 10, p.47.

3.3.4.2 The Contribution of ICT Capital to Growth and Productivity in the OECD

It is generally agreed that ICT capital has made a significant and rising contribution to growth in output and productivity in the majority of OECD countries during the 1990s (Bassanini, Scarpetta and Visco (2000), BMBF (2001), Daveri (2000), Roegers (2001), Schreyer (2000), Temple (2000), van Ark (2001)). However, the contribution varies between countries and is generally lower than in the US. Where as in the US, for the period 1990 to 1996, the contribution of ICT equipment accounts for half of the growth contribution of fixed capital, and in Canada and the UK 40%, in France, Germany, Italy and Japan the contribution is smaller (see table 7, below).^{34 35} More recent calculations by Van Ark (2001) show that, although the US stands out in absolute terms, the contribution to growth from the use of ICT is increasing in most countries.

The literature finds that those countries who have invested more in ICT equipment have also generally benefited more in terms of output and productivity growth. Daveri (2000) reports that the biggest gains from investment in ICT in the 1990s were achieved by the US, Australia, Canada, the UK and the Netherlands, which all invested heavily in ICT. Although Finland, Denmark and Sweden also invested substantially in ICT, the contribution to growth was not large. However, in Finland and Sweden this was due to severe recessions in the early 1990s, that had nothing to do with the introduction of new technologies. Saying this, however, he also reports that the growth contribution of ICT in Finland, Denmark and Ireland increased significantly in the second half of the 1990s. It can be seen that the countries that invested heavily in ICT were also those that achieved better rates of growth. Countries that did not invest much in ICT received only marginal gains to GDP growth from ICT, and also achieved lower growth (Italy and Spain). Lastly, Belgium, France, Germany, and Sweden, which did invest in ICT but not heavily (except for Sweden) have received lower contributions to growth than in the countries that invested heavily.

34 Schreyer, P. (2000), The Contribution of Information and Communication Technology to Output growth: A Study of the G7 Countries, OECD STI working Paper 2000/2.

35 It should be pointed out, however, that Schreyer's (2000) results are obtained only for the period up to 1996, because of difficulties in obtaining internationally comparable data, and that he does not include IT software but only looks at IT hardware. As a result, his results are bound to underestimate the contribution of ICT. Also, as seen in studies for the USA, the contribution of ICT to productivity and growth rose significantly in the second half of the 1990s.

Schreyer (2000) says that the lower growth and productivity contribution in some countries is due to the smaller share of ICT assets in the total capital stock in these countries, which could be the result of the fact that ICT investment has been concentrated in services, that occupy a relatively smaller role in some European countries and Japan, than in the US and UK. BMBF (2001) also attributes the smaller contribution of ICT to growth in Germany to lower investment. According to this study, despite Germany reaching a new record in terms of ICT investment in 2000, in international comparison, ICT investment has been low. Investment in ICT was less than 6% of GDP in Germany for the year 2000, where as in the US and Sweden this figure was more than 8% of GDP. Germany's lagging position is even more apparent when IT investment is taken by itself and by looking at Internet usage/access directly (I talk about this in more detail in the following chapter). It should be noted, however, that comparison is complicated because of different definitions of ICT investment used in different countries.

3.3.4.3 The Contribution of Growth in MFP to Growth and Productivity in the OECD

The literature finds that the majority of OECD countries did not experience significant rises in MFP in the 1990s (Bassanini, Scarpetta and Visco (2000), Schreyer (2000), Gust and Marquez (2000)). However, for a few countries (Australia, Canada, Denmark, Finland, Norway, Sweden, the UK, and the US) MFP growth increased significantly (see table 6, above). In Ireland MFP growth was high but did not increase. It is interesting to note also that, these countries were also those that invested heavily in ICT, during this period. However, in Sweden and Finland increased MFP growth was accompanied by falling employment, and a slow down in GDP growth. While Germany, Greece, and Portugal saw no rise in MFP growth, in other countries (Japan, France, Italy, Austria, Belgium, the Netherlands, Spain and Switzerland) MFP growth has fallen significantly.³⁶

In terms of the contribution of the ICT industry itself to labour productivity, the data suggest that labour productivity growth from the ICT industry have been smaller in most other OECD countries, than is the case in the US.³⁷ This is largely due to the "first-mover advantages" that the US enjoys in this sector. Saying that, however, a number of the smaller European countries are also experiencing booming ICT sectors. One case in point is Finland, who's contribution far exceeds that of the US. In addition, as with the

36 Bassanini et al. (2000), Knowledge, Technology and Economic Growth.

37 Bassanini et al. (2000), Knowledge, Technology and Economic Growth, p.13.

use of ICT, recent evidence from Van Ark (2001) shows contributions are beginning to increase in most countries, and generally faster than in the US.

Table 7: ICT Contribution to Output Growth in a Selection of Countries (Total Industries, using harmonised ICT prices)

		Canada	France	Western Germany	Italy	Japan	United Kingdom	United States
Output Growth	1980-85	2.8	1.7	1.4	1.4	3.5	2.1	3.4
	1985-90	2.9	3.2	3.6	3.0	4.9	3.9	3.2
	1990-96	1.7	0.9	1.8	1.2	1.8	2.1	3.0
Contributions (%) from:								
ICT equipment	1980-85	0.25	0.17	0.12	0.13	0.11	0.16	0.28
	1985-90	0.31	0.23	0.17	0.18	0.17	0.27	0.34
	1990-96	0.28	0.17	0.19	0.21	0.19	0.29	0.42
Total capital	1980-85	1.3	1.0	1.0	0.9	0.8	0.8	1.1
	1985-90	1.1	1.3	1.2	0.9	1.3	1.1	1.0
	1990-96	0.7	1.0	1.0	0.7	1.0	0.8	0.9

Source: Schreyer (2000), *The Contribution on Information and Communication Technology to Output Growth*, Table 4, p18.

3.4 Employment Effects from the Internet and ICT

3.4.1 Theoretical Considerations

The Internet is likely to have a number of effects on the job market and the level of employment. Firstly, it increases “job-matching” process efficiency. Secondly, it effects the level of employment by contributing to structural change: positive employment effects accrue through the increased demand for new production processes, products, services and skills, while there are negative effects because of the reduced demand for older production processes, products, services and skills. Thirdly, the Internet causes a positive shift in demand in favour of the highly skilled.

