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Austria's digital transition: The diffusion challenge

Rauf Gönenç,
Béatrice Guérard

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ECONOMICS DEPARTMENT

AUSTRIA'S DIGITAL TRANSITION: THE DIFFUSION CHALLENGE

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By Rauf Gönenç and Béatrice Guérard

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ABSTRACT/RESUMÉ**Austria's digital transition: The diffusion challenge**

Austria's transition to a digital economy and society is slower than in other high-income small open European economies. The rate and pace of utilisation of eight main ICT applications shows that Austrian firms follow peer country counterparts with a gap, which has widened in most areas in recent years. Two dynamics drive digital transitions and Austria has room for progress in both of them. First, the potential for digitalisation in all firms, and especially in the smaller ones (where gaps are largest) should be freed-up by upgrading the full range of ICT-generic, ICT-specific and ICT-complementary skills. Second, Austria needs to make its business environment more conducive to firm entry and exit. The rate of entry of new firms and their growth are crucial for the diffusion of new business models and ICT innovations but fall behind peer countries. The adoption of ICT innovations by households also follows a staggered path: young and highly educated Austrians adopt ICT applications in similar ways to their counterparts in peer countries, while middle and older age cohorts display noticeable gaps. This calls for policies to help lagging groups become more acquainted with innovations. A whole-of-government approach, including large-scale utilisation of e-government applications in enterprises and households, should help to embrace change and facilitate the flourishing of innovative businesses, work practices and lifestyles throughout Austria.

This Working Paper relates to the 2017 OECD Economic Survey of Austria (www.oecd.org/eco/surveys/economic-survey-austria.htm)

Keywords: technological innovation, information technologies, diffusion of innovations, digitalisation

JEL: D24, L60, L81, L96, M15, O14, O32, O33, O38

La transition numérique de l'Autriche : Le défi de la diffusion

La transition de l'Autriche vers une économie et une société numérique est plus lente que dans les autres petites économies européennes ouvertes. Le taux et le rythme d'utilisation de huit applications principales des technologies de l'information et de communication (TIC) montrent que les entreprises autrichiennes suivent leurs homologues des pays pairs avec un écart, qui s'est élargi dans la plupart des domaines au cours des dernières années. Deux dynamiques conduisent aux transitions numériques et l'Autriche a marqué des progrès dans les deux. Tout d'abord, le potentiel de numérisation dans toutes les entreprises, et surtout dans les plus petites (où les lacunes sont les plus importantes), devrait être libéré en améliorant l'ensemble des compétences TIC-génériques, spécifiques aux TIC et complémentaires aux TIC. Deuxièmement, l'Autriche doit rendre son environnement commercial plus propice à l'entrée et à la sortie des entreprises. Le taux d'entrée des nouvelles entreprises et leur croissance sont cruciaux pour la diffusion de nouveaux modèles commerciaux et les innovations TIC. Pour ces indicateurs l'Autriche suit les pays homologues avec un écart. L'adoption des innovations en matière de TIC par les ménages suit également un chemin décalé: les Autrichiens jeunes et hautement qualifiés adoptent des applications TIC de manière similaire à leurs homologues dans les pays pairs, tandis que les cohortes d'âge moyen et supérieur affichent des lacunes perceptibles. Cela nécessite des politiques pour aider les groupes en retard à se familiariser avec les innovations. Une approche au niveau de l'ensemble du gouvernement, y compris l'utilisation à grande échelle des applications du gouvernement électronique dans les entreprises et les ménages, devrait contribuer à embrasser les changements et à faciliter l'éclosion des entreprises, des pratiques de travail et des modes de vie innovants dans toute l'Autriche.

Ce Document de travail se rapporte à l'Etude économique de l'OCDE de l'Autriche, 2017 (www.oecd.org/fr/eco/etudes/etude-economique-autriche.htm)

Mots-clés: innovation technologique, technologies de l'information, diffusion des innovations et numérisation

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AUSTRIA'S DIGITAL TRANSITION: THE DIFFUSION CHALLENGE

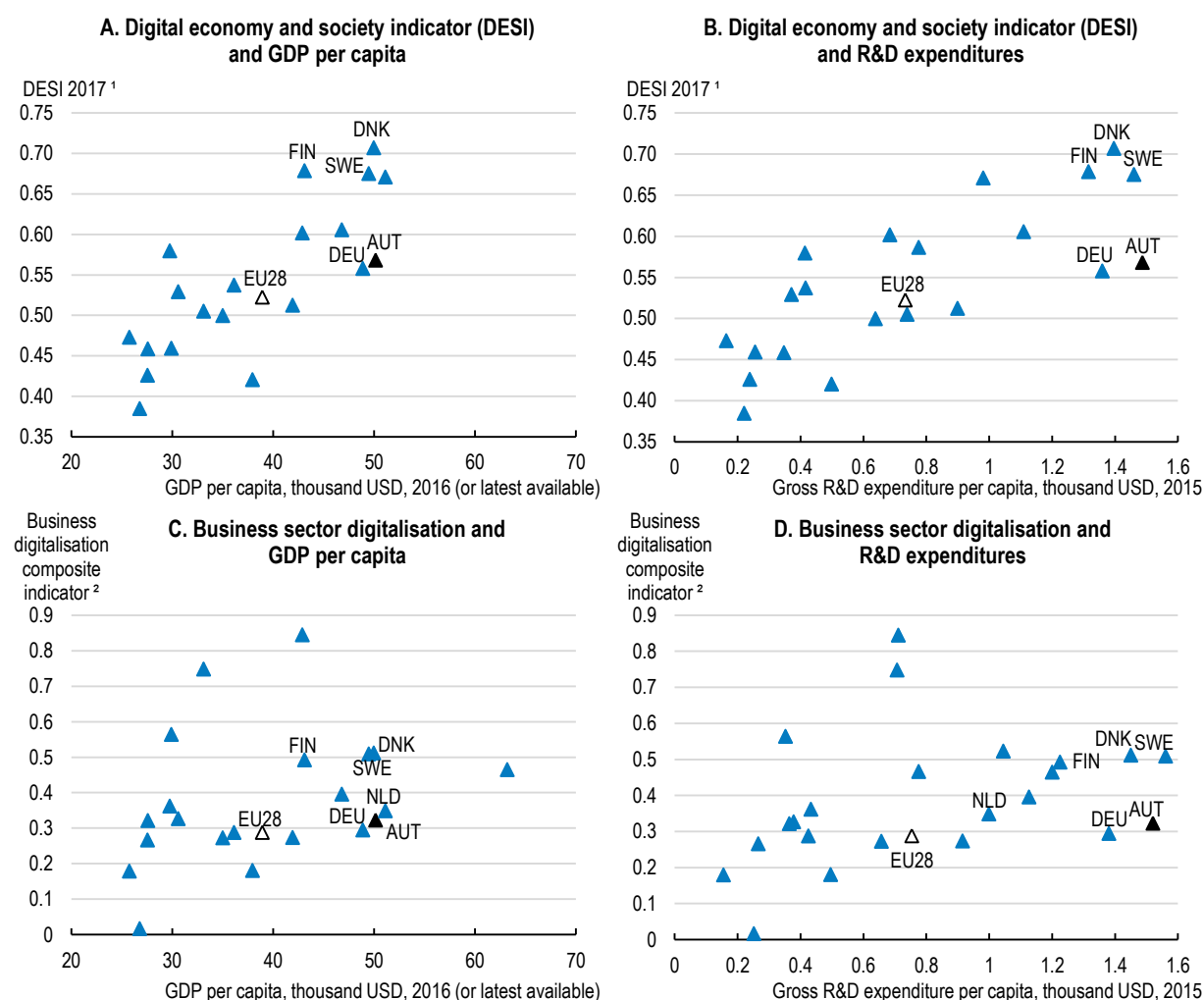
By Rauf Gönenç and Béatrice Guérard¹

Austria is in an intermediary position in the digital transition

Austria has set out ambitious objectives for the transition to a digital economy and society, but so far it has been lagging behind comparable economies (OECD, 2015a; Peneder et al., 2016). The composite Digital Economy and Society Index, plotted against broad measures of economic and technological development, illustrates this (Figure 1 Panels A and B). A composite indicator of digitalisation in the business sector alone gives a similar picture (Panels C and D). Overall, Austria appears somewhat behind its expected degree of transition to a digital economy and society. The gap was reduced in the early 2010s (OECD, 2015a), but frontier countries seem to have accelerated their deployment of information and communication technology (ICT) innovations since, and wedges for Austria may have widened again. Throughout this working paper digitalisation outcomes in Austria are highlighted in comparison to other OECD countries, but some detailed comparisons refer only to selected digitally-advanced European small economies such as Sweden, Denmark and The Netherlands for which detailed indicators are available (henceforth “peer countries”).

Austria's position is not uniform across dimensions and areas of digitalisation. For example, the tourism sector is close to the international frontier in certain digital applications and remains a laggard in others. Austrian enterprises producing digital goods and services are well advanced in the implementation of their own technologies and have more of an edge over other sectors than in peer countries. E-government is another case in point. Austria is a world leader in several e-government innovations such as electronic signatures and online service completion (Figure 2, Panel A), but their diffusion in society is, compared to other countries, relatively faster for firms than for households (Panels B and C). These variations suggest that, as in other OECD countries, there are uneven paths in the diffusion of digital innovations in Austria and room is available for fostering more dynamic diffusion in the lagging areas.

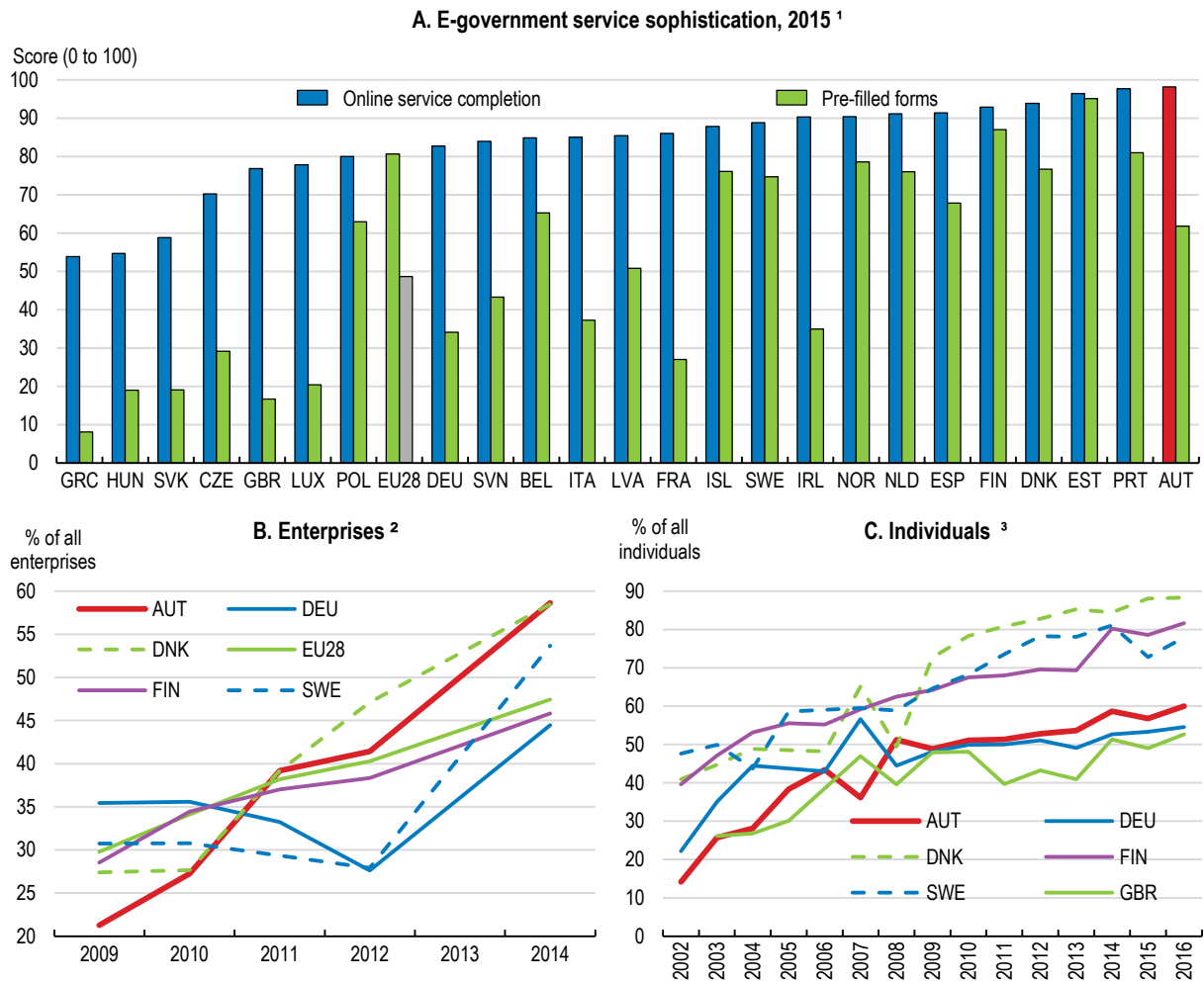
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Figure 1. Austria in the international digital transition

1. The Digital Economy and Society Index (DESI) is a composite index by the European Commission based on i) the deployment of broadband infrastructure and its quality; ii) endowment with ICT skills; iii) the variety of activities performed by citizens online; iv) the digitalisation of businesses and in particular SMEs; and v) the digitalisation of public services.

2. The business sector digitalisation indicator is computed as the average percentage share of enterprises i) selling online at least 1% of their turnover; ii) connecting to the internet via mobile broadband; iii) buying cloud computing services over the internet; and iv) exchanging electronic messages with public authorities. It is normalised between 0 (less) to 1 (more digitalisation).

Source: European Commission, Digital Economy and Society Index (DESI) 2017; OECD National Accounts database; OECD Main Science and Technology database; and OECD calculations based on European Commission data.

Figure 2. Austria is an innovation leader in e-government but diffusion is slow among households

1. Pre-filled forms measures to which extent data known to the public administration is pre-filled in forms presented to the user. Online service completion measures to which extent the steps in an interaction with the public administration can be performed completely online.

2. Enterprises using automated data exchange for sending or receiving data to / from public authorities.

3. Individuals using internet to interact with public authorities.

Source: OECD ICT database and Eurostat.

Austria's current position in digitalisation is in line with its secular “technological follower” model (OECD, 2007). The distance of the business sector to the frontier typically widens when the frontier moves rapidly. Even so, gaps tend to be gradually resorbed and global good practices end up being widely shared in the economy and society. Various mechanisms of knowledge diffusion backed by social partnership, including the market-responsive vocational education and training system, help secure this broad-based propagation (Musset *et al.*, 2013). Lags do happen in the diffusion of international innovations (Tellis *et al.*, 2003), but so far they have been considered as temporary and relatively benign. Nonetheless, the present gap in digital innovation may turn out to be more disturbing:

- i Digitalisation entails increasing returns for successful innovators (Box 1). Changing competition conditions in “winner-takes-all” markets risk relegating lagging firms far from the global frontier, with durable productivity, competitiveness and well-being losses (OECD, 2016c);

- ii Too small a group of “enabling customers” (households and firms purchasing innovative goods and services) may deprive local producers from a dynamic local market, with negative feed-back effects if full access to the broader international market is not secured (Atluri et al., 2016);
- iii Active engagement of the society as a whole in support of digitalisation would facilitate the adjustment of the broad set of legal, regulatory and labour contractual frameworks. Successful adjustments may generate a virtuous cycle accelerating digital transitions. Otherwise, a vicious cycle may slow them down (Blix, 2015).

Box 1. Special economic impacts of digitalisation

The codification of analogue signals to binary bits and the emergence of internet have revolutionised information processing, data transmission and communication on a global scale. This takes many forms such as exchanging e-mails as a substitute to letters, encoding business and industrial processes, translating analogue measures into a form enabling computer calculations and control, and using social networks as alternatives to face-to-face interaction (DSTI/CDEP/GD(2017)4).

Economic activities subject to digitalisation, i.e. incorporating a significant share of digital techniques in their products, services or work processes, undergo major changes in their cost structures and competition conditions (OECD, 2017a). Notably, contrary to traditional manufacturing and services with high fixed costs and substantial marginal costs, the lower marginal costs of digitalised products and services enable firms and platforms to scale up very rapidly. In such activities, successful early movers rapidly build up a dominant position in national and international markets, especially in those with network externalities. On the demand side, the rapid spread of information on social networks hastens the emergence of such “superstars”, with fast reputation build-up and prompt access to financial markets - which further accelerate the growth of winners. In turn, these developments can suddenly go in reverse. Resulting variations generate sharper fluctuations than in the past in firm-level employment and skill demand, which may conflict with expectations of stability - of employment tenure by workers, of profits by investors and of predictability of aggregate activity in local communities.

