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Digital Transformation, International Competition and Specialization

INTRODUCTION

'E-commerce', 'industry 4.0' or 'sharing economy' are terms that are associated with progress, innovation and a renewal of the economy. These developments are part or consequences of a digital transformation that is a paradigm shift in the economy, which changes production and organisation. However, stimulating changes are not exceptional, as a brief look at the economic development of the last 200 years shows. Technological progress has always taken place, introducing fundamental innovations and thus making significant contributions to economic growth. Figure 1 shows the 'long economic cycles' first identified by Russian economist Kondratiev (1927), as well as the two other cycles that have since been added (Nefiodov 1994; Linde and Stock 2011). The first cycle started with the invention of the steam engine facilitating work, while significantly increasing production efficiency. The subsequent distribution of railroads and the expansion of marine transport fuelled worldwide trade, as well as the first wave of globalisation (1870–1914, see Williamson 1996). Around 1900 discoveries and developments in chemistry and electricity drastically reduced energy costs. Major innovations in communications, the growing importance of the electronics sector and new applications of petroleum characterise the fourth cycle. These innovations, together with the removal of trade barriers, also fostered the current second wave of globalisation. The fifth Kondratiev cycle started in 1990 and is marked by progress in information technologies, but also by a stronger focus on sustainable and ecological innovations.

These stimulating innovations show a definitive trend in social and economic development: the first innovations target the exploitation of new energy sources and productivity increase that are crucial for a manufacturing-based society. By contrast, the more recent innovations pave the way for an information-based society that is mostly characterised by access to and an increase in the volume of information available, as well as communication.

DIGITISATION AND INFORMATION GOODS

By definition, digitisation is the transformation of (physical) information into (electronic) bit sequences. In this process, analog data with continuous specifications are encoded using binary systems. As the complexity of the information grows, a larger code is required to describe it. Compared to physical information, digital information has far lower storage, processing and transmission costs. The physical space required to store digital data is almost negligible thanks also to the rapid miniaturization of technology. A library with over 2,500 books encoded in binary code, for example, can be easily stored on one DVD with a physical area of approximately 113 cm^2. Digitized data can be almost instantly evaluated, modified, used for further processing and calculations by any computer. To do the same with analog data, by contrast, you either have to digitise them first, or apply time-consuming physical methods. Digitalisation, that is the optimisation of the use of digitised information, is accompanied by the internet as a distribution channel, which enables the fast and cost-effective transmission of information on a global level. In the process of digital transformation, new business ideas and processes based on the merits of digitisation are being developed. These include, for example, new services like cloud computing that reduce the physical space required for data storage and processing even further (Armbrust *et al.* 2010; Nazir 2012; Bartholomae 2018).

This change in the cost structure and availability of goods has important effects on consumers, firms and politics. Consumers are increasingly demanding e-books: while the share of e-books in Germany was still 0.53 percent in 2010,

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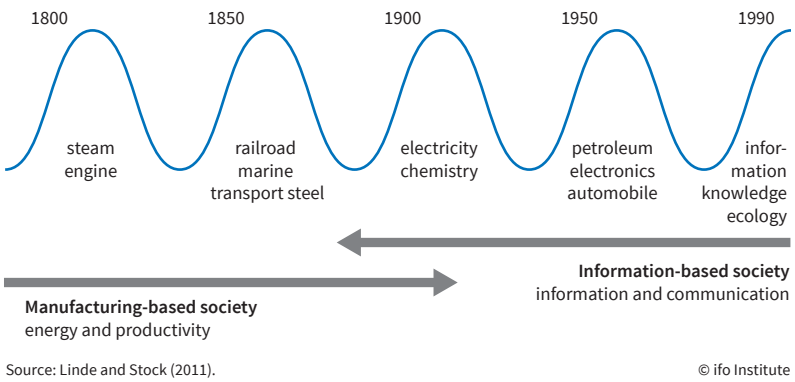
Figure 1

Long Economic Cycle (Kondratiev Cycles)



Source: Linde and Stock (2011).

it had already increased nine-fold to 4.73 percent by 2017 (Börsenverein des Deutschen Buchhandels 2018). This change in consumer behaviour has an impact on business strategies, meaning that publishers are increasingly required to supply digital product lines. Changed consumer preferences are also affecting the public sector: the number of income tax statements submitted online since 2000 has increased from 0.14 to 22.1 million in 2017 (ELSTER 2018). The legislator is accordingly obliged to react to changed consumer and firm behaviour. As these examples show, digital transformation has already had significant effects.