As discussed in chapter 2, the Internet increases market efficiency. The Internet increases job-market efficiency by improving job matching between the unemployed and available vacancies (Wadhawani, 2000). Improved job matching is achieved because it makes the job/employee search process easier. Firms can place vacancies in the Internet to advertise jobs to a larger pool of potential employees. In turn, potential employees can search for adverts, and advertise themselves, all over the world. As previously discussed, new intermediaries, in this case online employment agencies, increase market

transparency and make the process more efficient.³⁸ As a result, the NAIRU should fall: lower unemployment and inflation can be achieved simultaneously.³⁹

The Internet and ICT are part of massive structural change, as we move towards a knowledge-based economy, leading to both positive and negative effects for employment. On the one hand, it has long been the view of the “progress pessimists” that technological progress leads to a substitution of labour for machines and, thus, adds to unemployment. On the other hand, “progress optimists” argue that loss of jobs will be compensated for by the creation of new ones.⁴⁰ According to Schreyer, M. (2000), compensation will take place if as productivity rises so does growth. These arguments together constitute Schumpeter’s theory of “creative destruction”: innovation leads to the creation of new and better products and thus to new production plants but also to obsolescence and destruction of older ones. Creative destruction implies a continual reallocation of workers to new sectors. Because, however, the job-matching process is not frictionless, innovation is often initially associated with increasing unemployment. However, improved job-matching efficiency brought about by the Internet could help ease structural unemployment.

Related to this, the Internet is affecting the job market by increasing the relative need for skilled labour. Because the Internet and ICT are “general-purpose technologies”, being used throughout the economy (in nearly all sectors), they are not only requiring different skills but are also requiring employees be more highly skilled. This has the potential to increase employment of the highly skilled but will also cause increased unemployment of the relatively low skilled. Thus, increased relative demand for highly skilled labour may contribute to structural unemployment. If the demand for the highly skilled is greater than the supply, not only will it act as a barrier to fast diffusion of the New Economy, it will increase wage inequality.⁴¹

38 See part 2: Reintermediation and the Appearance of New Intermediaries.

39 See part 3.2 Inflation.

40 Schreyer, M. (2000), Wachstum und Beschäftigung vor dem Hintergrund des Solowschen Produktivitätsparadoxons, Schriftenreihe des Promotionsschwerpunkts Makroökonomische Diagnosen und Therapien der Arbeitslosigkeit, Nr. 14/2000, p. 53.

41 Schreyer, M. (2000), Wachstum und Beschäftigung vor dem Hintergrund des Solowschen Produktivitätsparadoxons, p. 58-59.

3.4.2 Empirical Evidence

Van Ark (2001) analyses the effects of ICT on employment in a number of OECD countries during the 1990s (See table 8 below). He finds for the ICT-producing sector that only five out of the ten countries analysed received strong growth effects for employment (Canada, Finland, the Netherlands, the United Kingdom and the United States). These strong growth effects were mainly to be seen in the ICT-producing services sector. Here, the biggest receivers were: the United Kingdom, which received an employment growth contribution of 0.09% over the whole period of observation (1990-98) and 0.23% in the latter half (1995-98); and the United States, which received an employment growth contribution of 0.10% and 0.16% over the whole period of observation and the latter period, respectively. Notably, Germany was the only country in the sample to have received negative employment effects from the ICT-producing services industries, which incidentally worsened in the latter half of the 1990s. However, these results should be interpreted with caution, in light of a general down turn in reported employment in the German economy over this period, largely due to reunification, compared with major employment gains in the others.

The employment effects are much larger in ICT-using industries, here again, mainly in ICT-using service industries. Also here, the US is at the forefront, together with a number of other countries, receiving an employment growth contribution from ICT-using services of 0.36% over the whole period of observation and 0.59% in the latter half (almost a 1/3 of total employment growth). In the case of Germany, positive employment effects were only achieved in the ICT-using service sector, which remained stable throughout the 1990s at 0.11%.

With regard to skills, the BMBF(2001) finds that the level of skills in the world population is increasing, generally because younger generations are more highly qualified than older ones. Although Germany compares well, they argue that this is based on past investment: while other countries are catching up, Germany is witnessing relatively low student shares, especially for the natural and technical sciences. They conclude, therefore, that more investment should be made in education. However, while there has been a relative increase in the employment of the highly skilled in the USA there is also evidence of a lack of skilled labour, evidenced by increasing wage inequality between the highly skilled and the relatively low skilled. Schreyer (2000) finds that in 1980 college

graduates earned 1.5 times that of high school graduates. By the 1990s, this had grown to 1.9 times.⁴²

Table 8: The Contribution of ICT-producing and –using Industries to Employment Growth

	Employment growth	Contribution of ICT-producing manufacturing (%)	Contribution of ICT-producing services (%)	Contribution of ICT-using manufacturing (%)	Contribution of ICT-using services (%)
Canada					
1990-98	1.04	-0.01	0.15	-0.04	0.23
1995-98	1.92	-0.01	0.16	-0.02	0.43
Denmark					
1990-98	0.26	-0.01	-0.03	0.00	0.07
1995-98	1.54	0.02	0.00	0.06	0.39
Finland					
1990-98	-1.57	0.12	0.02	-0.06	-0.17
1995-98	2.24	0.15	0.18	-0.01	0.22
France					
1990-98	-0.02	-0.02	0.02	-0.05	0.08
1995-98	-0.01	-0.01	0.04	-0.01	0.15
Germany					
1991-97	-0.64	-0.11	-0.04	-0.15	0.11
1994-97	-0.55	-0.08	-0.09	-0.11	0.11
Italy					
1990-98	-0.21	-0.01	0.00	-0.02	0.10
1995-98	0.37	0.00	0.03	0.01	0.25
Japan					
1990-98	0.57	-0.02	0.05	-0.02	0.21
1995-98	0.29	0.00	0.03	-0.01	0.25
Netherlands					
1990-98	1.46	-0.05	0.10	-0.05	0.36
1995-98	2.60	0.00	0.22	-0.01	0.61
United Kingdom					
1990-98	0.22	-0.02	0.09	-0.03	0.30
1995-98	1.77	0.04	0.23	0.03	0.49
United States					
1990-98	1.48	0.00	0.10	-0.02	0.36
1995-98	2.05	0.04	0.16	0.00	0.59

Source: Compiled using data from the OECD's ICT database published in tables 4 and 5 of van Ark, B. (2001), The renewal of the Old Economy: Europe in an Internationally Comparative Perspective.