There is shared awareness in Austria of the benefits of broad-based digitalisation, and of the factors which may stagger and therefore slow down its diffusion in the business, government and household sectors. There is also awareness that the acceleration of digitalisation might disrupt the labour market and social cohesion, eroding social support for digitalisation. A “Digital Roadmap” introduced in 2017 at the federal government level, and similar initiatives at *Länder* level, reflect this awareness and the shared policy objective of accelerating the digital transitions and anticipating their disruptive impacts (see Box 4, on “Austria’s Digital Roadmap”, in the Assessment and Recommendations).

Convergence with the global technological frontier is uneven across sectors and firms

Recent OECD research has shed new light on the diffusion of frontier technologies and on productivity convergence in OECD economies, with implications for Austria. Between 2001 and 2013, frontier firms across OECD countries achieved steady productivity increases, while laggard firms did not, contributing to increased productivity and income divergence between the top and the bottom (Andrews et al., 2016). The specific influence of digitalisation in this regard has only just started to be investigated. Early evidence suggests that the discontinuities associated with digitalisation may be further altering the path of diffusion of new technologies, making them even less uniform.

Productivity gaps result less from higher capital investment by successful firms than from their higher multi-factor productivity (MFP) gains, i.e. more efficient combination of capital and labour, partly aided by technological and non-technological innovations. These firms may be more advanced in digital transitions (Hall et al., 2012). They appear to possess superior capabilities to make good use of digital technologies and a more supportive intra-firm environment, such as well-informed management, more information-intensive business models and more innovative and flexible work practices (OECD, 2016c; OECD, 2013b).

The gaps between frontier firms and laggards are the largest in areas where regulation restricts competition. Available estimates suggest that up to half of MFP divergence may have been avoided and the diffusion of the best technologies and organisational models would be accelerated if countries engaged in more extensive market liberalisation, in particular in services (Andrews et al., 2016). As services in Austria are relatively less exposed to competition (OECD, 2017f, EC, 2016), digitalisation in these sectors may be negatively affected.

Specifically, four policy areas are important for the diffusion of best practices: i) reducing barriers to entrepreneurship; ii) reducing the rigidity of employment rules; iii) reducing the cost of bankruptcies; and iv) improving access to venture capital (Andrews et al., 2015). Austria stands out as one of the OECD countries which can accelerate technological catching-up and productivity convergence through policy reforms in these areas.

Furthermore, trade with frontier countries, participation in global value chains (GVCs), quality of skill match in labour markets and e-government readiness are found to be positively correlated with the diffusion of frontier technologies. Early exit avenues for failing firms also exert an impact. Austria appears to have room for further convergence with OECD policy innovations in these areas as well (Saia et al., 2016).

Start-up dynamics play a special role in technology diffusion and productivity convergence through vintage (firm cohort) effects. Calvino et al. (2016) examine the role of new firm creation and expansion across OECD countries and find that Austria has room for progress. The vigour of the process is measured by the rate of job creation by new firms, and ten policy areas (including tax incentives for start-ups, tax schemes affecting the supply of entrepreneurial funds, independence of bank supervision, etc.) are found to have a relationship with the dynamism of start-ups.

OECD research also suggests that digitalisation makes the diffusion of productivity-enhancing practices more staggered and less linear (OECD, 2016d). In the ICT-intensive sectors, frontier firms increase their market share more rapidly and productivity divergences are deeper. In addition, the productivity of “elite” firms (defined as the 2% most productive enterprises in each sector) diverges further from the already strong productivity of other frontier firms. Declining marginal costs due to digitalisation further nurture such “winner-takes-most” competition (Moazed and Johnson, 2016). Other factors are also found to prevent the broad-based diffusion of new technologies, including their increased complexity, the higher role of tacit knowledge, the monopolistic pricing of some of the goods and services embodying them, and the necessity of complementary investments to transform firms’ business models (OECD, 2016d).

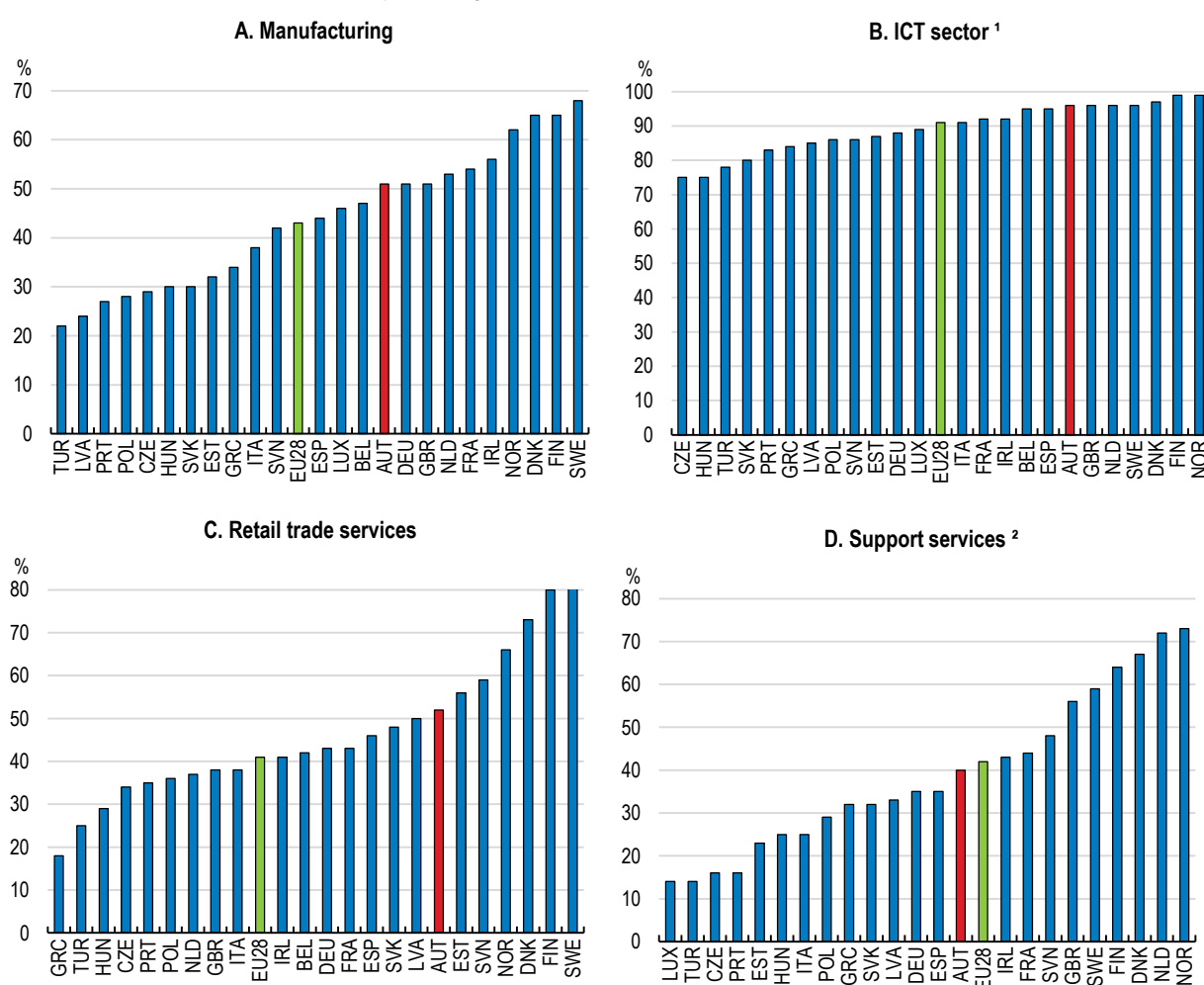
Microeconomic analyses of front-runner and laggard firms highlight some further developments. Tentative metrics on the distance between front-runners and laggards across different dimensions of digitalisation (such as spending in ICT hardware, software, telecommunications; share of digital payments; share of digital tasks and jobs) confirm that gaps between firms are large and are correlated with firms’ financial strength and investment and skill acquisition capacity (McKinsey, 2016a). Divergences thus risk becoming self-perpetuating. In addition, three factors influence firms’ capacity to converge with the frontier: i) their “operational context” (their market’s technical proneness to digitalisation); ii) the degree of competition they are exposed to; and iii) their size. Different sectors populated by different types of firms therefore follow uneven digitalisation paths. “Knowledge-intensive” sectors are already highly digitalised (they encompass ICT producing sectors themselves, media and finance). “Capital intensive” sectors have further potential to digitalise their physical assets, including in oil and gas, chemicals and basic manufacturing. Services have a long tail of small firms with large additional room for digitalisation. These observations imply that Austria’s leading manufacturing firms are likely to be close to the global

digital frontier, while smaller size manufacturing businesses on the one hand, and service firms less fully exposed to global market conditions on the other, may face handicaps.

As Austria has a strong presence in medium-to-high technology sectors and is an innovative and competitive provider of intermediary inputs in global value chains (Stehrer and Stöllinger, 2013), the capacity of manufacturing firms to fully draw on the digital revolution is of special interest to policymakers. An aggregate measurement of the propagation of digital technologies across sectors, approximated by the share of workers using a computer with internet access, suggests that Austrian manufacturing is in an intermediary position among OECD countries, but still behind peer countries. This gap is nonetheless smaller in manufacturing than in services (Figure 3).

Figure 3. ICT usage across industries

Share of persons employed using a computer with internet access, 2016 or latest available



1. Production of ICT goods and services.

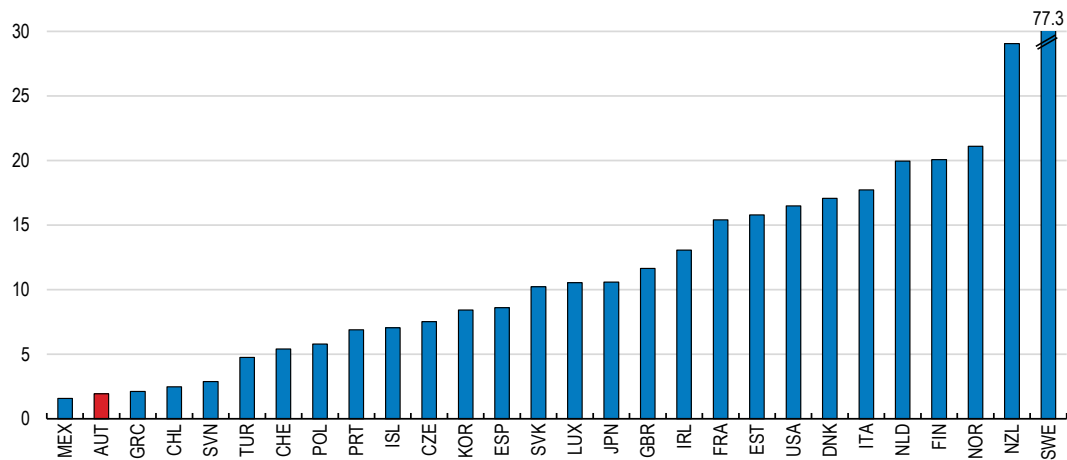
2. Administrative and support services to businesses and households.

Source: Eurostat.

Digitalisation is more advanced in sectors that themselves produce digital goods and services, and Austria's gap vis-à-vis the OECD frontier is smaller in these activities. However, the diffusion of machine-to-machine communications which can be seen as a measure of progress toward Industry 4.0 points to a large gap for Austrian firms (Figure 4).

Figure 4. Machine-to-machine mobile cellular subscriptions

Subscriptions per 100 inhabitants, June 2016



Note: Machine-to-machine (M2M) connections link remotely located devices over a mobile network. A segment of M2M communication relies on mobile wireless networks and, as with mobile telephony, is based on the use of SIM cards for authentication and telephone numbers for connectivity. They are used in the management of production processes within factories, logistic applications such as the tracking of ships and trucks and the cargo containers that they carry, alarm installations etc. They provide the basic infrastructure of Industry 4.0. Switzerland: data for June 2016 are estimates.

Source: OECD, Broadband Portal, www.oecd.org/sti/broadband/oecdbroadbandportal.htm.

Digitalisation trends in the business sector

While a number of Austrian firms are advanced users and producers of digital technologies (Federal Economic Chamber, 2016), the Austrian business sector as a whole exhibits gaps in the diffusion of standard ICT applications in four key areas: i) broadband connections, ii) digital marketing, iii) digital management, and iv) cloud computing.

The generalisation of ICT applications in the business sector is slower than in peer countries

Broadband access

Broadband internet is the infrastructure of the digital society and economy (OECD, 2017a). Demand for faster broadband is increasing due to expanding volumes of Internet traffic, connection of large numbers of smart objects, and access to remotely stored data and software. Given the growing importance of connections on-the-go, mobile broadband has become a natural extension of this infrastructure.

The share of Austrian firms with broadband connections expanded from 82% of all firms with 10 employed persons and more in 2010 to 98% in 2016. Information on micro firms employing less than 9 workers (which represent a quarter of total business sector employment) is incomplete. However, overall, small, medium and large firms have practically caught up with the global frontier of full connectivity (Figure 5, Panel A).

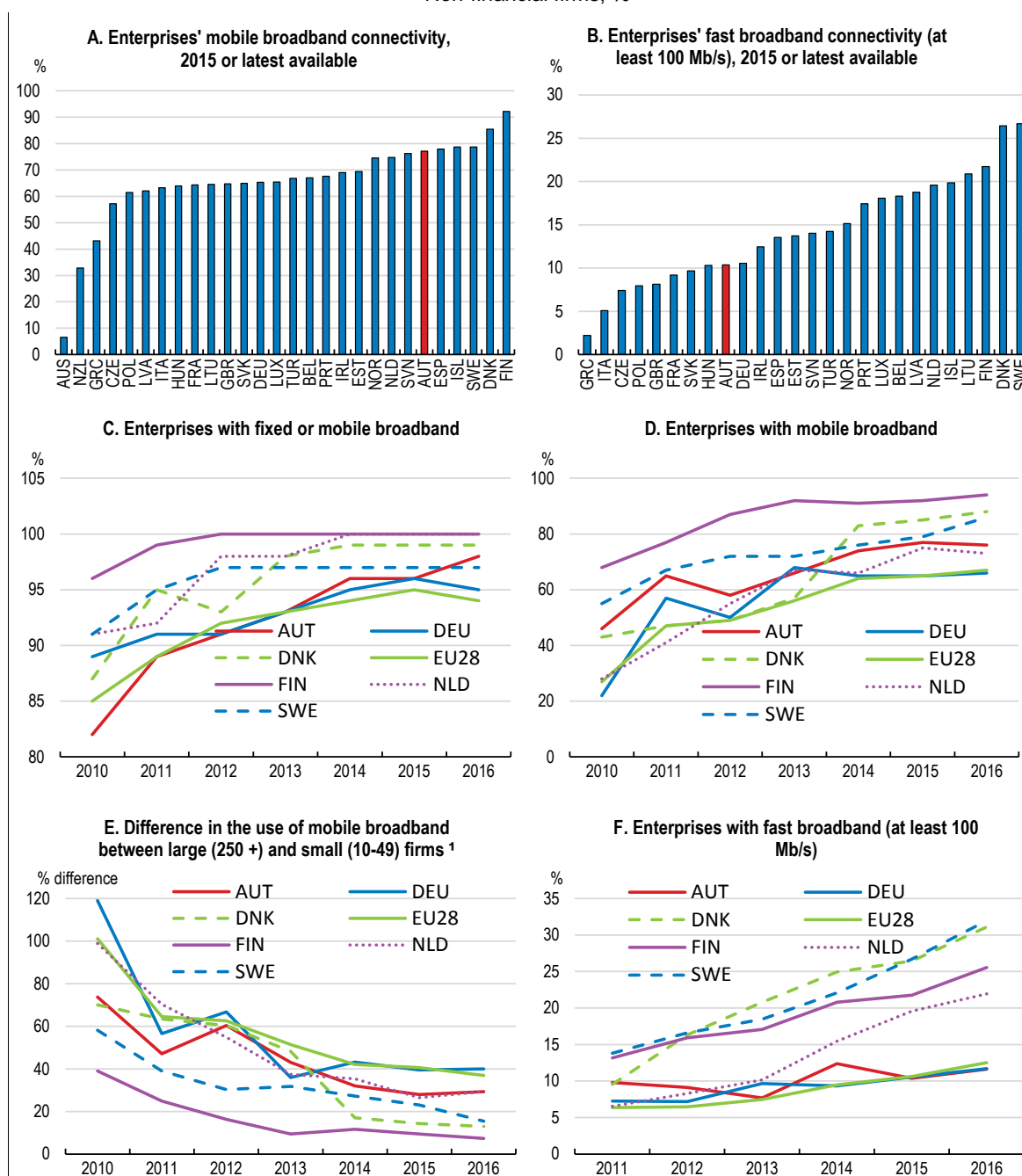
However, connectivity to mobile broadband clearly lags behind peer countries. While more than 90% of firms in the most advanced peer countries are presently connected, only 75% are in Austria. Austria is nonetheless doing better than Germany and The Netherlands (Figure 5, Panel B). Large and medium-sized firms are well equipped, and firms producing digital goods and services are even better connected than in other countries. However, barely half of manufacturing firms are connected, against 90% in the most advanced peers. The gap between large and small enterprises is larger than in peer countries, hinting at the possibility of even larger gaps in micro firms (Figure 5, Panel C).