In general, digitisation turns physical goods and services into digital products or information goods, which partly changes their character as a good. Unlike their physical counterparts, they have four specific characteristics (Linde 2009; Bartholomae 2014): (1) the character of a public good; (2) high fixed costs with low variable costs in production; (3) information asymmetries between the market sides; and (4) network effects.

Information is a public good as its consumption is possible without purchase (non-excludability), and its consumption does not prevent someone else consuming it (non-rivalry). It may be possible to exclude others from using information, through copyrights, patents or, in the case of data files, copy protection, for instance, but as soon as the information is available unprotected, even for a very short time, its distribution can (almost) no longer be controlled (Linde 2005). The immanent characteristics of public goods ultimately lead to a free-rider problem, as third parties may easily copy or imitate information without having to bear the costs of research and development (Foray 2004).

In the process of digitalisation, high fixed costs occur, as the information technology infrastructure that has to be built or integrated into existing database systems also has to be managed. The subsequent use of the data, such as the read back, processing, evaluation or transmission of the information, however, causes almost negligible costs (Ba *et al.* 2000; Linde 2005).

Information asymmetries exist when one market side has more information than the other market side about the quality of the goods, for example. In the best case, this may prevent trade between the market partners or, in the worst case, lead to a collapse of the entire market (Akerlof 1970). Information is an experience good (Shapiro and Varian 1999), i.e. the user can only determine the extent to which his expectations have been fulfilled during or after consumption.

Network effects can be one of the greatest advantages of information goods. This means that a consumer's benefit or the value of the digital product increases in line with the number of additional consumers (Katz and Shapiro 1985; Shy 2011). Firms need to be aware of this effect: if some information is only required for one employee, the benefits of digitising this information will hardly compensate for its costs. If on the other hand, several employees need this information, possibly at the same time and at different locations, the benefits of digitisation are already considerably greater. If this information is also relevant for business partners and customers, digitisation becomes even more advantageous. It is also crucial that digitisation takes place in a format that is readable by all relevant actors. Exotic isolated solutions only used by a few provide fewer benefits than common standard solutions (Shy 2001a).

NATIONAL COMPETITION AND MONOPOLISATION

Digitalisation allows for the development of new products and services. Due to the described characteristics of information goods, monopolies are very likely to emerge. On the cost side, the production of digital goods has high fixed costs at low variable costs. This implies that average costs decrease as output volumes increase (economies of scale). Thus, a natural monopoly results, as it is economically efficient that only one firm supplies the market. On the demand side, network effects cause an increase in the consumer's willingness to pay – according to Metcalfe's law, this willingness increases in square terms in the number of users (Shapiro and Varian 1999; Bartholomae 2012). The online auction-platform eBay benefits from this effect: sellers know that many potential buyers are looking for products there and buyers know that many sellers use the platform to offer their products. Both buyers and sellers, who use lesser-known or smaller platforms, will find it difficult to find or sell products. Thus, network effects create a monopoly.

Digital transformation can also cause monopolies in traditional competitive industries because of the cost savings achieved. This is all the more likely the more drastic the cost savings are (Shy 2001b). If a firm experiences only a gradual or minor cost reduction through digitalisation, competition is hardly affected. In this situation, the firm does not change its prices, but increases its profits. If its competitors also reduce their costs by digitising, firms eventually will pass the cost savings down to consumers and lower their prices. Thus, the initial profits of the pioneers of digitalization will disappear again. However, digital transformation may also cause a drastic cost reduction by the firm. In this situation, even if the firm chooses the profit-maximising monopoly price, its costs are so low that it can undercut the price of its competitors. In addition to the firm, which now earns a monopoly profit, consumers also benefit from a lower price. Provided they have sufficient reserves, competitors will certainly press ahead with digital transformation in order to restore their competitiveness.

While in the case of a minor cost reduction, consumers only may benefit from price reductions after some time, a drastic cost reduction immediately lowers prices. This effect will be lasting if enough com-

petitors survive and are able to reduce costs. However, if the monopoly remains, welfare losses can occur in the long term, since monopolists often protect further innovations through patents that could endanger their monopoly position (Gilbert and Newbery 1982), which ultimately impairs economic efficiency.

In Germany, larger industrial companies show a higher degree of digitalisation compared to smaller firms (Kopke *et al.* 2016). Based on the previous analysis, possible reasons for this may be that digitalisation is too expensive due to the high cost of the initial investment, and therefore subsequent cost savings are too low. As digital transformation only pays off if network effects are sufficiently high, small firms with only a few employees may benefit less than big firms that reduce the costs of coordination and cooperation between lots of employees. Customer relations also play a crucial role. If the most important customers are not digitalised, additional costs arise if the digitised information first has to be brought back into analogue form in order to exchange it with the customer or supplier – e.g. by printing product brochures or forms, which then have to be digitised again later for their own processing. It is therefore hardly surprising, especially in the case of small and medium-sized companies and craft businesses, that they do not fully rely on digitalisation.