42 Schreyer, M. (2000), Wachstum und Beschäftigung vor dem Hintergrund des Solowschen Produktivitätsparadoxons, p. 59.

3.5 Summary and Conclusions about the Contribution of ICT at the Macroeconomic Level

In connection with the efficiency and welfare enhancing effects of the Internet on the economy, discussed in part 2, there is growing evidence of a so called “New-Economy effect” in the US. Empirical evidence shows that, despite the singularly phenomenal macroeconomic performance of the United States during the 1990s, it has not been the only country to have benefited from the New Economy. A number of observations can be made in this regard:

Evidence shows that the Internet and information and communication technology (ICT) reduces inflationary pressures, both as a result of falling prices for ICT goods but also because of increased price competition in electronic markets. Numerous studies show that prices are lower when buying goods through the Internet and that other forms of price competition are also increasing.

Productivity increases in a large number of countries during the 1990s were due to large investment in ICT in one set of countries, while, in an other set, they were largely due to falls in employment associated with a move towards the employment of the relatively more highly skilled. The first set includes the US, Australia, Canada, and a number of the European countries (Denmark, Norway, and Portugal). The second set includes the countries, Finland, Germany, Italy, and Sweden. In those countries where increases in labour productivity growth were associated with increased or stable employment and better investment in ICT, growth rates of GDP also generally increased. The few countries that benefited from increased MFP growth were also members of the first group, the exceptions being Finland and Sweden (which also gained but are members of the second group). The contribution of ICT-producing industries to output and productivity growth during the 1990s was generally lower in other countries compared to the US, the major exception being Finland, who’s contribution far exceeds that of the US. It should be noted however that current data indicate increasing contributions from ICT in most countries.

Increased “job matching” is said to increase job-market efficiency and, therefore, reduce unemployment. Structural change should lead to both job losses in less efficient sectors and job gains in new, more efficient, ones. Finally, increased demand for skilled labour should increase relative employment of the more highly skilled. The evidence shows

that, although strong employment effects have been achieved in a few countries (Canada, Finland, the Netherlands, the United Kingdom and the US) (also those who have invested heavily in ICT), in the majority this is not the case. Also, in the US, although the supply of skilled labour has increased in response to increased demand, evidence of an increased wage gap between the relatively more highly skilled and the relatively less skilled shows that more investment in education is needed, even in the US.

In the case of Germany, GDP growth and Employment rates fell over the 1990s, and although productivity grew this was mainly due to a fall in the employment of the low skilled. While ICT has made a contribution to growth in Germany, it is much smaller than in other countries (in the US 50% of the contribution to growth from fixed capital came from ICT, and in Canada and the UK 40%). The lower contribution of ICT capital to growth in Germany is generally attributed to lower investment in ICT, which was 6% in 2000, compared with 8% for the US and Sweden. However, comparison is complicated by use of different measures of investment. Germany received no apparent increase in MFP growth over the 1990s. There was also no evidence of strong employment gains from ICT. Germany received negative employment effects from the ICT-producing service industries. However, gains were made in the ICT-using service sector, which remained stable throughout the 1990s at 0.11%. Germany fares well in terms of skilled labour, however, this is based on past investment, current student numbers are low in international comparison.

Therefore, it can be seen that there is evidence of a New-Economy effect from ICT in a number of countries, not just the US. This evidence supports the idea of learning lags in the diffusion of new technologies, which, in turn, suggests that it could be some time before the full macroeconomic impact of the Internet will be seen, even in the US. After all the personal computer was around for 20 years before the United States began to receive significant macroeconomic benefits. The Internet, in comparison, has only been commercially active since 1995, and since then its growth has been dynamic, to say the least.

The New-Economy effect has, however, been unevenly distributed amongst industrialised countries. It is thus the case that, if it wants to share in the macroeconomic benefits from the New Economy, Germany has to invest more in ICT (i.e. the use of ICT should be encouraged). In addition, efforts should be made to increase the level of skills in the working population, by investing more in education and by encouraging use of

foreign labour, where it can alleviate home market deficits (This refers to the “green card” issue for foreign specialists). Lastly, attention should be paid to providing the correct environment for businesses to expand into new areas of the ICT industries themselves. Otherwise, it faces the prospect of being left on the wrong side of the “digital divide”. In the light of these results, the next chapter involves a look at Internet access issues: a look at the digital divide and what factors influence the use/access of the Internet.

4 Unmetered Internet Access: The Solution to the Digital Divide

In parts 2 and 3 of this paper, we found that the Internet makes the economy more efficient and competitive, and in doing so has positive macroeconomic benefits, in terms of reduced inflation and unemployment, and increased growth and productivity. We also found that the gains, thus far, from ICT and the Internet have been unevenly distributed across countries, to a large extent the result of lack of investment in and use of ICT by some, as is the case in Germany. It is therefore the purpose of this chapter to look at the so called “digital divide” more closely and to assess its causes/remedies.

4.1 What is the Digital Divide and Why Do We Need to Address It?

The digital divide “...refers to the gap between individuals, households, businesses and geographic areas at different socio-economic levels with regard to both their opportunities to access information and communication technologies (ICT) and to the use of the Internet for a wide variety of activities.” OECD (2001)

It is important to understand why there is a digital divide and what can be done about it because those individuals, households, businesses and geographic areas who are excluded can not reasonably be expected to receive significant gains from ICT. We have already identified in part 3 that countries who have been slow to take part in the New Economy have already missed out on significant macroeconomic gains. This can also be considered to be the case for individuals and businesses. Individuals who are not connected to the Internet will not be able to take part in the gains of being online, such as reduced search costs, and increased consumers power etc. They will also not be able to take advantage of easier job-search facilities and may find getting jobs increasingly more difficult, as the skills and experience achieved by using ICT become more in demand. Businesses who are not connected and do not take advantage of benefits to them

and their customer and suppliers of using the Internet can also be expected to lose competitive advantage, as others do. By identifying the reasons for the digital divide, policy can be directed at tackling it and the most can be made of the Internets' potential.

4.2 Evidence of a Digital Divide

4.2.1 ...at the Level of the Individual/Household/Firm

A number of studies assessing the digital divide find that there is a significant difference between people of different ages, levels of skill/education, gender and income as to their access/use of the Internet (ARD/ZDF (2000), Emnid TNS Interactive (2001), GfK (2001), and OECD (2001)). These studies generally find that it is younger, well educated, highly paid, men that are more likely to use the Internet. Also, that it is larger rather than smaller firms that are making use of the Internet in their activities. However, they also find that these gaps according to socio-economic factors are narrowing over time, as more people and firms in all groups join.