Austria lags in the area of fast broadband, which is the infrastructure of the latest generation of ICT applications. Only 10% of Austrian firms subscribed to fast broadband in 2016, against 30% in frontier

countries. In addition, while the rate of access to this type of network increased steeply in peer countries in the past five years, it stalled in Austria (Figure 5, Panel D). This is occurring despite internationally low service prices in Austria, and seems to reflect a gap in the intensity of external digital communications in businesses of all sizes. Austria displays a particularly large gap vis-à-vis the OECD frontier in the adoption of fibre technologies in its telecommunications network. This may be a handicap in the implementation of the latest vintages of “data hungry” applications (see Figure 23 below).

Figure 5. Broadband connectivity

Non-financial firms, %



1. Differences in the utilisation ratios by large (250+) and small (10-49) firms are expressed as a percentage of the average utilisation ratio of large and small firms in each country.

Source: OECD ICT database and Eurostat.

Digital marketing and selling

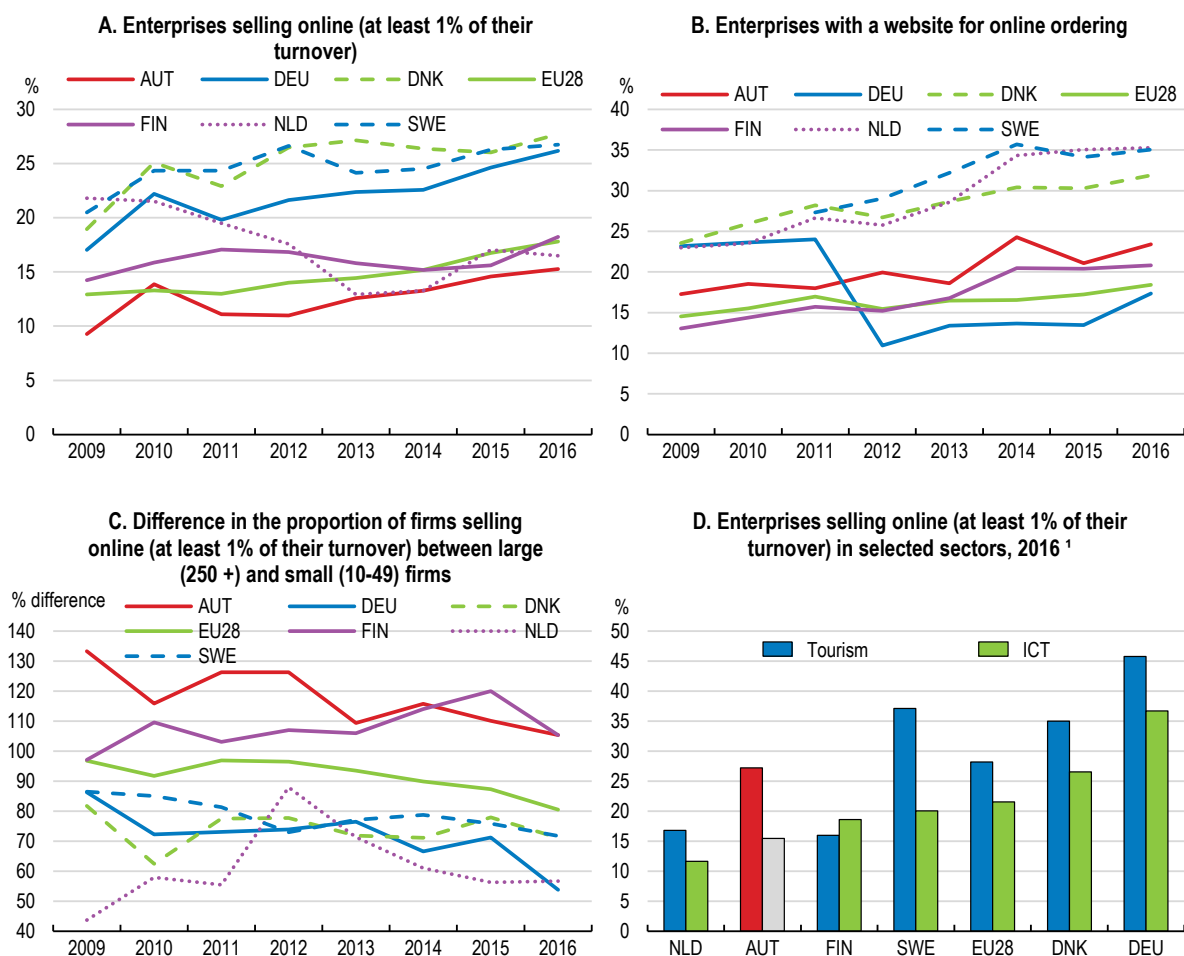
OECD firms are massively using the web to engage in e-commerce (OECD, 2017a). The majority of enterprises now possess a website or a homepage, and more and more of them support it via social media. Many firms start to take orders online and these represent a growing share of their total sales. The transition proceeds at an uneven pace, however, in different countries. Even in the most digitalised ones, only 20-25% of firms currently realise more than 1% of their sales via internet. In certain areas such as tourism and retail trade e-commerce has taken root more rapidly. Enterprise size also matters: half of large OECD firms achieve more than 1% of their sales via internet, as against some 20% of small firms (OECD, 2017a).

Austrian enterprises have developed e-trade more slowly than in peer countries (Figure 6). In 2016, only 15% of Austrian firms realised more than 1% of their turnover online, against 25% in Denmark and Sweden. The lag is larger in smaller size firms (Panel C) and affects all sectors (Panel D). For example, in tourism and accommodation, where Austrian firms are internationally present and competitive, only 30% make more than 1% of their sales on line, against 70% of their counterparts in peer countries.

A large gap is also apparent in retail trade. Only 15% of Austrian retail firms attained the threshold of 1% of e-sales, compared to 30% in peer countries. Austrian retailers' well-established brick-and-mortar networks and the high degree of loyalty that they have built with their local customers (see below) may partly explain this difference.

Figure 6. Digital marketing

Non-financial firms, %



1. 2015 for Austria ICT sector and 2014 Finland tourism sector.

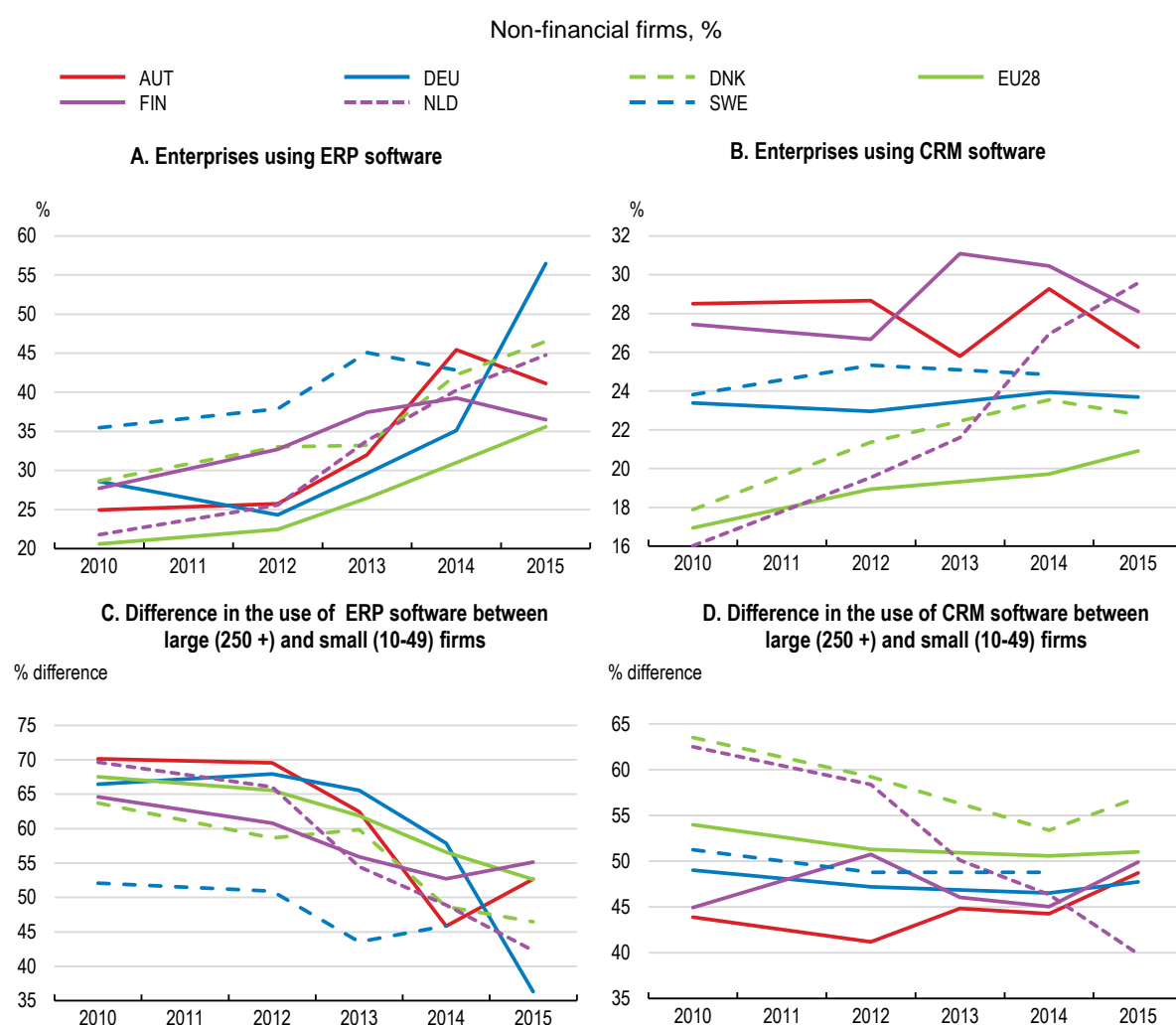
Source: Eurostat.

Digital management

OECD firms are integrating ICT tools into an ever-widening set of business functions. These help modernise enterprise management in all dimensions. Innovations are not easy to capture in simple metrics, but the pace of diffusion of new management tools provides proxies. The adoption of two key techniques, enterprise resource planning (ERP), and customer relations management (CRM), are relevant indicators.

ERP applications encompass product planning, purchasing, manufacturing, marketing, shipping and finance, with a unified software collecting, storing, managing and interpreting data from these different business activities. In the most advanced economies practically all large firms, nearly 80% of medium-size firms and almost 50% of small firms operate ERP systems. The Austrian business sector appears behind (Figure 7, Panel A). While large firms are almost as fully equipped as international counterparts, and firms producing digital goods and services are even better equipped than in frontier countries, only around 30% of small firms implement ERP, against 50% in peer countries. There is also a special gap in manufacturing: 40% of all Austrian manufacturing firms are equipped, compared to 50-60% in peer countries. Less than 25% of Austrian tourism firms have ERP systems, against 50% in peer countries. This low rate of equipment with ERP applications could reflect their outsourcing to external providers, but the low rate of recourse to cloud computing reduces this likelihood.

Figure 7. Digital management



Source: Eurostat.

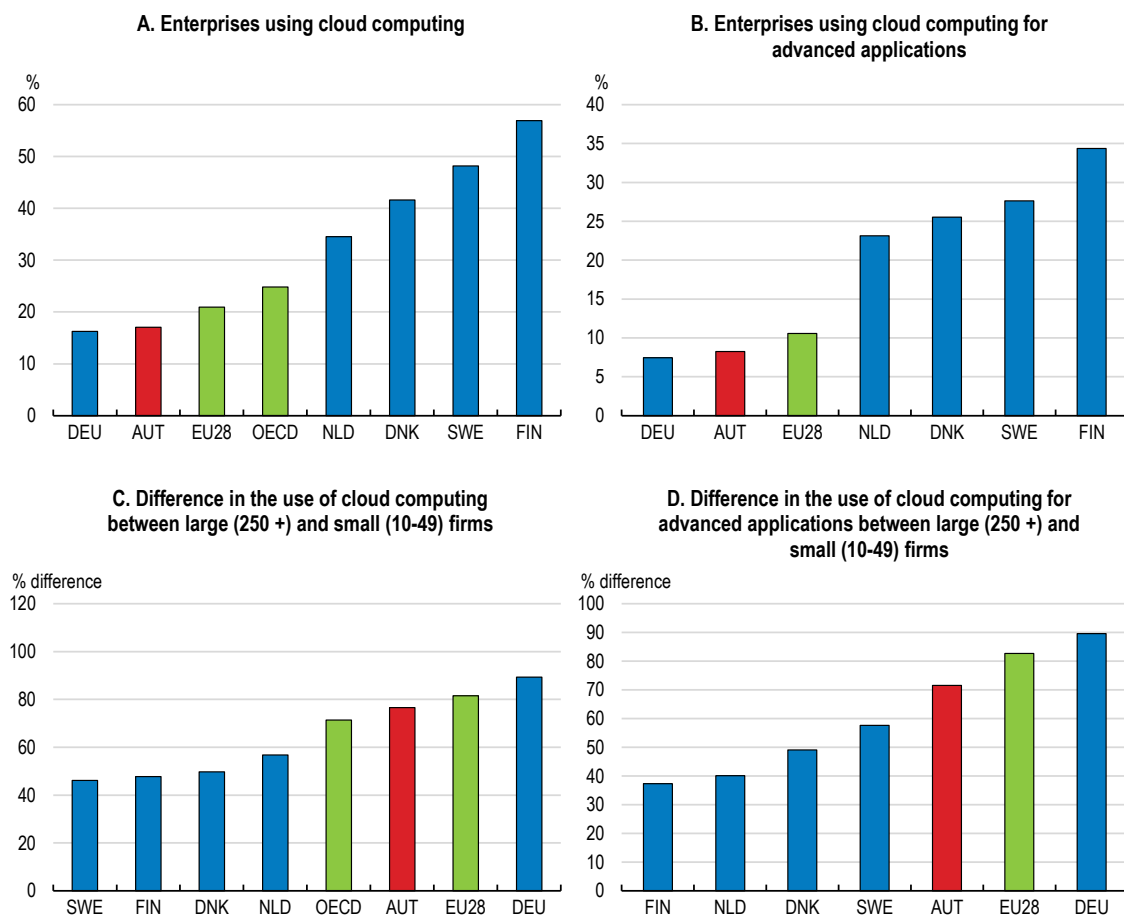
CRM applications support firms' interactions with current and future customers. They draw on online data from various sources (sales, website visits, social media etc.) and process this information to generate targeted marketing plans. They also help automate interactions with customers, typically via e-mail. Certain CRM systems can trigger geographic marketing initiatives based on customers' physical localisation via GPS applications. Austria is among the international leaders in this area. Nearly 45% of Austrian firms use CRM software, at par with frontier countries, compared to a European average of 33%. The adoption rate ranges from 70% in large firms to 40% in small businesses. The gap between large and small firms is one of the smallest in international comparison. In two areas where Austria is behind in other digital innovations, i.e. retail trade and tourism, it emerges as an international leader in CRM. This superior performance might stem at least in part from the active role of some successful Austrian service firms in this sector (Specific-Group Austria, 2017; Maihiro Group Austria, 2015; Torggler, 2008).

Cloud computing

Cloud computing deserves special attention (OECD, 2015a). It transforms computing into a service model that offers access in a flexible, scalable and on-demand way. Firms may turn the corresponding capital expenditures into operating expenses and can therefore more rapidly shift to advanced applications. Cloud computing represents a new plateau in digital transformations (OECD 2011, EC, 2014).

Figure 8. Cloud computing

Non-financial firms, %, 2016



Source: Eurostat.

The diffusion of cloud computing has accelerated in all OECD countries in recent years (OECD, 2017a). About 25% of all OECD firms currently use cloud computing, with large differences between countries. Utilisation rates range from above 50% in the most advanced countries to below 10% in others. Around 40% of all large OECD firms and 20% of all small firms are users.