Overall, digital transformation tends to favour large firms as they can significantly reduce their costs and have the capacity to skim all the benefits off the savings. This may endanger competition, as larger companies with financial reserves can influence competition by investing in digitalisation to their advantage. This is particularly the case if they (initially) pass on the cost savings directly to consumers, and thus put smaller firms under pressure; or even drive them completely out of the market.

INTERNATIONAL COMPETITION AND PRODUCTIVITY

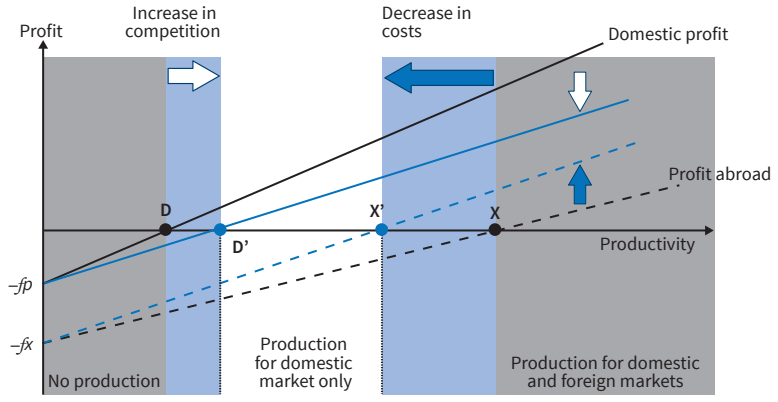
Digital transformation also has a major impact on the international competitiveness of firms. In addition to the decrease in production costs that increases firm productivity, trade costs decrease too: the coordination of logistics gets more efficient; relevant documents are accessible worldwide; search costs for suitable suppliers and customers fall; and steadily improving software is translating digitalised transport documents in an increasingly reliable manner. This reduction in trade costs will lead to an intensification of competition, as shown by Figure 2 (Melitz 2003; Morasch and Bartholomae 2017).

The continuous line 'Domestic profit' in Figure 2 describes a firm's profit in its home market depending on its productivity – the more productive the firm, the higher its profits. In addition to production costs, fixed costs f_P have to be covered too, which yields a minimum productivity D that is necessary to generate non-negative profits. Firms with productivity in the left grey area will not survive in the market. The dashed line 'Profit abroad' shows what profits firms can expect to generate when engaging in export activities. As additional fixed market entry costs f_X occur and trade costs lower profits even further (the line is flatter), a higher productivity X is necessary to generate positive profits abroad. Thus, there are medium-productive firms that only supply the domestic market, and high-productive firms that also supply foreign markets.

Most obviously, as digitalisation reduces trade costs, firms' profits abroad increase – the line 'Profit abroad' becomes steeper. This means that even companies with lower productivity X' are able to sell their goods abroad. However, this positive effect affects domestic profits negatively: as foreign firms also benefit from decreased trade costs, more of them will start to export and thus enter the domestic market. Competition increases and the line 'Domestic profit' becomes flatter, as profit at all productivity levels decreases. In the end, firms with a productivity below D' will leave the market. To sum up, two effects occur: firstly, average firm productivity increases, since the least productive firms do not survive the competition, and secondly, a higher share of firms will supply both the domestic and the foreign market. Taking into account that digitalisation also increases firm productivity and reduces fixed costs, the development described above is exacerbated and competition intensifies to an even greater extent, which increases average productivity and more firms engage in international activities.

Figure 2

Effect of a Reduction in Trade Costs on Export Activity



Source: Morasch and Bartholomae (2017).

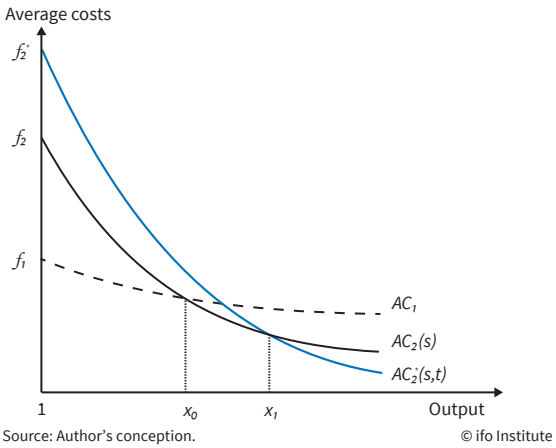
This positive effect on competition from foreign competitors can counter the trend towards monopolization, but it also increases the pressure on all firms to realize any cost savings made possible by digitalisation to maintain their competitiveness. At the same time, however, the lower trade costs also open up greater opportunities in international markets for those surviving medium-productive firms. From the consumer's point of view, this development is advantageous, since it gives consumers a larger product range to choose from at low prices.