The "ARD/ZDF-Online-Studie 2000"⁴³ is the fourth in a series of analyses undertaken once a year since 1997. This study, carried out between 22nd March and 24th April 2000, asked 1005 Internet users, representative of the German population, questions about their use of the Internet. Results (seen in table 9 below) show that, despite a continuing difference in Internet use based on socio-economic factors, in the last couple of years (1999 and 2000) the biggest increases in online access have been in those groups who, a few years ago, had little contact with the new medium.⁴⁴

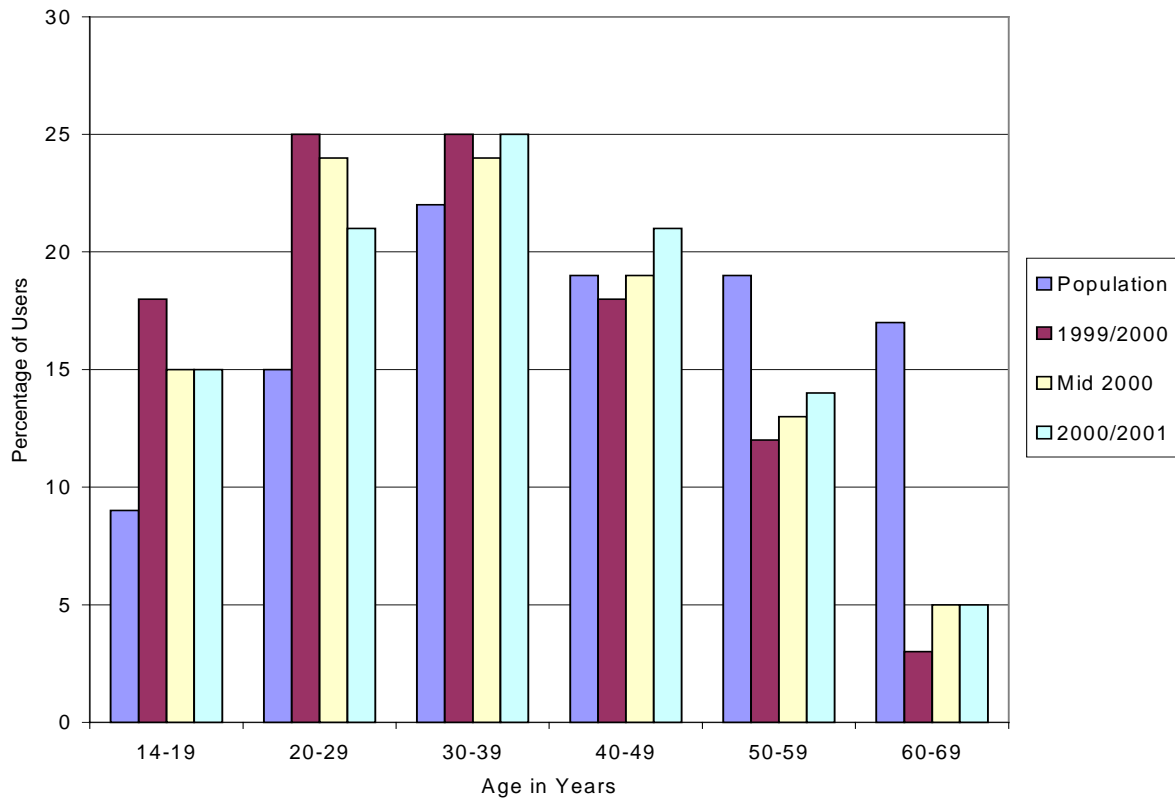
While a few years ago the "typical" online user was easy to identify (male, employed, highly educated and between 20 and 39 years old), since 1999 a structural change seems to have taken place with much higher numbers of women, the old and young, as well as people of average education level becoming Internet active. The largest growth rates were seen for women and older people. The percentage of women using the Internet rose from 3.3% in 1997 to 21.3% in 2000. So that women accounted for 39% of the online population in 2000. Indeed another study carried out for Germany finds that this proportion has risen to 42% (as of January 2001).⁴⁵ With respect to the age structure of

43 Carried out by the Institut für Markt- und Sozialforschung ENIGMA.

44 ARD/ZDF (2000), ARD/ZDF-Online-Studie 2000, p. 340.

45 GfK (2001), GfK Online-Monitor, p. 17.

Diagram 2: The Age Structure of Internet Users



Source: Compiled using diagrams from p. 17 and 18 of GfK (2001), Online-Monitor, 7. Untersuchungswelle

Internet users, the ARD/ZDF (2000) study finds that in the categories 50+ in the year 2000, the number of Internet users was 8 times that of 1997.⁴⁶ The main point to note is that increases in activity across all age groups is leading to an evening out of the age structure of Internet users. Where as in 1999 only 33% of those 40+ were using the Internet, as of January 2001 this had risen to 40%.⁴⁷ So that the proportion of Internet users in each age category is approaching that of its share in the population (see Diagram 2 on the previous page). With respect to education, it can be seen that, in the group of people who were educated up to high school level, Internet use has risen more than four times since 1997. Despite these relative improvements however, in absolute terms, the largest numbers of Internet users and the largest increases, over the period 1997-2000, have been in the “typical” user group.

46 ARD/ZDF (2000), ARD/ZDF-Online-Studie 2000, p. 340.

47 GfK (2001), GfK Online-Monitor, p. 19.

Table 9: Use of the Internet as a Percentage of Socio-economic Group

	1997	1998	1999	2000
Total	6,50	10,40	17,70	28,60
Gender				
Male	10,00	15,70	23,90	36,60
Female	3,30	5,60	11,70	21,30
Age in Years				
14-19	6,30	15,60	30,00	48,50
20-29	13,20	20,70	33,00	54,60
30-39	12,40	18,90	24,50	41,10
40-49	7,70	11,10	19,60	32,20
50-59	3,00	4,40	15,10	22,10
60+	0,20	0,80	1,90	4,40
Education				
Ext. elementary school	1,30	2,90	4,90	7,50
High school	5,90	7,50	15,70	31,40
A-level (Abitur)	16,50	23,90	50,90	79,20
University	29,10	48,50	62,50	86,00
Employment				
In apprenticeship	15,10	24,70	37,90	58,50
Employed	9,10	13,80	23,10	38,40
Pensioned/ unemployed	0,50	1,70	4,20	6,80