In Austria, cloud computing is clearly less advanced than in peer countries (Figure 8). Only 35% of large firms resorted to cloud computing in 2016 and only around 15% of small firms (Figure 8, Panel C). Certain sectors are more engaged than others: firms producing digital goods and services have adoption rates of about 30%. Still, even in these sectors, there are large gaps vis-à-vis international frontrunners.

Gaps are deeper in more sophisticated cloud applications (Panel B). These encompass distant operation of large accounting, management and marketing software packages. Only 5% of Austrian firms use such applications, much less than in peer countries (25%). Gaps are visible in all sectors. In the production of digital products and services, 15% of Austrian firms resort to such applications, against 50% of their counterparts in peer countries. Adoption rates are lower in other activities, gravitating around 5% in other manufacturing and service businesses. Concerns about commercial and personal privacy and related data breaches are high in Austria, as in Germany, and this may contribute to the low utilisation of cloud services. Policymakers should aim at enhancing trust in digital applications.

Three factors foster diffusion in the business sector

The staggered path of digitalisation in Austrian businesses reflects three factors: i) Austrian firms face shortages in the necessary skills; ii) some of their owners and managers may not be convinced by the benefits of digitalisation and may be less keen to renew their business models; and iii) the channels of know-how dissemination are not uniformly strong.

Access to digital skills

There are apparent gaps in Austria's digital skill base, which may slow down the diffusion of digital innovations. Given the cross-functional character of digital applications, a large spectrum of qualifications and occupations are involved. The OECD has identified two main families of technical skills which are not evenly available across countries: ICT-generic and ICT-specialist skills. The so-called "ICT-complementary" skills play a major role too and will be discussed in a subsequent section.

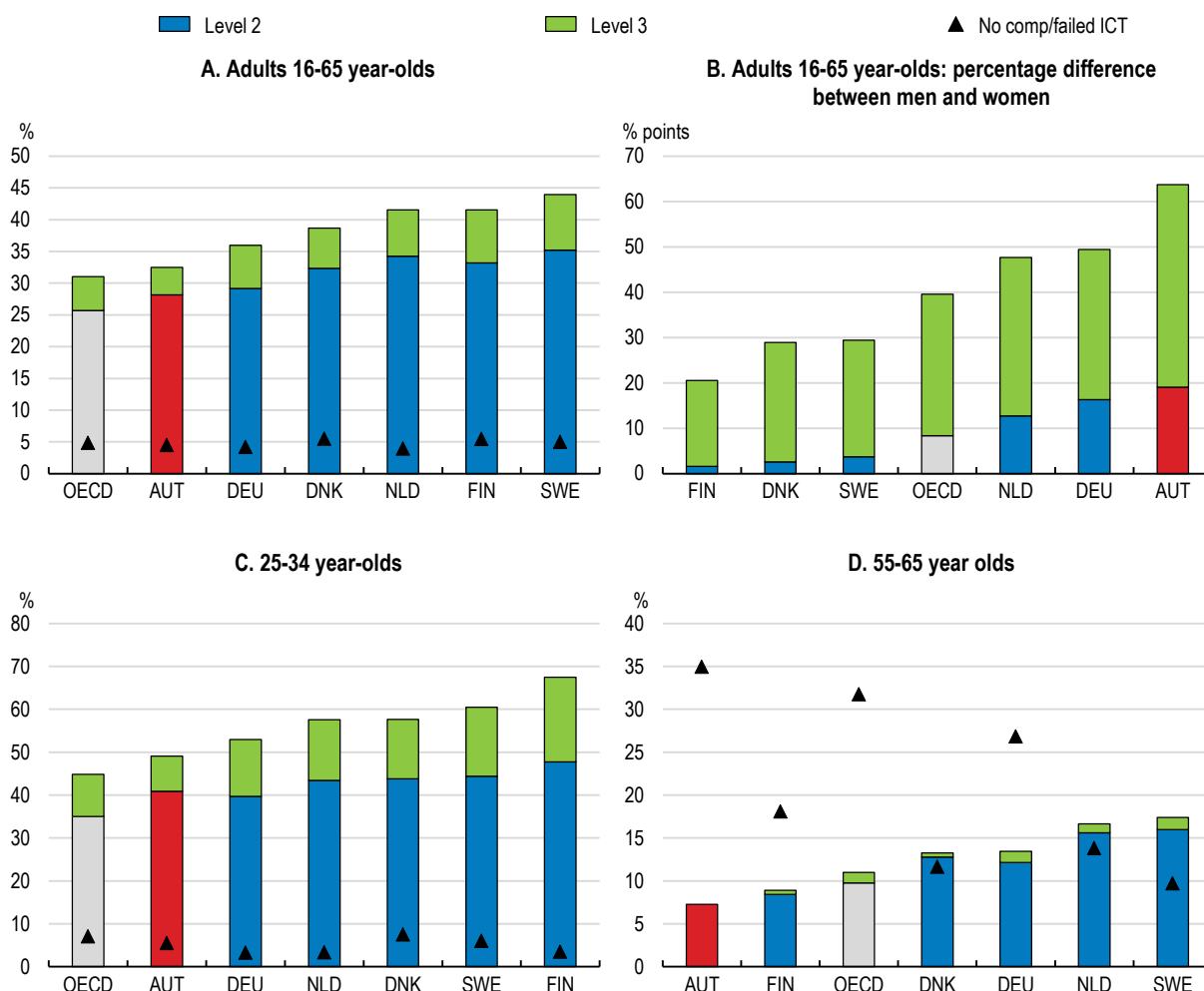
ICT-generic skills

The OECD Survey of Adult Skills (PIAAC) defines digital problem-solving skills as the capacity to solve problems in a digital environment, i.e. using a computer (OECD, 2016h). These skills include writing an e-mail and browsing the web (level 1), implementing more advanced tasks involving multiple steps (level 2), and the capacity to use both generic and specific software applications with inferential reasoning (level 3). Digital problem solving tests help grade each country's working age population capacities in this area.

In Austria, 33% of the population aged 16-65 have digital problem solving capacities corresponding to levels 2 and 3 (Figure 9). This is slightly above the OECD average (31%), but below peer countries (40%). About 37% of Austrian men and 28% of Austrian women possess it, as against up to 46% and 42% respectively in peer countries. This may hamper the diffusion of ICT innovations in the business sector.

Figure 9. The adult population's digital problem solving proficiency is lower than in peer countries

Percentage of adults scoring at level 2 or 3 in digital problem solving or having no computer experience, 2015



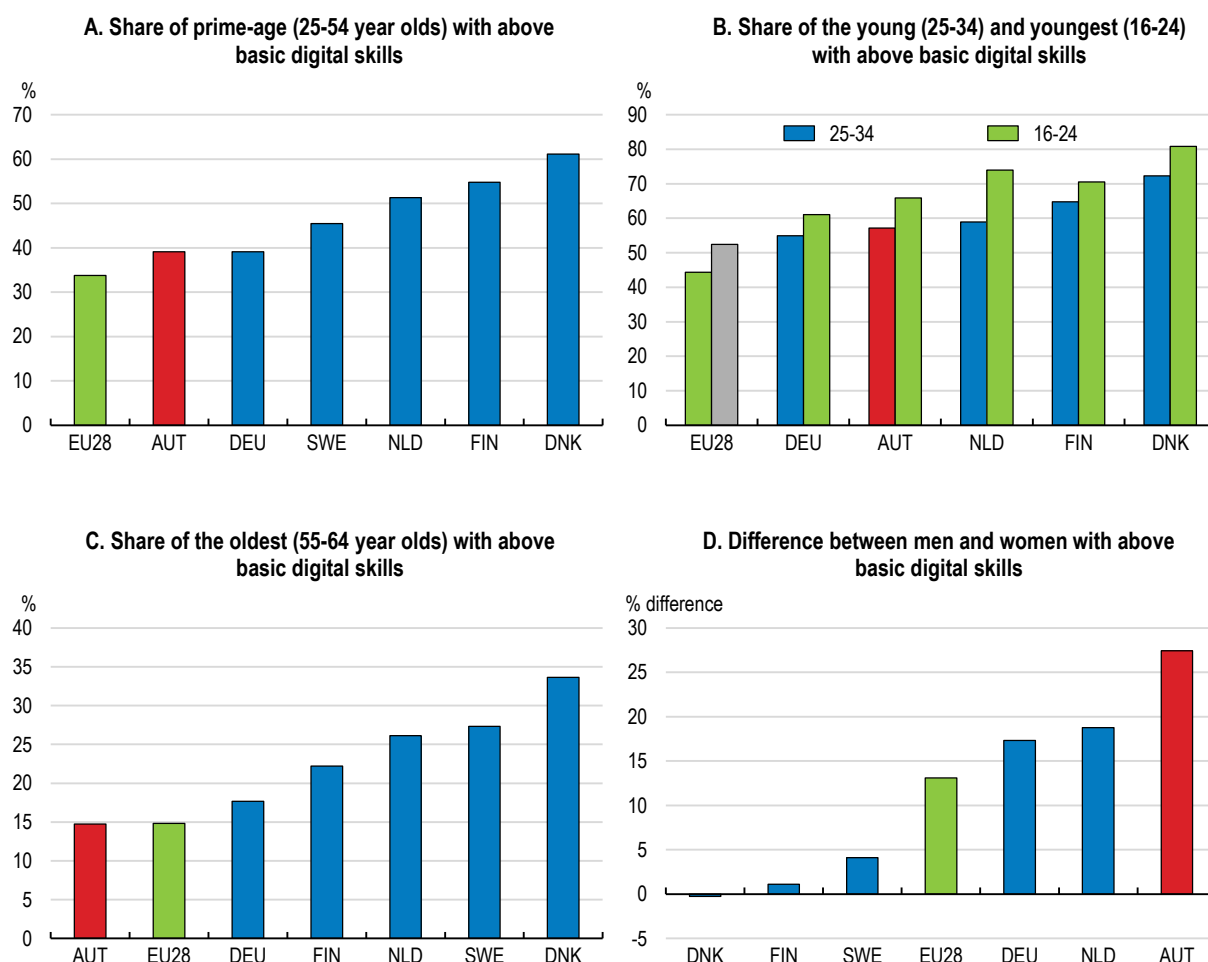
Source: OECD (2016), Skills Matter: Further Results from the Survey of Adult Skills.

Younger Austrians are more familiar with new technologies. About 50% of those aged 25-34 acquired basic levels 2 and 3 familiarity. This is above the OECD average (45%), but still below peers (60%). For these cohorts gaps are more severe at the higher proficiency level 3: only about 8% of Austrians aged 25-34 have attained this higher degree of acquaintance, against 15-20% of their cohort in peer countries.

Older age cohorts also feature skill gaps but with a different profile. Only 8% of Austrians aged 55-64 have the generic skills of levels 2 and 3, below the 15-20% attained in peer countries. Another gap appears more substantial: those without any computer experience and who failed to take the computer-based test represent as much as 35% of this age cohort, much above the 10% in peer countries. The age-based divide in basic digital skills is clearly deeper in Austria.

Figure 10. Too few Austrians have advanced digital skills

Individuals, in 2016, %



1. Advanced digital skills are the skills identified as “above basic” in the Methodological Manual for Statistics of the Information Society (Eurostat, 2016). They comprise the ability to create documents which integrate text, pictures, tables and charts; to use advanced spreadsheet functions to organise and analyse data; to write code in a programming language; to transfer files between computers or other devices; to change the settings of operational systems and security programmes; and to upload self-created content to websites.

Source: Eurostat.

Eurostat’s 2015 Digital Skills Survey shed additional light on Austria’s human capital in this area. The survey was based on self-assessment, with each person identified as having “no”, “low”, “basic” or “above-basic” skills. Only around 40% of working age Austrians had “above-basic” skills enabling them to be more active in ICT environments, well below peer countries (Figure 10). About 40% of prime-age Austrian men and 30% of prime-age Austrian women had this level of proficiency, versus around 60% and 50% in peer countries.

A higher proportion of youth have such above-basic skills. Nearly 60% of young Austrians attained this level, slightly less than their counterparts in the most advanced peer countries (Panel B). The gap for Austrians aged 16-24 is also small. But older cohort gaps continue to weigh down Austria’s average. Only about 25% of senior Austrian workers aged 45-54 have above-basic operational skills, against nearly 50% in the most advanced peer countries.

The survey also provides information on the socio-economic determinants of digital skills. The educational background of individuals appears as the driving factor in Austria, more than in peer countries. Austrians with less than upper secondary education display exceptionally low levels of acquaintance with digital technologies. Gender gaps in low-educated groups are also much larger than in peer countries. In contrast, rural versus urban location and income level make a smaller difference in the acquisition of these skills. This observation may be reflecting the fact that societal divides along these lines are less pronounced in Austria (OECD, 2013a).

ICT-specialist skills

Austria may also be facing a shortfall in ICT-specialist skills. These encompass the engineering qualifications required for the design and operation of digital systems. Specialists design applications, manage networks and analyse big data (OECD, 2015c). Their training goes beyond programming and must include advanced engineering and domain-specific knowledge.

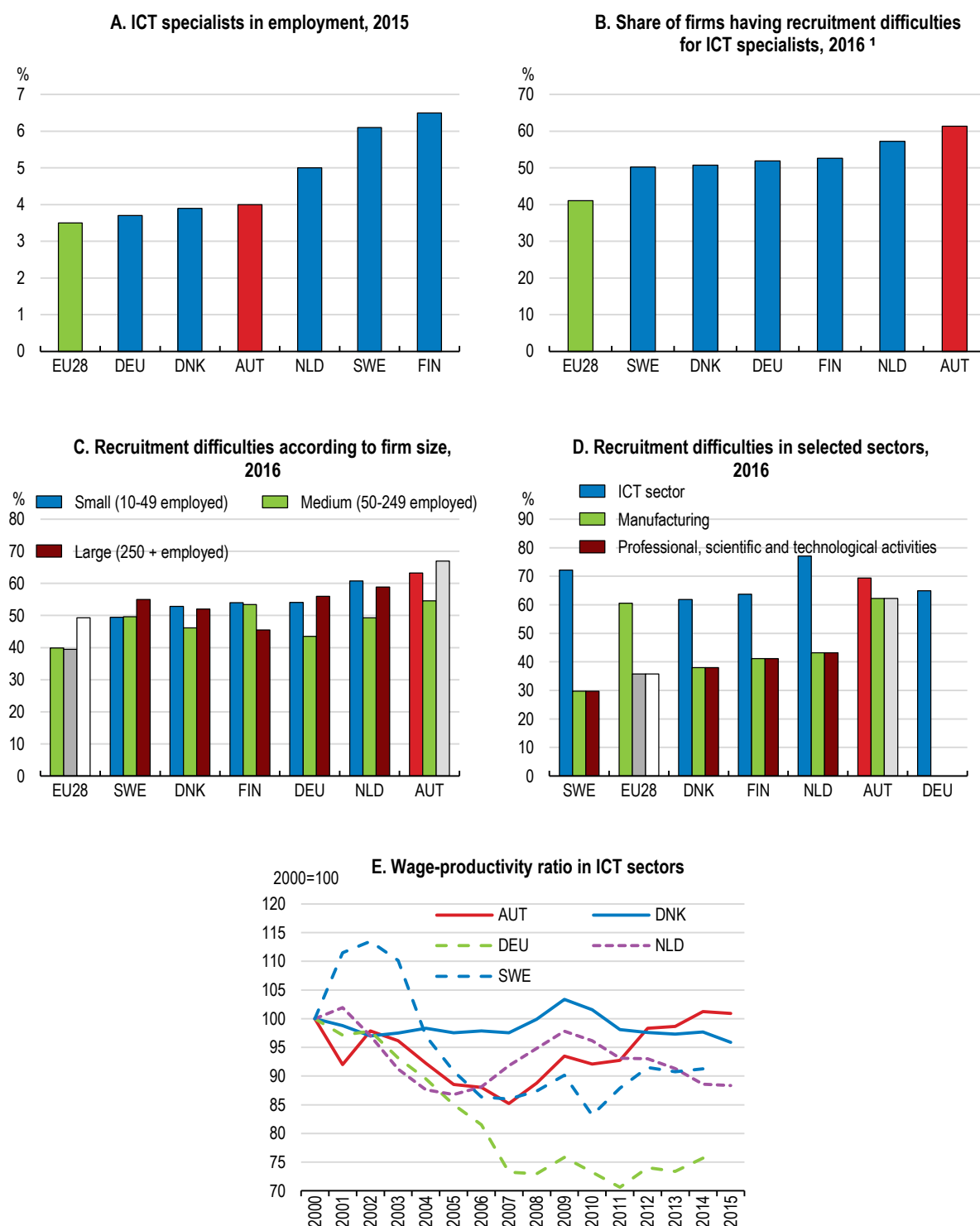
Labour market indicators for ICT specialists should be interpreted carefully. A country or region may experience a shortfall in these skills not because its supply of specialists is limited, but because its industrial structure or its pace of digitalisation is more dynamic than elsewhere. The reverse may occur in less dynamic countries and regions. Three sources of information are available to document the availability of these skills in Austria: i) the share of ICT specialists in the labour force; ii) the recruitment difficulties faced by enterprises trying to hire specialists; and iii) wage developments for ICT professionals.