FRAGMENTATION AND OFFSHORING

Fragmentation is one way in which firms can significantly reduce their production costs by capitalising on specialisation advantages. To this end, the various production steps are grouped into production blocks, which are then allocated to different locations according to the local advantages. However, this requires additional services that are not necessary in an integrated production process, such as the organisation of an appropriate logistics, insurances against transport-related production stoppages or additional quality controls. As these additional services connect the production blocks, the associated costs are summarised as service-link costs (Jones and Kierzkowski 1990; Morasch and Bartholomae 2017). Fragmentation therefore only makes sense if the service-link costs are lower than the cost savings resulting from more efficient production.

Figure 3 depicts average production costs, whereby curve AC_1 represents the average cost of integrated production, and f_1 the corresponding fixed costs. As production benefits from economies of scale, average costs fall. Let us suppose that production is split into two blocks. This affects costs in two ways: firstly, fixed costs increase, as additional production sites have to be maintained, and secondly, variable costs decrease as a result from specialization and better realization of economies of scale. However, additional service-link costs s have to be considered, which increase costs and are already included in total average costs $AC_2(s)$. Since cost reduction becomes significant with increasing production, fragmentation is only profitable for quantities produced of x_0 or more. Digitalisation reduces service link costs, by enabling the improved coordination of production processes, real-time monitoring of production processes at different locations and rapid exchange of information on changes in demand. This decreases $AC_2(s)$, which makes fragmentation profitable even for lower quantities.

Figure 3
National and International Fragmentation



Source: Author's conception. © ifo Institute

Moreover, by performing international fragmentation (offshoring), the comparative advantages of different location can be used, leading to even more efficient production. As $AC_2^*(s,t)$ summarizes, this use of comparative advantages through offshoring (implying a steeper run) is associated with higher costs: fixed costs f_2^* are higher and, in addition to the service-link costs, trade costs t occur. A firm opts for offshoring if it sells x_1 or more. As digitalisation reduces trade costs, this threshold also decreases.

In summary, digital transformation favours both the national and international fragmentation of value chains. This increases economic efficiency as advantages of specialisation, as well as the comparative advantages of the countries, are used. As a result, the cost savings from digitalisation are greater than initially apparent: an increase in production and organisational efficiency not only leads to direct cost savings, but also offers additional possibilities for further cost reductions that were not feasible before.

INTERNATIONAL KNOWLEDGE SPILLOVER AND INNOVATION ACTIVITY

The public good character of digital products has a major impact both on international specialisation and on firms' innovation activities, as information distributes very quickly and easily. If external economies of scale prevail, a country's specialisation pattern is path dependent. Productivity depends on the cumulative production experience in an industry, i.e. the more a product has already been produced, the more efficient the industry becomes in its production (Krugman 1987). In addition, the industry may also benefit from foreign experience. However, the influence of these international spill-overs is not as pronounced as that of one's own experience. The path dependency protects the favoured industries from international competition, as the competitors would first have to accumulate sufficient production experience to become dangerous for the industry. However, digital transformation is jeopardizing this comfortable situation by stimulating knowledge spill-overs between the countries. Endangered industries have two options: they intensify their innovation activities to maintain a sustainable technical advantage, which foreign competitors find difficult to catch up. Alternatively, they

attempt to evolve from an industry favoured only by path dependency to a core competence industry. Of course, industries can also survive by reducing their production costs in order to benefit from knowledge spill-overs from abroad, at least in the short term. However, this is not a sustainable strategy in the long term, since it only works if there is something to learn, i.e. if foreign industries are innovative.

The innovation process on the firm level is closely linked to product life cycle (Grubel and Lloyd 1975; Vernon 1966). Typically, innovation takes place in developed countries, as they offer the necessary infrastructure and sufficient human capital. The development of a new product causes high costs for the firms that are initially not offset by any sales. Thus, functioning capital markets are an important precondition for innovation. After successful development, the product launch begins, whereby the innovative country is the only production location for the new products. In this phase, consumers are informed and sales increase; in addition, a firm may start to export to its first foreign markets. As there are no real alternatives at this early stage, the price elasticity of consumers is low. In the growth phase, sales begin to increase exponentially, and at the same time, the production experience gained makes it possible to standardise production processes and thus reduce costs. At the same time, consumers are becoming more price-sensitive, which increases the need to reduce costs further and to relocate parts of production to countries with lower production costs. Eventually, the standardisation of production is well advanced and the product sufficiently mature. In this phase, firms from other countries are able to offer cheaper alternatives and to export them to the innovator's market. Trade flows thus reverse, as the country's previous exports now become its imports.