Source: ARD/ZDF-Online-Studie 2000

Evidence can also be found of a difference in Internet use according to net income levels: Internet use rises with income (GfK (2001); OECD (2001)). Other evidence of the importance of financial matters come from a complementary study to the ARD/ZDF Online-Studie 2000, the “ARD/ZDF Offline-Studie 2000”. This study finds that one of the main factors preventing Internet use is cost (of equipment and Internet access). In interviewing both Internet users and non-users about their opinions about the Internet, they find that the biggest difference of opinion is as to the role of financial hurdles: where as only a quarter of users are of the opinion that only a few people will be able to afford Internet use, more than half of non-users believe this to be the case.⁴⁸

The OECD (2001) finds that differences in ICT penetration can be found between people of different racial, ethnic and cultural groups, but concludes that is also related to income and education factors.⁴⁹ They also find that ICT penetration increases with firms size, but that over time these differences are diminishing.⁵⁰

48 ARD/ZDF-Offline-Studie 2000, p. 355.

49 OECD (2001), Understanding the digital divide, p. 22.

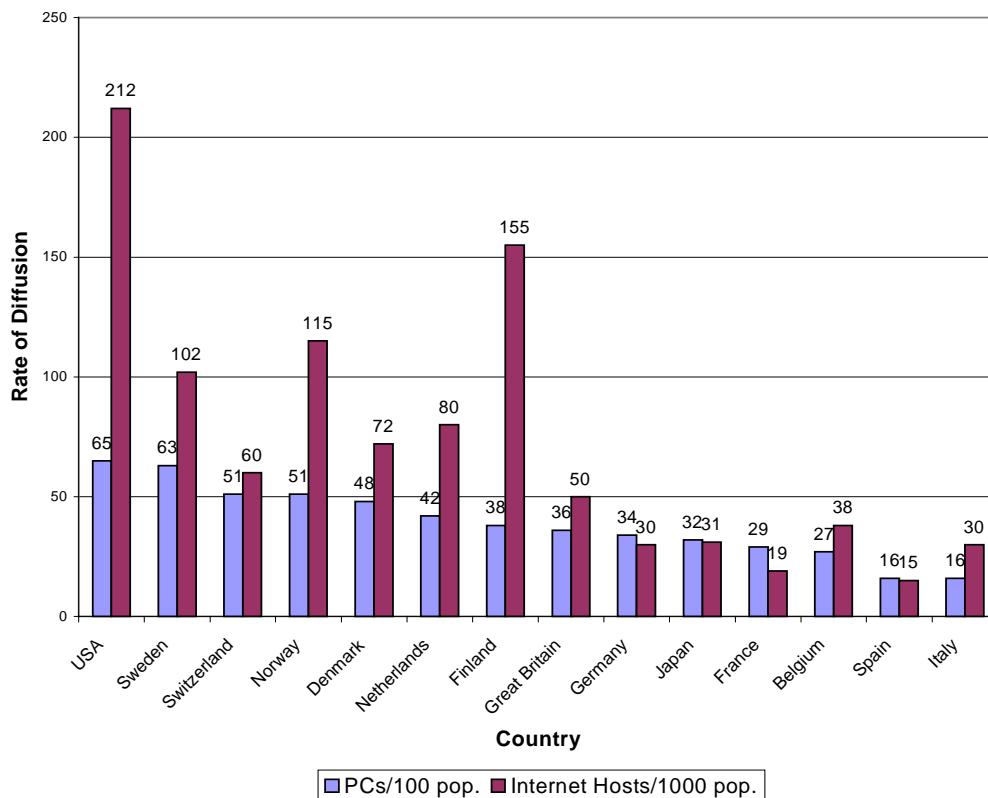
50 OECD (2001), Understanding the digital divide, p. 25.

Thus, though there are gaps between people of different socio-economic groups, with regard to age, education, and gender, and between firms, with regard to their size, over time these gaps are narrowing. Despite a reduction of the digital divide due to these factors, financial matters remain a significant barrier to Internet use/access.

4.2.2 ...at Country Level

At an international level, the diffusion of ICT across countries can be observed directly by looking at data on: PC density, Internet host density, Internet use, and other measures of communications infrastructure density. Diagram 3, below, illustrates the diffusion of PCs and Internet hosts for Western Europe, the USA, and Japan. The diagram shows that the USA leads the field in both PC penetration and number of Internet hosts, with 65% of the population owning a PC (the main form of Internet access) and with 212 Internet hosts for every 1,000 population. After the USA, it is again the Nordic countries, Switzerland, the Netherlands and Great Britain, that perform well in terms of PC and Internet host density. Germany, Japan and the rest of the larger Western European

Diagram 3: PC and Internet Host Diffusion in Western Europe, the USA and Japan, 2000



Countries, in comparison, are trailing far behind. Only 36% of the German population owns a computer, and there are only 30 Internet hosts per 1,000 Germans. In addition, PC penetration is only expected to grow to 43% by 2003.⁵¹

This trend is reiterated if we look at statistics on the number of Internet users and other measures of ICT infrastructure density. Table 10 presents statistics on the ICT connectivity of a selection of OECD countries, based on Internet use, and the density of ISDN channels, DSL connections, cable TV connections and mobile phones, for 2000. The table shows Germany, and the other large Western European Countries, lagging behind the USA in terms of Internet access. Where as in the USA 48% of the population is connected, in Germany this figure is only 28%. With regard to other measures of ICT penetration the picture is more mixed, however, as diagram 4 illustrates, the USA is the clear winner, especially in terms of more direct measures of Internet use: Internet users and density of DSL connection (high speed Internet access). The only areas where Germany performs better are with regard to ISDN channels and mobile phones.