Specialists trained in ICTs represented 4% of all employed individuals in Austria in 2015, against an EU average of 3.6% and over 6% in certain peer countries (Figure 11). Even if definitional differences may affect international comparisons, this hints at a risk of shortage for such specialists in Austria.

This is confirmed by data on recruitment difficulties (Panel B). According to a Eurostat survey in 2016, 60% of the Austrian firms which tried to recruit ICT specialists met difficulties, against 40% in the European Union and nearly 50% in peer countries. Only a minority of firms try to hire ICT specialists however, and the most dynamic Austrian firms and sectors face the highest tensions (Panels C and D). Hiring bottlenecks rose above 70% in firms producing digital goods and services, against 60% in manufacturing and 40% in retail trade.

The link between productivity and wage growth in ICT sectors also points to tensions (Panel E). Wage growth in Austria's ICT sectors well exceeded productivity growth over the past decade, while it was in line with or even stayed below productivity gains in peer countries. Wage developments have different drivers across countries but the scarcity of specialists probably plays a role in Austria.

Meanwhile, the frontier between ICT-generic and ICT-specialist skills is getting blurred. A recent cross-country review of about 1000 occupations and 20 job families concluded that skill profiles are changing in 40% of existing occupations as a result of digitalisation (WEF, 2016). According to this study, part of the needed adaptations may be achieved by re-training existing employees, but the remainder requires in-depth changes in basic cognitive and professional capabilities. The evidence in this working paper suggests that firms in Austria may be facing this challenge more than in peer countries.

Figure 11. Austria's position in ICT-specialist skills

1. In percentage of firms which recruited or tried to recruit ICT specialists.

Source: Eurostat and OECD STAN database.

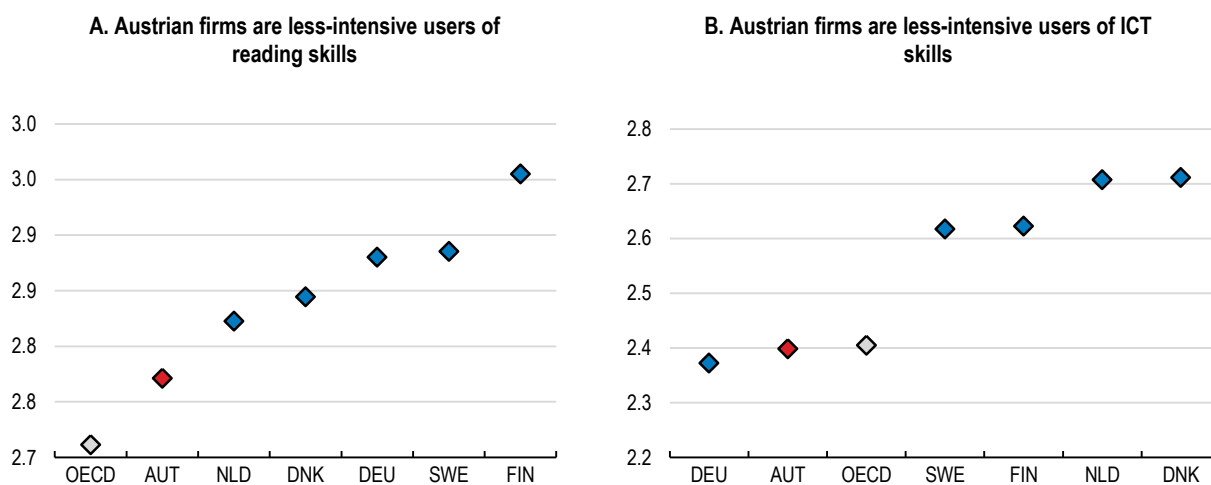
Modernisation of business models and complementary skills

The supply of digital skills does not guarantee their effective use. A vast research literature documents the complementarity between the effective use of ICT innovations and the re-design of firms' business models (Brynjolfsson and McAfee, 2014). ICT applications often involve much larger flows of information, which require firms to re-organise their management and work processes. This calls for "ICT-complementary" skills at all levels in firm hierarchies. A recent OECD review confirmed that effective ICT use depends directly on complementary investments in knowledge-based capital (KBC), and that failing to invest in such complementary skills limits the productivity impact of ICTs (OECD, 2016c). Firms at the global productivity frontier demonstrate a high capacity to combine technological, organisational, and human capital throughout global value chains (GVCs), harnessing the power of digitalisation at a high scale.

New business models come into being gradually: a 2015 survey has over 40% of global business executives reporting that digital technologies are helping them enhance their existing goods and services, and less than 30% that they were instrumental in launching new goods and services (OECD, 2016c). Work organisations become more decentralised, and teamwork more pervasive (Biagi, 2013). Labour relations at shop-floor level evolve accordingly. Field research suggests that workers' commitment also plays an important role in the absorption of ICT innovations (Schröder, 2016; Ortman and Guhlke, 2014). Organisational changes are more effective when the qualifications and interests of those involved at all levels are integrated in decision making.

Figure 12. Austrian firms' work processes are less information-intensive

Average skills use from 1 (never) to 5 (every day), working population aged 16 to 65



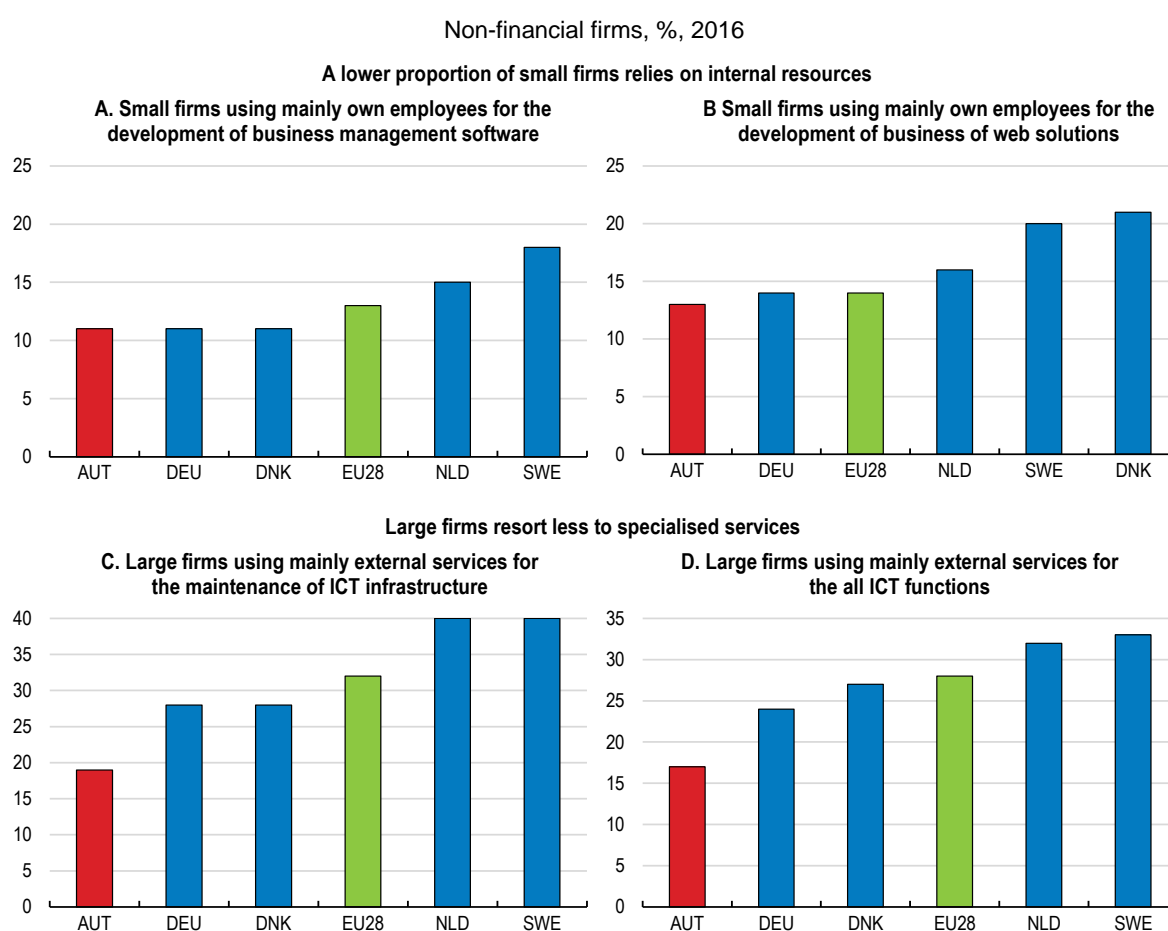
Source: OECD (2016), Skills Matter: Further Results from the Survey of Adult Skills.

A leading edge of firms notwithstanding, Austria's business sector as a whole appears slower to undertake this organisational renewal:

- In the 2013 OECD PIAAC Survey Austrian firms reported using their workers' information-processing skills less than in peer countries (Figure 12, Panels A and B);

- A lower share of small firms than in peer countries have put in place internal teams developing ICT applications (Figure 13, Panels A and B).
- A lower share of large firms rely on specialised external services for core ICT functions (Panels C and D).
- General tasks such as holding discussions in real time, executing online transactions and e-mailing are less intensely practiced in Austria than in peer countries. This reflects an occupational structure which is tilted towards sectors that rely less on these tasks, but also the fact that, for the same jobs, these tasks and therefore ICT is less solicited in Austria.

Figure 13. The organisation of ICT functions in firms differs from peer countries



Source: Eurostat.

The overhaul of business organisations around ICTs is at an early stage in all OECD countries. Most firms lack a clear view of available options and a strategy in this area (Bughin, 2016). Only a minority of them have successful new business models in place and data is scarce about these (OECD, 2016c). A recent review across OECD countries (Van Ark, 2016) detected several technical and organisational barriers to the overhaul of organisational models. As new business models are moving targets, Austria's lag in this area is difficult to document. It nevertheless calls for the attention of policymakers.

A relevant factor is the size-distribution of firms. All studies find that firm size influences the effective use of digital innovations (OECD, 2016b). The latest OECD PIAAC survey confirmed that the intensity of skills use is positively correlated with firm size in all OECD countries, and this is also the case in Austria (Figure 14). This prevails even when ICTs help micro and small firms to outsource their internal services, to specialise in activities where they have a genuine competitive advantage, and to reach to broader markets (Bhatt, 2016). The rise of such a “granular” economy permitting small entities to compete more effectively will apparently be gradual, and small size remains a handicap. A 2014 survey of 1 000 SMEs in Germany found for example that 70% felt that digitalisation was irrelevant for them. Availability of relevant know-how and supportive finance are reported as obstacles. Another study by the German Ministry of Economy concluded that ongoing research projects on “Industrie 4.0” are not presenting their results in a format and language appropriate for SMEs, calling for additional efforts for adaptation (German Ministry of Economic Affairs and Energy, 2015).

The share of SMEs (defined here as firms employing up to 250 workers) is slightly above peer countries in Austria (OECD, EAG, 2017). They represent nearly 70% of total business sector employment, against around 60-65% in comparable countries. Respective weights of size sub-groups are also comparable, including the weight of micro firms (those employing less than 10 workers, which represent around a quarter of total employment in both Austria and peers). More than the specific size composition of the business sector, other factors appear to slow down the modernisation of business models in Austria. Private and public sector initiatives are called for to facilitate knowledge and resource sharing between smaller size firms.

Some 95% of OECD countries have put in place special programmes to support the adoption of ICTs by SMEs (OECD, 2017c). These offer either financial support to ICT investments, via tax incentives, cash subsidies or loans; or non-financial services, e.g. training, consulting and mentoring. In France the programme “Investissements d’Avenir” offers loans to SMEs for the acquisition of robots. In Japan, the Ministry of Economy, Trade and Industry gives tax incentives to promote the productivity-enhancing investments in SMEs, including special incentives for ICT investments. Austria also introduced several programmes to support SMEs in their digital transitions (Box 2).

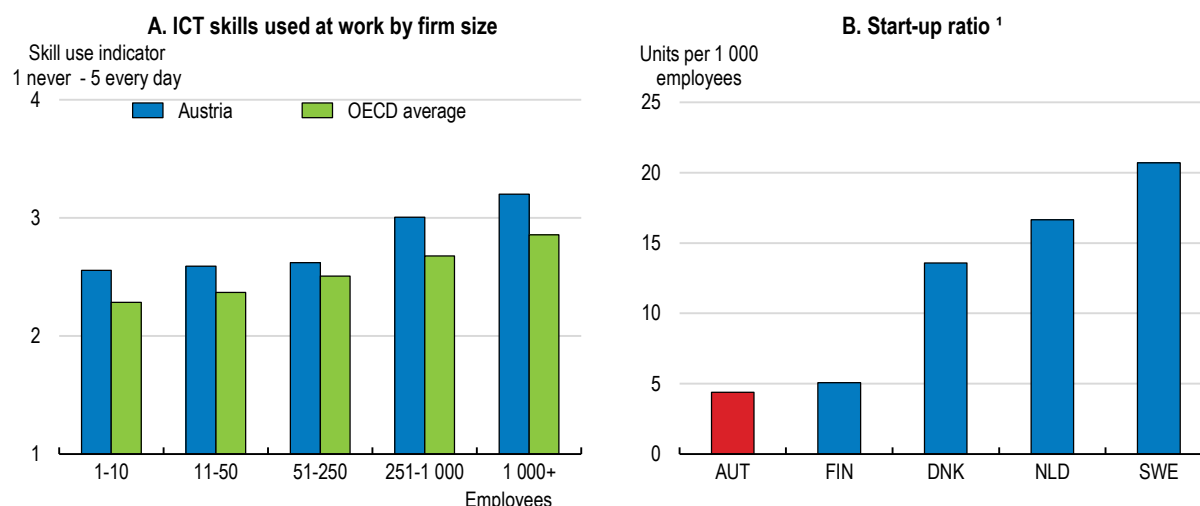
Other countries rely chiefly on non-financial support, notably in the form of business information, trade shows and feasibility studies. In Germany, the public programme “Trusted Cloud” eases the application of cloud technologies by SMEs by offering them a basic introduction to cloud computing. Denmark encourages partnership among SMEs in specific sectors, e.g. retail and wholesale trade and transportation, to promote the use of digital technologies, e.g. ERP, e-sales and marketing.

The entry of new firms is also a crucial driver of the renewal of business models and digital transitions in all countries, but Austria has a particularly low level of start-up activity (Calvino et al., 2016; Figure 14, Panel B). Exit policies are also likely to play a role, as high exit costs may influence the decision to enter and experiment with radical innovations (Adalet and Andrews, 2016). The special role of new entrants was confirmed by a recent large review of business practices in 33 countries (Future of Business Survey, 2016). It suggests that start-ups make more active use of ICT applications than incumbent firms, and reap additional performance benefits. Interestingly, enterprises created by women are younger and smaller on average, but are also more effective users of digital tools. These findings confirm the relevance of Austria’s strategic target of becoming a “Number One Start-Up Country”. The regulatory framework will need to be adjusted in several dimensions, and financial markets will need to be diversified further to move in this direction.

Access to financing is a particularly important issue for start-ups. Debt finance dominates external financing for firms, and especially small and medium-sized enterprises in Austria, but is ill-suited for new, small and innovative companies which have a higher risk-return profile and often rely on firm-specific

intangibles that are not suitable as collateral. Equity sources and hybrid instruments which combine debt and equity features are relevant in these cases. They have grown in several OECD countries and help young firms reduce their borrowing needs and costs (OECD, 2010). R&D grants, subsidies and tax incentives also mitigate the financing constraints of start-ups. In addition to rather generous R&D and innovation support, Austrian policymakers try to diversify the sources of finance for small young firms beyond traditional bank loans with a “Start-Up Package” topping up (doubling) the investments of eligible business angels in technology start-ups (Invest in Austria, 2017).

Figure 14. Firm demographics may be affecting the modernisation of business models



1. Start-up ratio is the number of entering units (entrants) over total employment (in thousands).

Source: OECD (2016), Skills Matter: Further Results from the Survey of Adult Skills, Table A4.11 ; Calvino, and al. (2015), “Cross-country evidence on start-up dynamics”, OECD Science, Technology and Industry Working Papers, 2015/06, <http://dx.doi.org/10.1787/5jrxtkb9mxtb-en>.