The digital transformation has a considerable influence on the individual phases. International knowledge spill-overs shorten development times, as new technologies disseminate more rapidly and international exchange increases. The price elasticity of consumers will be much more distinct, as the knowledge spill-overs also lead to the development of imitation products at a relatively early stage. The later phases are also shorter, as the accelerated innovation activity speeds up the development of technically better successor products to which consumers quickly adapt their preferences. The intensified competition and associated knowledge spill-overs thus require rapid and sustained innovation by firms.

INTELLECTUAL PROPERTY RIGHTS AND CYBERCRIME

To safeguard their positive contribution to business success, however, innovations must be protected, especially in increasingly digitalised economies (Illing and Peitz 2006). Without protection, it is very likely that the innovator will only benefit to a limited extent from research, which reduces the incentive for firms to innovate. For this reason, developed countries grant innovators patent protection for a certain period. This allows firms to be the only ones to use the innovation and to generate monopoly profits (Gilbert and Shapiro 1990). However, in order not to jeopardize further innovation, knowledge is published during the patent procedure, which can help other potential innovators to solve certain problems or suggest further applications. As patent protection is only granted in the country for which it was requested, a firm must be aware of which countries or markets are relevant to it. Nevertheless, patent protection is not necessarily a guarantee that innovation is really protected, what matters is how the institutional framework is designed or how strongly the institutions advocate compliance with protection.

In addition to institutional problems, the comprehensive digitisation of important company documents also increases the risk of cybercrime. This includes all criminal activities that employ a computer network at any time (Kshetri 2006). The danger potential of cybercrime is enormous, as access to digital documents is usually possible worldwide. At present, the threat from (international) hackers is not too serious. German companies, for example, stated in surveys that former employees are mainly responsible for data theft, whereby in some cases this is only due to careless handling of company data (Bachmann *et al.* 2015; Kopke *et al.* 2016). Nevertheless, on average every second company in Germany has been affected by data theft (Bachmann *et al.* 2015). As the costs of cybercrime are relatively low (Bartholomae 2018), attacks on smaller and less protected firms are also profitable, although the potential value of the data is definitely lower than that of large companies. In the latter case, attacks on departments responsible for research and development are particularly prevalent (Bachmann *et al.* 2015). The damage caused by cybercrime can endanger a company's existence. While direct costs, such as for the recovery of damaged or destroyed files or ransom demands by criminals, are manageable, indirect costs can be significantly higher − e.g. if competitors gain knowledge of key trade secrets. Thus, it is not surprising that, of all types of crime, plagiarism and patent infringements cause the highest damage (Bachmann *et al.* 2015; Kopke *et al.* 2016).

Since customer relations in particular are based on sensitive data and a loss of or unauthorised disclosure of this data can destroy valuable trust, only one in five companies turns to government agencies after a cyber-attack (Bachmann *et al.* 2015). This, however, aggravates the problem, as it makes it impossible to prosecute the (successful) offenders − i.e. the threat to other companies remains and potential hackers are not deterred. Overall, cybercrime can become a serious threat to the competitiveness of companies, and

thus to the prosperity of a society. IT security and data encryption technology will therefore play an increasingly important role, so that the disadvantages do not outweigh the advantages of digital transformation.

CONCLUSION

In summary, from an economic point of view, digital transformation has a positive effect on competition. Although the immanent characteristics of information goods, such as network effects in particular, favour the emergence of monopolies, cost reductions also lead to an intensification of (international) competition. In addition to direct cost savings, digital transformation improves production and organisational processes, which increases overall economic efficiency. As digital transformation continues to increase the importance of innovation, (economic) pressure on countries with weak institutions will increase, leading to international convergence. An immediate challenge that can ultimately only be tackled in a global environment is cybercrime. This threatens the existence of companies and thus the prosperity of a society. Since cybercrime is a cross-border problem, international cooperation and the improvement of all prosecuting institutions are indispensable (Bartholomae 2018).

Both society and firms must therefore always be aware of the trade-off between cost reduction and increased efficiency on the one hand, and data security and the need for constructive cooperation between all stakeholders on the other. In other words, for the digital transformation to be successful, pure competition must become cooperative competition (coopetition), in which even competitors who are in strong competition with each other cooperate in fundamental areas like data protection or data security, as this is the only way to safeguard the basis for efficient and sustainable economic development.

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