In addition to measures of access diffusion, it is just as important to consider the amount of use, i.e. the length of time users spend online. Once more we find significant differences between OECD countries. Where as in countries with metered telecommunication's charges/ Internet access usage ranges between 5 and 9 hours per month (in Germany 7.5 hours), in the Nordic countries, which have relatively low metered charges, usage is higher. In comparison. however, countries with unmetered access (e.g. New Zealand and the United States) usage is significantly higher. According to the OECD (2001), the average US AOL user stayed online for 32 hours per month in mid-2000. Also Telecom New Zealand reports average usage in excess of 20 hours per month.⁵²

Flat-rate Internet access increases users length of time spent online because they pay a fixed monthly fee (a flat rate) which allows the Internet to be accessed and used independent of further costs due to the length of use. Once the flat rate is paid customers can and will use the Internet as much as they would like to. As a result, flat-rate Internet access is important for making the most of the benefits of the Internet, in particular, it is vital to the growth of electronic commerce, allowing customers to *"...have more time to browse, to attend auctions and to interact."*⁵³

51 BITKOM (2001), Wege in die Informationsgesellschaft, p. 10.

52 OECD (2001), Understanding the digital divide, p. 16.

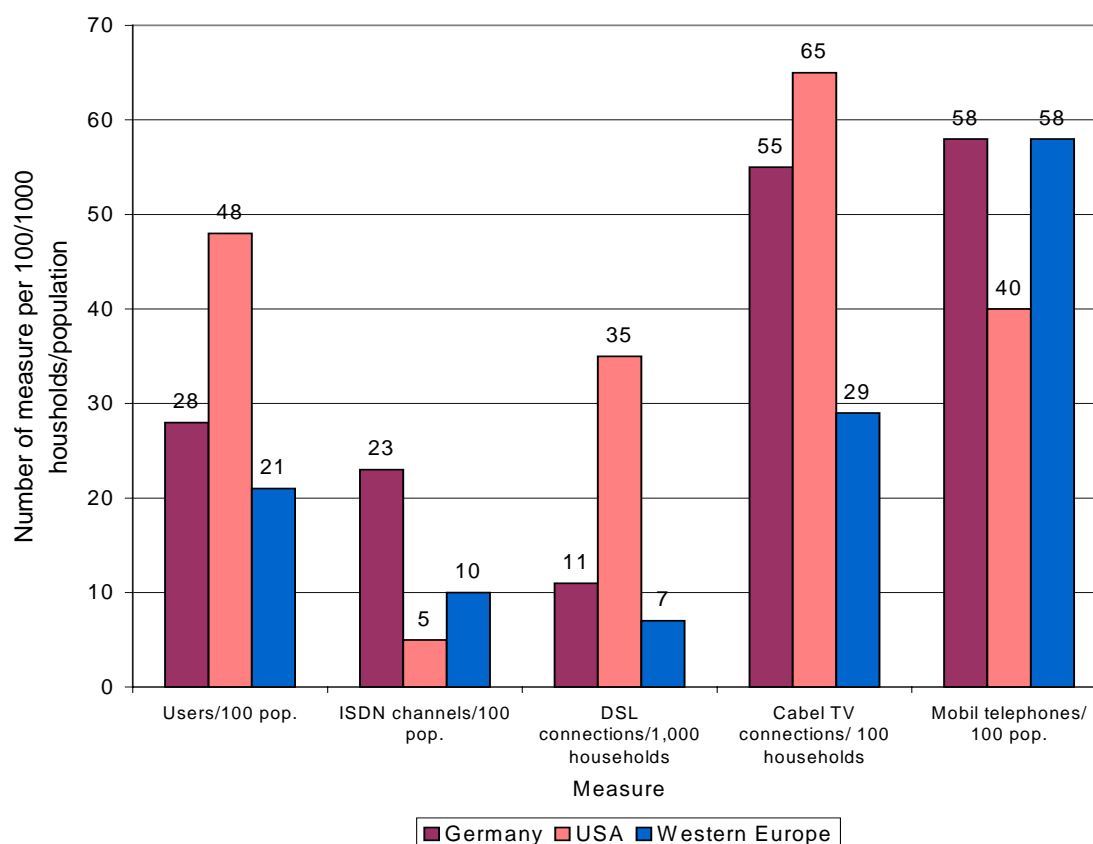
53 OECD (2001), Understanding the digital divide, p. 16.

Table 10: Measures of ICT Connectivity for 2000

Country	Users/100 pop.	ISDN channels/100 pop.	DSL connections/1,000 households	Cable TV connections/100 households	Mobil tele-phones/ 100 pop.
France	17	7	5	13	51
Germany	28	23	11	55	58
Great Britain	29	7	4	14	68
Italy	19	8	4	2	74
Japan	21	11	2	18	47
Spain	14	4	5	7	66
USA	48	5	35	65	40
Western Europe	21	10	7	29	58

Source: Compiled using data from BITKOM (2001), Wege in die Informationsgesellschaft

Diagram 4: Measures of ICT Connectivity for Germany, the USA and Western Europe, 2000



4.3 Evidence of the Role of Unmetered Internet Pricing in Solving the Digital Divide

Empirical and anecdotal evidence highlight unmetered Internet pricing/liberalised telecommunications policy as the key to both increased access as well as use of the Internet. Hargittai (1999) was one of the first to perform a multiple regression analysis to assess the contribution of different factors to Internet connectivity. By doing so, she is able to isolate the impact of each explanatory variable, controlling for other factors. This enables, for the first time, an understanding of the relative importance of each factor in explaining Internet connectivity. This is an important development because policy, directed at encouraging diffusion of the Internet, needs to be able to prioritise: to address factors that will have the largest, most wide spread impact.

Measuring the impact of a broad range of factors on cross country Internet connectivity (host numbers for OECD countries), Hargittai (1999) finds that the most important factors explaining Internet connectivity are economic wealth and telecommunications policy. A dummy variable is used to distinguish between countries with monopolies in their telecommunications sectors and those that had some level of competition, in the year studied.⁵⁴ This shows a large, negative and highly significant effect on Internet host numbers. GDP also has a positive and significant effect on host numbers. Surprisingly, access prices only have a marginally negative effect and this is not significant. Thus, although we find a small negative relationship between price levels and the number of Internet hosts across OECD countries, we can not say with any confidence that this relationship is stable. Therefore, we can conclude that GDP and price structure have a more important influence on the number of Internet hosts than the price level.

Similarly, Haring, Rohlfes and Briceño (2001) perform multiple regressions for 15 OECD countries⁵⁵ where the dependent variables are, firstly, Internet usage demand (measured by the number of hours per month per user) and, secondly, Internet access demand (measured by the ratio of Internet users to the population). The explanatory variables are income, Internet access price levels, and a dummy is used to take the value

54 This was done based on information about the level of competition in telecommunications markets, reported in OECD (1997d), *Communications Outlook 1997*.

55 The countries included in the analysis are: Australia, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Sweden, UK, and US.

of 1 for those countries that offer flat-rate prices for ISP and telecom services.⁵⁶ Income is used as a “*catch-all*” socio-demographic variable.