Know-how dissemination channels

The propagation of new technologies is supported in all countries by a network of know-how dissemination channels. These are more or less resourced, and active, in diffusing ICT knowledge across sectors, regions and types of ICT applications (OECD, 2017e). The two most common dissemination instruments are technology transfer platforms and local technological clusters.

Technology transfer platforms

Austria has a time-tested network of technology transfer platforms (Austrian Research and Technology Report, 2016). At the end of 2014, a national “Platform Industry 4.0” was also launched at the suggestion of the business sector, and on initiative of the Austrian Ministry for Transport, Innovation and Technology (BMVIT). The objective is to develop and diffuse good ICT practices, and strengthen Austria’s position as a global Industry 4.0 site. BMVIT invested € 1 billion in new projects on “production of the future” and “ICT of the future”. It funds the development of four 4.0 pilot factories in different regions. The first of these factories opened at the Vienna University of Technology to help companies observe various Industry 4.0 techniques (Aichholzer et al., 2015). Box 2 provides more details on the broad strategy and some specific programmes supporting the diffusion of digitalisation knowledge.

Länder governments are also taking initiatives. Upper Austria and Styria are pioneers in Industry 4.0 projects. Upper Austria aims at becoming a model region for Smart Production and launched its own “Platform Industry 4.0” initiative. The region offers favourable conditions due to the legacy of engineering

disciplines and plans to cooperate with Styria to pool ICT competences in leading companies and research institutions.

Box 2. The Open Innovation Strategy and digitalisation-oriented programmes

An “Open Innovation Strategy for Austria” was launched in 2016 by the Ministry of Transport, Innovation and Technology and the Ministry of Science, Research and Economy “to expand and develop the innovation system and to improve the digital literacy of innovation actors through new forms of co-operation”. Austria is one of the first countries in the world to have introduced this type of strategy (EC, 2017b). Several schemes are being introduced, to involve other ministries in their respective areas as well as provincial and municipal actors.

In the area of Industry 4.0, a “Pilot Fabrics” project supports the experimentation of new techniques and production processes in a realistic environment. It helps SMEs to test new technologies without interrupting current production activities. Partners from larger firms and research laboratories participate in these pilot fabrics.

A “Silicon Austria” programme with an annual budget of € 110 million supports research and innovation in the field of electronics, microelectronics and nanoelectronics “as these form the technological basis of megatrends such as autonomous driving, intelligent infrastructures and Industry 4.0”. Half of its resources will be used for the creation of a new research centre.

A “Talents Programme” offers traineeships for pupils and provides financial support for regional education projects in schools in the fields of mathematics and informatics. The objective is to engage children and adolescents in science and technology. It has a special “Internships for Female Students” component to help female students discover scientific and engineering positions in industry.

A special programme will co-fund development projects for products operable and usable by older generations with limited ICT-skills. In the spirit of the Open Innovation Strategy, senior citizens will be involved in the research phase of the projects. The programme has an initial annual budget of € 2.5 million.

*

The Ministry of Science, Research and Economy introduced a “SME.digital” programme to enhance awareness on digitalisation opportunities. It is publicising information about digital innovations relevant for SMEs, including best practices from other countries (Part I of the programme). It will equally support directly skill acquisitions in SMEs (Part II) and will put in place a network of competence centers (“digital innovation hubs”, Part III). The programme will be implemented through 2017 and 2018 and its efficiency and impact will be evaluated at the end of the first year. The initial budget for 2017-18 is € 10 million.

The Ministry of Science, Research and Economy has also introduced a “Smart and Digital Services (SDS)” programme to co-fund digitalisation projects with a potential to increase value added and exports in services. It notably aims at raising service companies’ awareness about the large potential benefits of R&D investments and aims at involving “non-technological” researchers in these projects. It has a budget of € 8.0 million for 2017-18.

However, most of these dissemination efforts concern manufacturing in Austria. This is a historical legacy, stemming from the traditional focus on the productivity and competitiveness of tradable manufacturing. Today, both the large scope of ICTs in services, and the role of services in overall economic performance justify the extension of such efforts to service sectors. There is awareness of this need, to wit Styria’s recent goal to support “Smart Production in Services” (Austrian Research and Technology Report, 2016).

Technological clusters

Several OECD countries are encouraging the development of local ICT clusters (OECD, 2016c and Ziemann, 2017). These operate as networking platforms cultivating science-to-science links (between public and private research centres and universities), science-to-industry interactions (with business firms), and industry-industry partnerships (between business firms). They also engage in cluster-to-cluster co-operation at interregional and international levels.

Austria has several dynamic ICT clusters. Certain initiatives launched in Upper Austria have been particularly effective and accelerated the diffusion of ICT technologies in several user sectors (European

Service Innovation Centre, 2014). Among these initiatives, the Hagenberg Software Park illustrates the potential of the approach (Box 3). Similar initiatives should be encouraged in all regions.

Box 3. Hagenberg Software Park

Softwarepark Hagenberg is a network of companies and educational and research institutions in the area of software development. Founded in 1989 as a spin-off of Johannes Kepler University Linz under the name RISC (Research Institute for Symbolic Computation), in the historical village of Hagenberg im Mühlkreis and in an old industrial region, it was buttressed by the establishment of a University of Applied Sciences in 1993. Back then, the first course in software engineering started with 30 post-secondary students.

Subsequently, an IT cluster was created as an initiative of Business Upper Austria, the business agency of the province of Upper Austria, and the Hagenberg Software Park became part of it. The cluster comprises 160 members, including academic and research institutions (University of Linz and the University of Applied Sciences) and some 140 IT enterprises. It includes a network of seven regional industry clusters, which aim to bring businesses and research institutions together on specific topics (mechatronics, automotive applications, medical technologies, etc.). It supports new start-ups from the concept development to the marketing stage. It also reaches out to 1 900 other companies involved and is Austria's largest IT cooperation network. In 2016, the *Länder* government presented its *20-Point-Plan for the Digital Future of Upper Austria*, which foresees additional investments in the cluster.

Software Park Hagenberg provides a common physical space for ICT innovators, principally in software applications. It includes some 75 enterprises, 11 research institutions and 23 education programmes. With state-of-the-art infrastructure and a diversified network of experienced industry experts, it supports young engineers and students to put their ideas into practice. It is a place of communication and meeting, where around 2 800 people work, research, teach, learn and live. Many successful start-ups were born and grew on its premises. There are plans to expand networking with international technology centres, and developing international student courses and programmes.

Digitalisation trends in households

ICT applications in households offer access to broader and better supplies of goods and services, wider sources of information, and time savings in several household tasks (shopping, banking, paying bills, etc.). The greater the number of households adopting ICT applications, the greater the network economies in the production and utilisation of ICT goods and services.

The generalisation of digital innovations in households is slower than in peer countries.

The diffusion of ICT innovations in Austrian households follows a pattern similar to that in the business sector. Young and highly educated Austrians tend to adopt digital innovations in similar ways and proportions to their peer country counterparts. Gender differences are also small in these young groups. In contrast, gaps vis-à-vis peer countries, as well as domestic divergences are larger for middle and older age cohorts, according to their education, income level, immigration origin, etc. These divergences are recurrent across ICT applications.

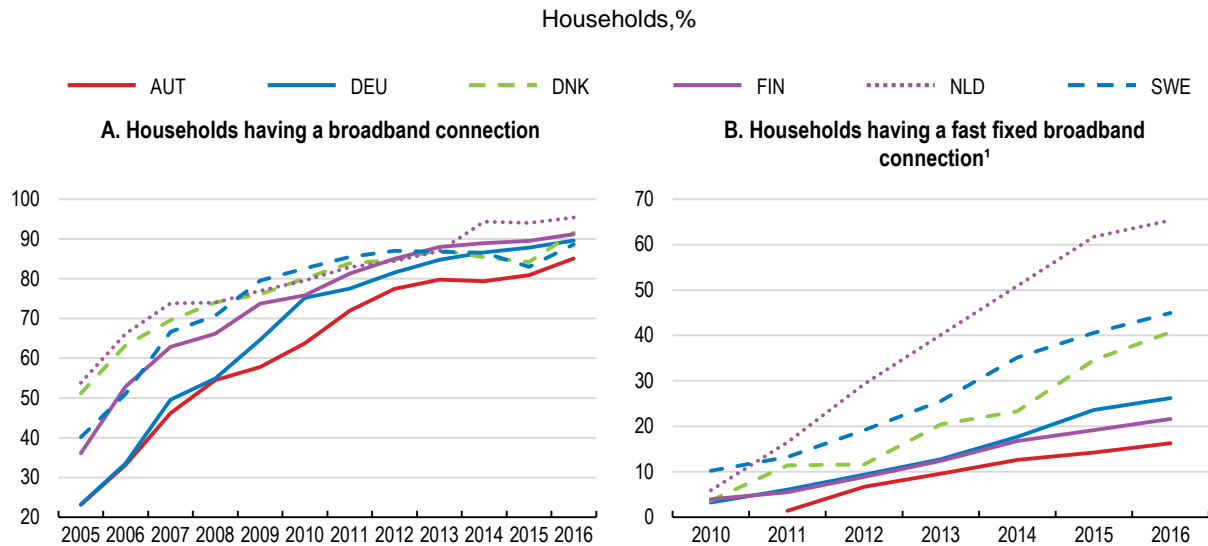
Broadband connectivity

Like in the business sector, broadband connections provide the basic infrastructure of digitalisation in the household sector. Only 25% of Austrian households had broadband in 2005 against 50% in peer countries. By 2016, however, this share had reached 85% in Austria, approaching that in peer countries (Figure 15).

In the area of fast broadband, however, and like in the business sector, large gaps persist. A negligible proportion of Austrian private persons had access to fast broadband in 2010, against 5 to 10% in peer countries. There has been progress in the 2010s, with the share reaching 15% in 2016. However, in the meantime, connections expanded more rapidly in peer countries and their edge over Austria increased (Figure 13, Panel B). This divergence occurred despite very low broadband service prices in Austria. The

average download speed (65 Mbps) remains below the OECD average (77 Mbps) and lags well behind the average speed in leading countries such as Sweden (240 Mbps) and Japan (166 Mbps) (Figure 16). The low penetration of fibre, especially in rural areas, may be slowing down the introduction of more attractive services (see Figure 23 below).

Figure 15. Broadband connectivity of households

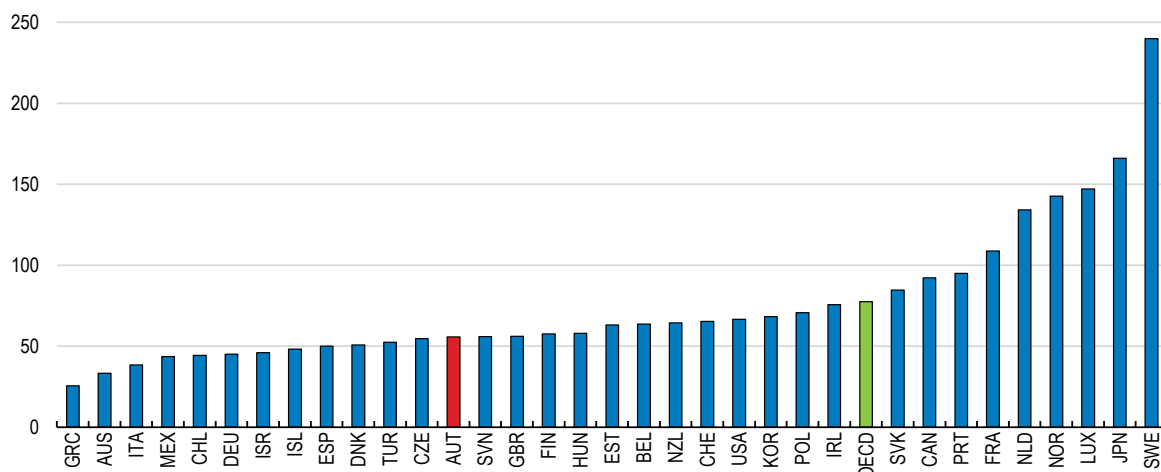


1. Fixed broadband connection with an advertised download speed above 30 Mbps.

Source: OECD ICT database and Eurostat.

Figure 16. Average advertised download speeds

Mbps, fixed broadband, September 2014



Source: OECD, Broadband Portal, www.oecd.org/sti/broadband/oecdbroadbandportal.htm.

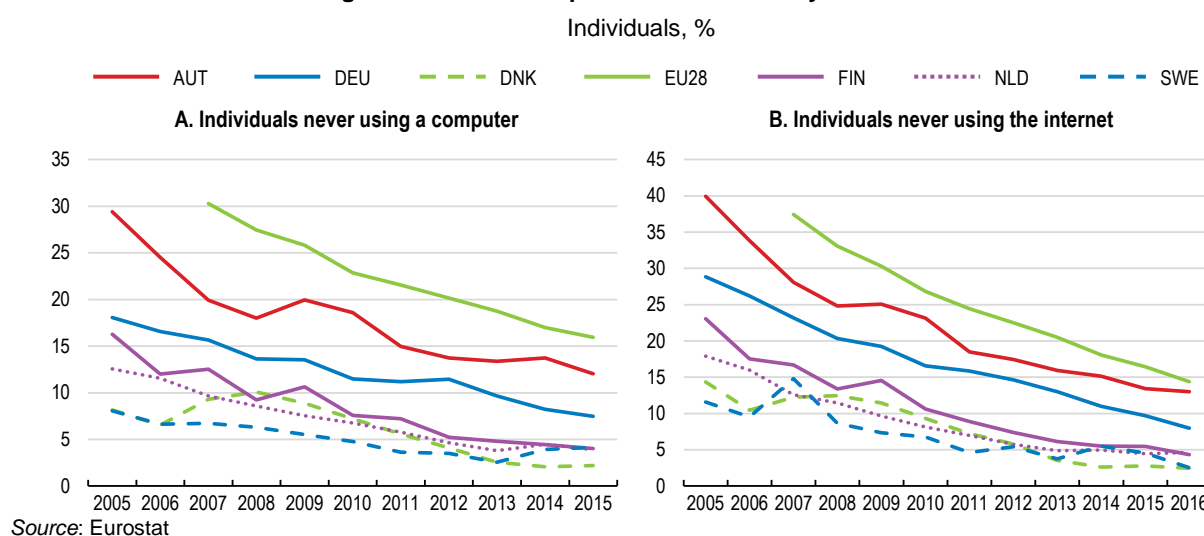
Computer and internet use

The proportion of persons who never use a computer is a standard indicator of ICT diffusion. One third of Austrians had no contact whatsoever with a computer in 2005 against 10-15% in peer countries. Their share declined to below 20% by 2010 and to below 15% by 2016. It remains three times bigger than in peer countries (Figure 17, Panel A).

The share of individuals never using the Internet shows a similar picture. About 15% of Austrians had no contact with internet in 2016, slightly below the EU average but well above the negligible share of this group in peer countries. This group has a particularly slow rate of attrition in Austria (Figure 17, Panel B).

Household access to cloud computing shows a similar picture at the high end of ICT utilisation. Only 20% of Austrians used cloud services in 2015, while this share reached 40-50% in peer countries. This confirms the limited weight of high-intensity ICT users among Austrian households. There is also a gender gap: 17% of prime age women use cloud computing, against 30% of prime age men, while this share stands at 50% for both genders in peer countries. In young cohorts the gender gap has disappeared but cloud utilisation remains 20 percentage points below peer countries.

Figure 17. Use of computers and internet by households



E-commerce

More than half of all individuals buy products online in OECD countries. The trend is accelerating and has unsettled the traditional distribution channels in certain sectors such as tourism and travel services. The generalisation of smartphones supports the practice and half of smartphone users now order via their mobile devices. The uptake of e-commerce by individuals varies considerably across countries, however (OECD, 2015a).

In Austria, e-commerce use by individuals grew more slowly than in peer countries. It reached a level slightly above the EU average, but well behind peer countries (Figure 15, Panel A). Younger Austrians have caught up somewhat but gaps remain large for the middle-age and older cohorts.