They find similar results to Hargittai (1999), in that income has a large, positive, and significant effect on Internet use/access, and price level is insignificant. Instead of using a dummy variable to represent the presence of monopoly in the telecommunications market, they directly measure the effect of the presence of a flat-rate pricing option. Like Hargittai’s (1999) large, negative, and highly significant result from the effect of monopoly on Internet host numbers, Haring et al. find that a flat-rate price structure has a positive and significant effect on the demand for Internet usage and access. They say, other things equal that “...*unmetered pricing for ISP and telecoms services increases access and usage demand by 31 and 35%, respectively, compared to regimes with usage sensitive ISP and telecoms charges.*”⁵⁷

There is also growing anecdotal evidence of the demand for unmetered Internet pricing. In particular is to note the actual effects of the introduction of unmetered pricing by AOL in America and the UK. When AOL introduced a flat-rate offer in America, Internet use tripled within 1 year. Before the introduction of the flat rate, in December 1996, average monthly subscriber usage was 8 hours. By 1998 this had risen to 22 hours, and by 2000 to 32 hours. A similarly large increase can be seen for introduction in the UK. Between May 2000 (two months before the introduction of unlimited dial-up Internet access) and February 2001, average usage in the UK increased by 78%.⁵⁸

A study by OFTEL (the British regulatory authority) published in May 2001⁵⁹, also finds a major increase in Internet penetration after the introduction of a flat rate in the UK. They find that, in the 6 months after introduction of flat-rate pricing, household Internet penetration grew by more than 33% from 30-40%. They also find that 35% of UK users were opting for unmetered products by May 2001, and that, on average, those with unmetered access stayed online twice as long.

56 Those countries in the sample that offered unmetered charges were: Australia, Canada, New Zealand, and US.

57 Haring, J., Rohlf, J., and Briceño, A. (2001), The Effect of Pricing Structure on Residential Internet Demand, Strategic Policy Research, p. 11.

58 Haring et al. (2001), The Effect of Pricing Structure on Residential Internet Demand, p. 8.

59 Oftel (2001), Consumers’ use of the Internet: Oftel residential survey Q5 May 2001.

Finally, there is also evidence of demand for unmetered pricing in the German market. Against the back drop of comments by critics that there is not enough demand for provision of a flat rate in the German market, AOL Deutschland has introduced a flat rate at a price of DM 39,90, restricted to 1,000 per week (because regardless of whether customers pay metered or unmetered prices ISPs have to pay metered telephone charges to Deutsche Telekom). Only a week after introduction, 100,000 people had registered there interest in obtaining the flat-rate offer.⁶⁰

4.4 Summary and Conclusions

The aim of this chapter was to discuss to what extent there is evidence of a “digital divide” between individuals/households/businesses and geographic areas, and to analyse its causes. The literature finds that there are significant differences between households/individuals use of the Internet/ICT as a result of socio-economic factors: age, income, gender, employment and education. So that the “typical” Internet user is male, employed, highly educated, highly paid and between the age of 20 and 39. However, these gaps are beginning to close. A digital divide can be discerned between businesses as a result of firms size: it is larger firms that tend to be more connected. However, this gap is also narrowing over time. It was also found that the biggest barrier to Internet use were financial.

With regard to differences in Internet/ICT connectivity between countries, the literature finds that there are significant and growing differences between OECD countries. It can be seen that, again, the USA, followed by the Nordic countries, Canada, and New Zealand, are leading the way. In comparison, Germany and some other larger EU countries are trailing.

The main reasons for this growing divide are becoming increasingly clear: empirical and anecdotal evidence clearly point to the structure of pricing as the main factor explaining the digital divide. While empirical evidence shows that both Internet access rates and use are significantly higher in countries with unmetered Internet pricing or liberalised telecommunications markets, anecdotal evidence shows that the introduction of flat-rate pricing in some countries caused an immediately significant increase in the number of users and their time spent online.

60 AOL Deutschland (02/08/2001), 100.000 Registrierungen für AOL Schmalband-Flatrate eine Woche nach Einführung, Pressemitteilung.

Therefore, as Haring et al. (2001) have put it:

“This is obviously a striking result of significant importance for public policy. Countries in which unmetered pricing offerings are not yet available are in a position to increase demand for Internet access and usage quite significantly, and thereby to realize the substantial economic productivity boosts likely to be associated therewith.”

5 Summary and Conclusions

For a long time now there has been intensive discussion in Germany, and other countries around the globe, amongst interested parties about the need for flat-rate Internet pricing. Proponents of the provision of such a pricing scheme have argued that it is crucial to increasing use and access of the Internet, eliminating the “digital divide”, and, thus, to exploiting the full economic benefits the new technology brings. Although recognition of the benefits have lead to the introduction of flat-rate Internet pricing in many countries, in Germany lack of competition in the market for local telephony has prevented it.

Therefore, the purpose of this paper has been to analyse the need for flat-rate Internet pricing in the German economy, by answering two main questions: firstly, is increased diffusion of the Internet economically desirable; and secondly, if so, is the introduction of a flat-rate pricing structure the most effective way of achieving this? Parts 2 and 3 addressed the first question and part 4 the second.

Part 2, about the effects of the Internet on efficiency and welfare, concluded that the Internet makes the market, as a whole, more efficient and competitive and thus increases welfare. In markets for knowledge products it was found that the Internet's effect is dependent upon the presence of standards and the demand for variety. On the whole however, it was found that the Internet leads to greater efficiency and welfare here as well.

Part 3, on the effects of the Internet on the macro-economy, analysed the extent to which the effects identified in part 2 have resulted in macroeconomic gains for different countries. We found that a number of countries have benefited from the so-called “New Economy”, in particular the US, Australia, Canada, Denmark, the Netherlands, the UK and, to a lesser but increasing extent, Finland and Ireland, but that Germany and a num-

ber of other countries, in particular Japan, France, and Italy, have not (Although current data indicate an improvement is taking place). The literature generally attributes this to lack of investment in ICT and thus, to a lack of use of ICT in the economy.

Therefore, part 4 involved an analysis of the factors influencing use of ICT at the level of the individual/household/firm and also at country level. At the level of the individual/household/firm we found that there are significant differences in ICT penetration dependent upon socio-economic factors (age, income, gender, education; and firm size) but that these differences are narrowing. The main factors preventing Internet access/use are financial. With regard to country differences again those countries who were found to have invested in and benefited from ICT were also those who were the most “connected”. Finally, it was found in empirical studies that the main factors explaining this divide were income and the availability of unmetered Internet access (a flat rate)/the amount of competition in the telecommunications market. It was also found that where unmetered Internet access was introduced it significantly increased both access to, and usage time of, the Internet.