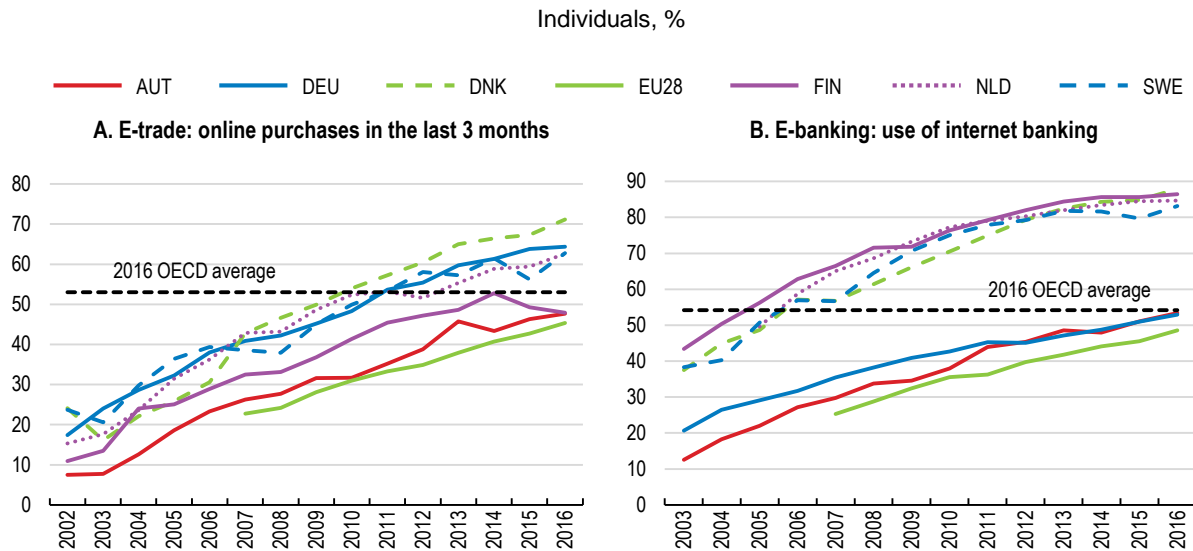
E-banking

The rise of online banking is redefining market boundaries and service access channels in banking. More than half of internet users in OECD countries now use online banking, increasingly via mobile devices. The ongoing trend is that of a reduction in the number of bank branches, with 20% of local branches projected to disappear within five years in certain Member countries (OECD, 2015a).

About half of Austrians were using internet banking in 2016, far below peer countries. Uptake rates approach 90% in Denmark and the Netherlands (Figure 15, Panel B). The prevailing financial practices of Austrian households, where men traditionally run family finances, contribute to a gender gap: 60% of

women aged 25-54 were using e-banking in Austria in 2016, against more than 90% in peer countries. There is also a gap between urban and rural areas (with uptake rates around 60% in the former and 50% in the latter, against 90% and 80% respectively in peer countries).

Figure 18. Specific internet applications used by households



Note: 2016 OECD estimates based on a simple arithmetic average of the available countries, and percentage of individuals who have purchased online in the last 12 months.

Source: Eurostat and OECD, ICT Access and Use database.

Factors influencing the adoption of digital innovations in households

The diffusion of ICT innovations in households appears to be strongly affected by socio-economic determinants in all OECD countries (OECD, 2015a). Factors such as age, education, gender and immigration background have all an impact. These effects appear even stronger in Austria.

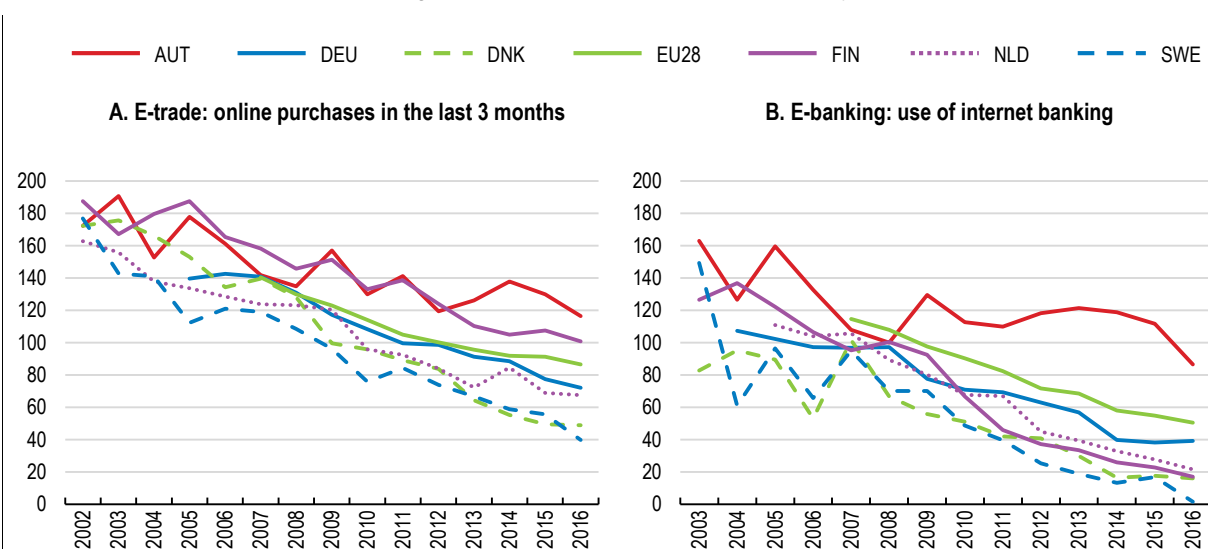
Age

In Austria, the influence of age on ICT use is stronger than in other EU countries, and much stronger than in peer countries. For instance, the rate of uptake of e-commerce by the 64-75 cohort is lower than the EU average (13% versus 19%) and much lower than in peer countries (30-40%). Those aged 16-24 participate more than the EU average (60% versus 50%) but less than in peer countries (70%). The gap in uptake rates between age cohorts stays high despite a decline over the past decade (Figure 19, Panel A).

The impact of age is even greater in e-banking. Older Austrians are particularly hesitant to engage in internet banking. Only 15% of those aged 65-74 draw on these services, against the EU average of 25% and up to 60-70% in peer countries. As in e-commerce, younger cohorts surpassed the EU average (75% versus 60%) but remain below the quasi-universal coverage in peer countries (95% in the age cohort 25-34). The age gap in uptake rates is declining but only slowly (Figure 19, Panel B).

Figure 19. Influence of age

Percentage difference between 16-24 and 65-74 year-olds



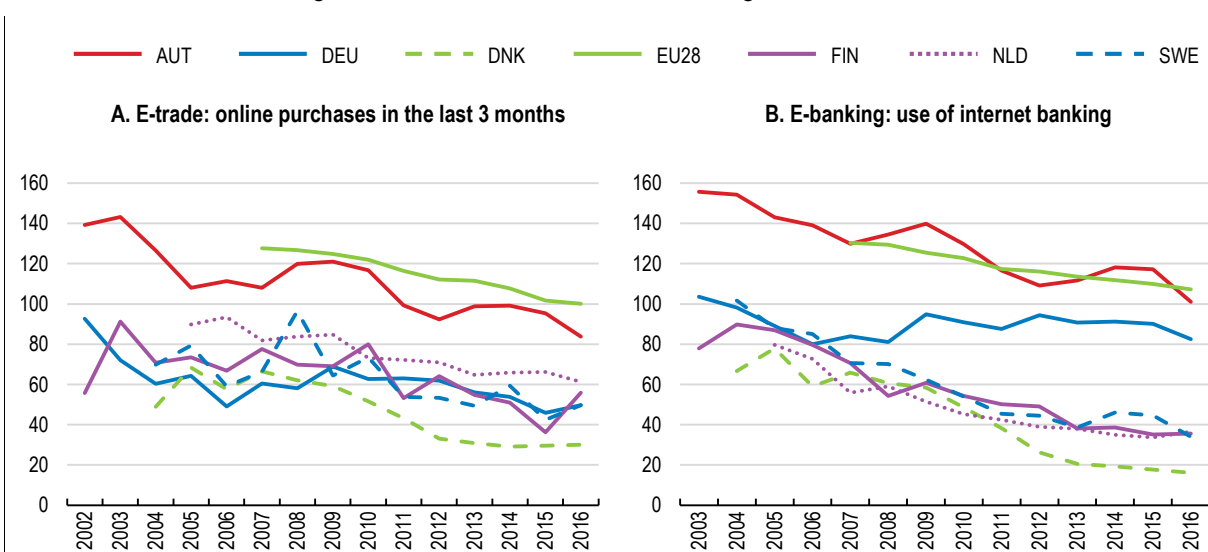
Source: Calculations based on Eurostat data.

Education

Education is the other key driver of familiarity with and proficiency in digital technologies. In the OECD area the utilisation rates of ICT applications by university-educated 65-74 year-olds are comparable to the average utilisation rates of the general population (OECD, 2015a). In some of Austria's peer countries, this rate matches even the adoption rates of the youngest cohorts.

Figure 20. Influence of education

Percentage difference between individuals with high and low formal education



Source: Calculations based on Eurostat data.

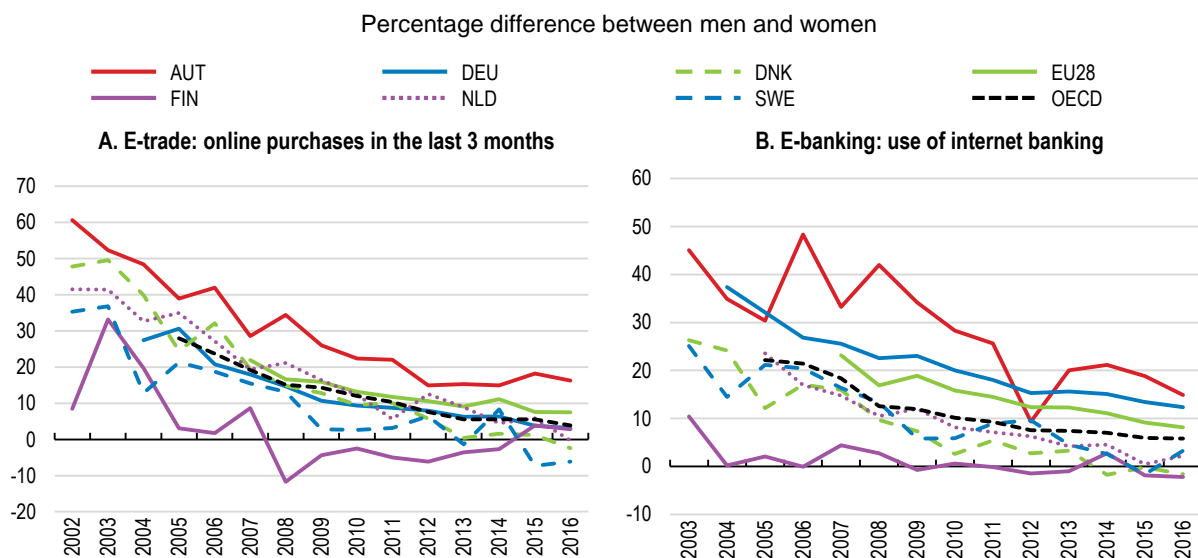
In Austria the influence of education on ICT utilisation is particularly high. For instance 20% of Austrians with low education participate in e-commerce, against 25% in the EU, and 50-60% in peer countries. For the tertiary educated groups the rate increases to 70% in Austria, matching the EU average, but falling behind the 85-90% rate in peer countries. This gap between education groups declined only gradually over the past decade (Figure 20, Panel A). The same picture is found in e-banking, with even larger differences between low, medium and high educated groups. As with e-commerce, these gaps are declining very slowly (Figure 20, Panel B).

Gender

Gender gaps have long been common in the uptake of ICT innovations. However, they declined over the past decade, and, in certain countries, they have been reversed. In Sweden and Denmark for example, women are now more active than men in e-commerce as well as in e-banking.

In Austria, gender gaps stay large in international comparison (Figure 21, Panels A and B). They may be reflecting, at least partly, the “separate gender roles” model which endures in many businesses and families (OECD, 2015b). The fact that many women stay focused on traditional tasks in workplaces and households may keep them away from ICT innovations. These gaps have declined for the tertiary educated and the youngest cohorts, however, which may herald their future erosion.

Figure 21. Influence of gender



Note: OECD estimates based on a simple arithmetic average of the available countries.

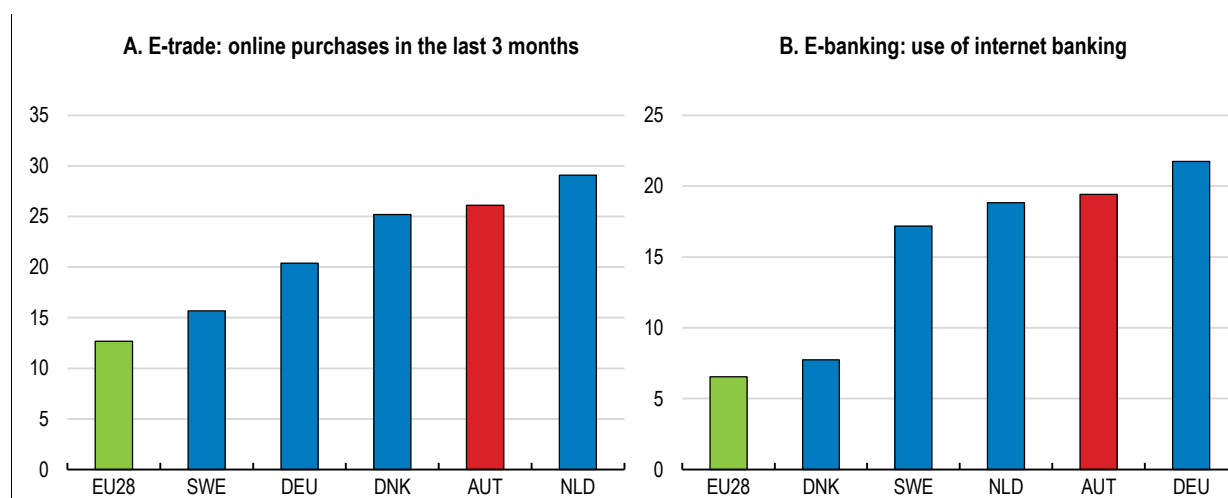
Source: Calculations based on data from OECD, ICT Access and Use database and Eurostat.

Other socio-economic factors

In all OECD countries the income level and other socio-economic characteristics of individuals also affect the adoption of ICT applications. Without multivariate models based on micro data, the respective impacts of specific factors are difficult to disentangle. Still, one variable stands out in Austria in the case of immigrants, namely their origin. Migrants from non-EU countries clearly have lower rates of uptake of ICT innovations than in peer countries. These gaps have not diminished through time (while they tended to decline in at least certain peer countries). Even if their persistence in Austria may be related to the larger educational gaps of these immigrant groups, they signal a digital divide in the making (Figure 22).

Figure 22. Influence of immigration origin

Percentage difference between individuals born in the country and those born in a non-EU country, 2016



Source: Calculations based on Eurostat data.

Austria has traditionally been conservative in the adoption of new technologies by households (Tellis, 2003). The digitalisation process may be reproducing this traditional pattern. It may reflect a cultural tendency to preserve prevailing habits, and to depart from them only slowly. For example, the slow uptake of e-commerce may reflect the preference of many Austrians for face-to-face interaction with their local retailers and service providers, in particular in the small communities where local trust is strong and personal contacts are particularly appreciated. Such cultural traits were identified in recent OECD economic surveys as being part of the drivers of well-being in Austria (OECD, 2013a).

There is also other evidence suggesting that digitalisation is being driven by the same basic socio-economic forces in Austria as in the other OECD countries. Young and better educated groups converge faster with the global lifestyles, and more swiftly adopt the new ICT goods and services. They precede other social groups, which follow with a longer lag than in comparable countries. In this process conservative preferences may be expected to gradually exert a smaller influence. The overall pace of digitalisation will result from these competing forces. The policy challenge is to raise awareness and diffuse knowledge on the benefits arising from digitalisation throughout the society, and let all citizens make use of them according to their preferences.

Public strategies to foster digital transition call for broad social support

The findings of this working paper are congruent with the broad message of two recent OECD reports on the policy implications of digitalisation (OECD, 2016c; OECD, 2017a). These reports stress that despite the rapid spread and uptake of digital technologies, adoption and use vary widely in all countries along demographic groups, industries and firm sizes. This raises challenges as to the inclusiveness of the digital transformation.

Barriers to more balanced and inclusive diffusion typically arise from a combination of lack of high-quality and affordable infrastructure, lack of trust in digital technologies, a shortage in the skills needed, service trade barriers, and high cost of financing for SMEs. These barriers play uneven roles in different countries. They should be addressed with comprehensive strategies (OECD, 2017a).

A “whole-of-government” approach is in order in all countries because many policy areas are involved, and advances in each individual area risk being offset by lack of action in others. The building blocks of a comprehensive strategy in Austria should include the elements below, many of which duly feature in Austria’s recent Digital Roadmap (Box 2). The discussion below emphasises some of the most important priorities.