As such we can conclude that if Germany wants to make the most of the numerous economic benefits brought about by the Internet it needs to encourage access to and use of the Internet. The most effective way to achieve this goal has been proven, on the basis of significant empirical and anecdotal evidence, to be the introduction of unmetered Internet access. Therefore, the dominant position of Deutsche Telekom in the market for local telephony and its refusal to allow ISPs to pay unmetered line-rental charges is a significant barrier to gaining the wide spread economic benefits the Internet brings.

Bibliography

AOL Deutschland (02/08/2001), 100.000 Registrierungen für AOL Schmalband-Flatrate eine Woche nach Einführung, Pressemitteilung.

ARD/ZDF (2000), ARD/ZDF-Offline-Studie 2000.

ARD/ZDF (2000), ARD/ZDF-Online-Studie 2000.

Bailey, J. (1998a), Intermediation and Electronic Markets: Aggregation and Pricing in Internet Commerce. Ph.D. dissertation, Program in Technology, Management and Policy, Massachusetts Institute of Technology.

Bassanini et al. (2000), Knowledge, Technology and Economic Growth: Recent Evidence from OECD Countries.

Bassanini, A., Sarpetta, S., and Visco, I. (2000), Knowledge, Technology and Economic Growth: Recent Evidence from OECD Countries.

BITKOM (2001), Wege in die Informationsgesellschaft.

Brown, J. and Goolsbee, A. (2000), Does the Internet Make Markets More Competitive? NBER Working Paper No. W7996.

Brynjolfsson, E. and Smith, M. (2000), Frictionless Commerce? A Comparison of Internet and Conventional Retailers, in Management Science (April).

Council of Economic Advisers (2000), Economic Report of the President, United States Government Printing Office, <http://w3.access.gpo.gov/eop/>.

Daveri, F. (2000), Is Growth an Information Technology Story in Europe Too? EPRU Working Paper Series.

De Prince Jr., A. E. and Ford, W. F. (1999), A Primer on Internet Economics, in Business Economics, October 1999, Vol. 34, Issue 4.

European Communication Council (2000), E-economics: Strategies for the Digital Marketplace.

European Information Technology Observatory (2001).

Federal Reserve Bulletin (October 2000), Productivity Developments Abroad.

GfK (2001), GfK Online-Monitor.

Goolsbee, A. (2000), In a World with out Borders: The Impact of Taxes on Internet Commerce, in Quarterly Journal of Economics.

- Gordon, R. J. (1999), Has the “New Economy” Rendered the Productivity Slowdown Obsolete?
- Gordon, R. J. (2000), Does The “New Economy” Measure up to the Great Inventions of the Past?
- Gust, C. and Marquez, J. (2000), Productivity Developments Abroad. Federal Reserve Bulletin (October 2000).
- Hargittai, E. (1999), Weaving the Western Web: Explaining Differences in Internet Connectivity Among OECD Countries. Telecommunications Policy. 23(10/11).
- Haring, J., Rohlf, J., and Briceño, A. (2001), The Effect of Pricing Structure on Residential Internet Demand, Strategic Policy Research.
- Jorgenson, D. W. and Stiroh, K. J. (2000), Raising the Speed Limit: US Economic Growth in the Information Age, mimeo.
- Kiley, M. T. (1999), Computers and Growth with Cost Adjustment: Will the Future Look Like the Past? Federal Reserve Board, Finance and Economics Discussion Series Paper 1999-36.
- L’Hoest, R. (2001), The European Dimension of the Digital Economy, in *Intereconomics: Review of European Economic Policy*, Volume 36.
- Leger, H., Licht, G., und Egel, J. (2001), Zur Technologischen Leistungsfähigkeit Deutschlands: Zusammenfassender Endbericht 2000. Gutachten im Auftrag des Bundesministerium für Bildung und Forschung.
- OECD (1997d), Communications Outlook 1997.
- OECD (2001), Understanding the Digital Divide.
- Oftel (2001), Consumers’ Use of Internet: Oftel Residential Survey Q5 May 2001.
- Oliner, S. D. and Sichel D. E. (2000), The Resurgence of Growth in the Late 1990’s: Is Information Technology the Story?
- Picot, A. and Neuberger, R. (2000), Prinzipien der Internet-Ökonomie, in *Wirtschaftsdienst: Zeitschrift für Wirtschaftspolitik*, Nr. 10, 80th year, Hamburg Institute of International Economics (HWWA).
- Quah, D. (1999), The Weightless Economy in Growth.
- Roeger, W. (2001), The Contribution of Information and Communication Technologies to Growth in Europe and the US: A Macroeconomic Analysis, European Commission Directorate General for Economic and Financial Affairs, Economic Papers, Number 147.

- Schreyer, M. (2000), Wachstum und Beschäftigung vor dem Hintergrund des Solowschen Produktivitätsparadoxons, Schriftenreihe des Promotionsschwerpunkts Makroökonomische Diagnosen und Therapien der Arbeitslosigkeit, Nr. 14/2000.
- Schreyer, P. (2000), The Contribution of Information and Communication Technology to Output growth: A Study of the G7 Countries, OECD STI working Paper 2000/2.
- Smith, M., Bailey, J and Brynjolfsson, E. (2000), Understanding the Digital Divide: Review and Assessment, in Brynjolfsson, E. and Kahin, B. eds. (2000), Understanding the Digital Economy.
- Temple, J. (2000), Summary of an Informal Workshop on the Causes of Economic Growth, OECD Economics Department Working Papers No. 260.
- The Economist, 23rd-29th September 2000, A Survey of the New Economy: Untangling e-economics.
- Van Ark, B. (2001), The Renewal of the Old Economy: Europe in an Internationally Comparative Perspective.
- Varian, H. R. and Shapiro, C. (1999), Information Rules: A Strategic Guide to the Network Economy.
- Visco, I. (2000), The New Economy: fact or fiction?, OECD Observer.
- Wadhvani, S. B. (May 2000), The Impact of the Internet on UK Inflation, in Bank of England Quarterly Bulletin.
- Whelan, K. (2000), Computers, Obsolescence, and Productivity. Federal Reserve board, Finance and Economic Discussion Series Paper 2000-6.