Recognising the employment and social cohesion challenges of digitalisation

Digitalisation has far-reaching effects on labour markets and social cohesion, through two main channels. First, digitalisation entails skill biases in employment, as it destroys and creates jobs for persons with different educational and skill backgrounds. Its impact is more significant for manual and intellectual routine activities (Ziemann, 2017). Second, the new “asset sharing” properties of digital business models generate more fragmented and less stable activity and employment forms, which do not benefit from the same legal and social protection framework as standard employment forms. On the positive side, they also offer entirely new opportunities for persons otherwise excluded from the labour market.

Acknowledging these challenges is important for a constructive social dialogue. The process has started in Austria (Birkner et al., 2016). The quality of this dialogue will shape the degree of social consensus on digitalisation trends, and will influence policymaking as well as collective agreements. Involving workers in non-standard activities in social dialogue is not straightforward because of lack of well-established representation channels. Nonetheless, a first “workers council” of bike-delivery workers was created in Vienna in April 2017 (Metropole, 2017).

Austria’s social partnership system as a “coalition of producers” (Nowotny, 1993) would in principle be supportive of digitalisation. The firms, the unions, the Chamber of Economy and the Chamber of Labour currently view digitalisation as an important source of productivity gains, provided that social cohesion is not threatened. This joint support is valuable and should continue to be cultivated.

Upgrading skills

The OECD recommends to all Member countries “to place a stronger emphasis on promoting ICT generic skills, ICT specialist skills, and ICT-complementary skills, in order to ensure that all citizens and enterprises can engage in and benefit from the digital economy” (OECD, 2017a; OECD, 2017d). Austria has shortcomings in this area and developed a Digital Skills Plan in the context of the 2015 Education Plan (see Ziemann, 2017). This effort should also encompass the age cohorts already in the labour force, and is integrated in the Digital Roadmap. Specific time-based targets and benchmarks could be set for effective implementation.

Certain OECD countries have introduced specific policies to address the limitations of middle-aged and older cohorts. For example, Ireland’s 2013 National Digital Strategy aimed at cutting the proportion of “non-liners” (people who have not yet engaged with internet) by half by 2016. In Sweden, as part of the 2011 Digital Strategy, the eGovernment Delegation developed a “Guidance on Web Development” which sets out how to meet the needs of elderly people and people with disabilities. In Denmark, two national campaigns were initiated to encourage the elderly to use ICT: the “Get Online Week” and the “Senior Surf Day”. They sought to inform and motivate new users about the benefits and enjoyment of using internet and involved around 1 000 ICT centres and libraries around the country. There are already a number of information and awareness programmes in Austria directed to old-age internet users (Help.gv.at, 2017) and the Digital Roadmap foresees further initiatives.

Renewing business models

There are deep differences in ICT adoption rates between firms in all OECD countries. As documented above, they are particularly large in Austria. Firms of different types, sizes and sectors are unequally engaged in digital transitions.

Governments in all OECD countries try to accelerate convergence, in particular in SMEs (OECD, 2016c). Most of the related public programmes focus on: (i) awareness raising and training, with an emphasis on ICT-related and organisational know-how, (ii) financial support, and (iii) social networking. Notably, Germany's "Mittelstand-Digital" programme may deserve special attention, as the diffusion of ICT innovations follows a staggered path similar to Germany's and the German initiative is considered as successful (OECD, 2016c). Austrian policymakers draw on international experience in this area and a new programme *sme.digital* was recently introduced to foster ICT adoption and digital change.

Austria's low start-up rates are a recognised handicap in digital transitions. Policymakers aim at stimulating the renewal of business demographics through a "Austria as a Number One Start-Up Country" initiative. Close attention to start-ups' specific policy needs is in order, as they generally lack the resources to participate in policy processes (OECD, 2017c).

Promoting more competitive digital markets

Digitalisation creates risks of closure, collusion and even monopolisation in several market areas (OECD, 2017a). Lack of open standards and fears of vendor lock-in are common. For example, in cloud computing, applications developed for one platform cannot be easily migrated to another cloud host, and users can become vulnerable to providers' strategic behaviour and price increases. Surveys have shown that the lack of such standards and the resulting fear of vendor lock-in is an important barrier to the generalisation of cloud computing (OECD, 2016c). New initiatives for developing open standards in the full range of ICT applications have emerged, at national (the Swedish Standards Institute is a leader), European and global levels. Preserving the openness of these markets requires close policy scrutiny and, when needed, pro-competitive regulations. The public sector may act as a role model by fostering open standards and interoperable solutions in its procurement policies.

The Austrian Competition Authority has an active competition advocacy role to play to prevent collusion and monopolisation in digital markets, and has already taken initiatives in this area. It co-operates with European and international counterparts. The World Trade Organisation and the World Intellectual Property Organisation also address the interplay between intellectual property and competition law at the global level. Several competition-relevant issues associated with digitalisation, including open standards, interoperability, market access rules, and balanced use of intellectual property rights remain on the agenda. Intellectual property rights (IPRs) may support innovation by making it an attractive investment but may also generate undesirable rents. With digitalisation, IPR has become more important in a wider range of sectors and policymakers need to find a good balance between nurturing innovation incentives and preserving competition (OECD, 2016c).

Reinforcing the broadband infrastructure

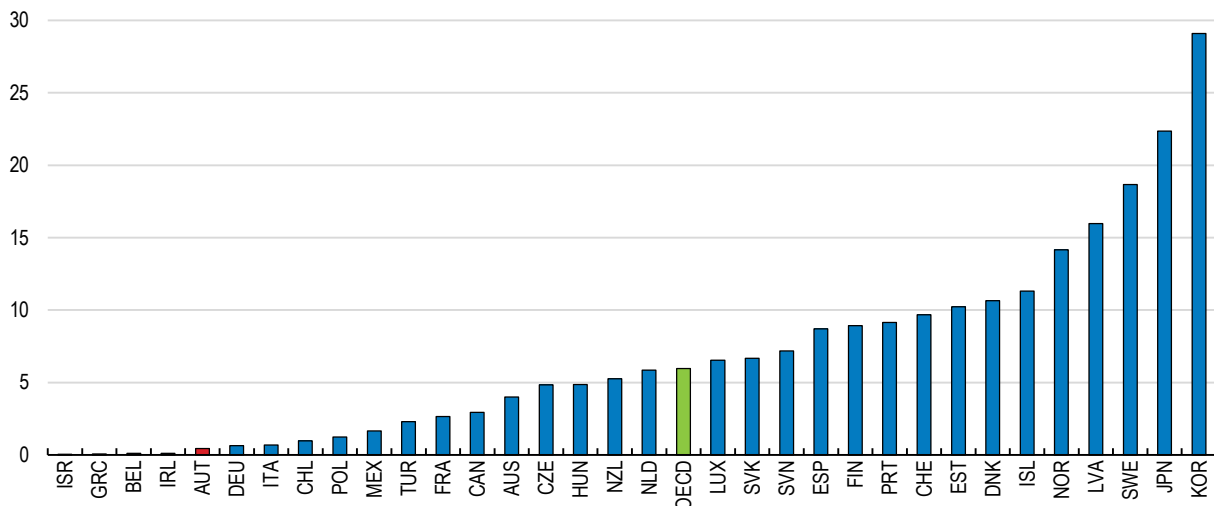
It is essential to continually invest in the development of digital infrastructure to meet existing and future demand (OECD, 2017a). Fast broadband supports the data-intensive new applications and business models and is indispensable for the implementation of Industrie 4.0 solutions.

Austria has an ambitious *Broadband Strategy 2020*, which aims at making ultra-fast broadband available to all firms and households by 2020. However, the country is currently among those with the lowest per capita investment flows in telecommunication infrastructure (Peneder et al., 2016). Three issues

remain: i) the low rate of “fiber coverage” on the last mile of fixed broadband networks (Figure 23), which restricts opportunities for new competitors to offer services beyond those defined by the incumbent, hence limiting competition and innovation from new players; ii) the reduction of the number of mobile network operators (MNOs) from four to three, after a merger authorised by the European Commission (against the advice of the national competition authority), which appears to have slowed down the pace of technological renewal in mobile broadband services (OECD, 2014); and iii) significant differences in the quality of the broadband infrastructure between regions (EC, 2017a).

Figure 23. Fibre subscriptions among countries

Subscriptions per 100 inhabitants, June 2016



Source: OECD Broadband database.

The OECD recommends that all Member countries establish national broadband plans with well-defined targets and update them regularly. These plans should address the existing barriers to the deployment of high-speed networks and services, and include measurable targets concerning competition and investment. These targets should include goals concerning the key technical enablers for new entrants and value-added service providers. Austria could continue to regularly update its Broadband Strategy along these principles.

Generalising e-government innovations

Austria is among the international leaders in e-government innovations but their pace of adoption by households falls behind. Certain OECD countries have accelerated the adoption of e-government innovations by making the use of public digital platforms mandatory - with opt-out provisions. To date, Austria has maintained neutrality between digital and non-digital platforms as policymakers place a strong emphasis on inclusion and freedom of choice for citizens. To encourage the use of digital platforms, a 40% reduction on fees (“online discount”) was nonetheless introduced for those applying digitally for certificates, using electronic identification means. Transition to pre-filled digital tax forms has been a successful innovation and is now fairly generalised, in particular in the business sector. A recent law, applicable from 2020, will guarantee to all citizens and businesses the right to interact digitally with the administration in areas falling under federal legislative competence (except for areas not suitable for electronic interaction). Open government data is also expected to nurture the emergence of new businesses by permitting the use and free distribution of new government datasets (OECD, 2017g). Stronger incentives, including financial incentives, may nonetheless be needed to encourage households to make the transition.

Fostering bottom-up innovations

Clustering initiatives in digital activities foster the network economies typical of these sectors. There are promising experiences in Austria, for example the Hagenberg Software Park (Box 2). Such initiatives should continue to be encouraged, including through co-operation between the Federal and *Länder* governments. The 2017 Digital Roadmap rightly stresses the expected contributions of clusters.

Uber- and Airbnb-type innovations are also important. They make the welfare benefits of platform-based ICT innovations accessible to a wide population. Their introduction has been managed smoothly so far in Austria. Regulators have not blocked these innovations, while addressing the concerns that they have raised (Box 4). Preserving an enabling regulatory framework while fostering a level playing field for all participants will be essential for future innovations.

Box 4. Airbnb and Uber in Austria: Vienna's approach to the "sharing" economy

Internet platforms such as Airbnb and Uber, which are experiencing outstanding growth globally, have also reached Austria. The sectors of hotels and accommodation and passenger transport are directly affected. Of the current 15 000 accommodations in Austria on offer via internet platforms, Vienna accounts for just over half. In 2016, the City of Vienna set out some principles on the regulation of the "sharing economy" in a paper entitled "Turning the sharing economy into a fair economy in Vienna". The emphasis was on establishing a level-playing field between different actors. The City reiterates its priority of preserving Vienna as a high-quality and attractive tourism location. This requires openness to innovative services.

The City started with an information campaign to raise awareness of these issues. In Vienna's social housing system, which accounts for around 45% of all apartments in town, allowing third parties to use social flats is not permitted. Non-compliance may result in the termination of the tenancy agreement. On the other hand, the owners of private apartments should also act in line with a Supreme Court ruling that all private apartment owners in a building must give their consent on all issues of common interest, including the lending of apartments to temporary tenants. Therefore, the legal, regulatory and contractual framework, without prohibiting them, sets relatively strict rules for Airbnb type of services.

The City started also to adjust certain specific regulations. In September 2016 the state parliament amended the Vienna Tourism Promotion Act, and stipulated that:

- Platform operators will have new reporting obligations. The name of accommodation providers and the addresses of the apartments on offer will be regularly communicated to the Vienna Tourism Board.
- Platform operators will supply the information required by the Tourism Board (for tourism promotion purposes) upon request.
- Fines for non-compliance will be raised from €420 to €2 100 for flat owners who do not register their accommodations.
- Flat owners will collect the local tax from the persons hosted, and will pay it to the municipal administration.

Concerning the platform-based taxi services, Uber is the biggest provider in Vienna. It does not operate in other Austrian cities. Uber testifies that in Vienna it works only with licensed taxi and chauffeur service companies, and not with private individuals. This has secured the consensus of existing service professionals but limits the pool of potential service providers. The City government has indicated that it monitors developments and aims at reconciling innovations with high working standards.

Improving trust and consumer protection

Trust reduces transaction costs in the digital economy, and facilitates the adoption of innovations. Three main dimensions pertain to cybersecurity, privacy and consumer protection (OECD, 2016c).

Cybersecurity risks have increased in all OECD economies. Cybersecurity has traditionally been approached as a technical problem, but the changing scale of security incidents is driving countries to re-evaluate their strategies. In recent years, many governments and stakeholders emphasised the importance of considering digital security risk as a strategic issue, which needs to be addressed at the highest level of governance. This is the approach of the *Recommendation of the OECD Council on Digital Security Risk Management for Economic and Social Prosperity* (OECD, 2015d). It requires a culture of dialogue and co-operation among stakeholders, which is well-developed in Austria.

As digital innovation becomes more data-driven, privacy becomes a key issue. Indeed, large volumes of personal data are collected in various ICT applications, which are either voluntarily reported by individuals themselves, or observed or collected without their knowledge. The resulting mass of information is then stored, creating risks of data theft or misuse. Other steps involve the processing of such information by data analytics, helping generate inferences even when individuals never directly share the related information. Ultimately, data-driven automated decision making, when applicable, may lead to distorted decisions. Information inferred from data analytics can serve to boost efficiency but also risks perpetuating existing stereotypes based on statistical probabilities. Individuals' and firms' capacity to secure employment, business, insurance or credit may be affected. Austria's policymakers have to tackle this entire agenda, as in all OECD countries. The Digital Roadmap rightly emphasises this priority and the *OECD Privacy Guidelines* (OECD, 2013c) provide a principles-based privacy framework to shape the approach.

The Internet economy also raises many consumer protection issues, particularly with respect to specific activities such as e-commerce, online banking, spamming and online line user tracking. Like other OECD countries, Austria has legal safeguards beyond general consumer protection rules that cover e-commerce transactions. They deal with online ordering and confirmation, information disclosure about goods or services, and advertising and marketing practices (Koske *et al.*, 2014). In Austria online advertising about tobacco, alcohol and medicinal products and by lawyers and doctors is prohibited. The selling of financial services is regulated by the EU Directive governing "distance marketing of consumer financial services". As cross-border e-commerce becomes more and more important, for both consumers and suppliers, Austria's consumer protection agency participates in international co-operation activities within the International Consumer Protection and Enforcement Network (ICPEN). The Austrian authorities can further rely on the recently revised *OECD Recommendation on Consumer Protection in E-commerce*, which has updated provisions on digital content, consumer reviews and ratings, non-monetary transactions, new payment mechanisms, and the use of mobile devices to conclude transactions (OECD, 2016i).

Digital Europe, digital world

Access to broader markets – European or worldwide – is particularly important for new market entrants in small open economies such as Austria. As "scale without mass" is becoming a core performance driver in digital markets, achieving the European Digital Single Market is crucial for small open economies such as Austria (OECD 2017a). The OECD Recommendation on Consumer Protection in E-commerce (OECD, 2016j) provides a set of policy principles to foster the development of cross-border e-commerce: fair and transparent business and advertising practices; information about businesses, goods and services, transactions, as well as adequate dispute resolution and redress mechanisms, payment protection, and product safety. Governments and stakeholders should work together to improve consumer protection and determine what policy changes are necessary to address the special circumstances of e-commerce, including for children and vulnerable or disadvantaged consumers.

The main policy recommendations of this working paper are summarized in the following Box. Several of these recommendations are part of the strategic goals of the 2017 Digital Roadmap. Their formulation in terms of specific and quantitative objectives may facilitate their implementation and monitoring.

Recommendations to facilitate ICT diffusion

Key recommendations

- Set up a transparent monitoring system for the implementation of the Digital Roadmap, with timelines and quantitative targets
- Integrate a Digital Skills Plan in the Roadmap, including for small firm owners and managers. Establish targets for ICT-generic, ICT-specialist and ICT-complementary skills.
- Facilitate new entries and stimulate competition in broadband services in the context of the Broadband Plan 2020.
- Ensure that competition policy responds to changing threats to competition in digital markets, including through international co-operation..
- Promote more effective data protection, cyber security and consumer protection. Improve public awareness that responsibility for risk management remains partly with firms and consumers themselves.

Further recommendations

- Develop further the social dialogue on digital transitions. Consider a joint report by social partners on the desirable labour market and social policy priorities.
- Develop further the technology transfer programmes for businesses, in particular for SMEs. These could include training and consulting activities and showcases of best-practices. Extend this support beyond manufacturing, to all service sectors.
- Further encourage the use of e-government platforms by reducing fees and/or making their use more attractive, including through specific training.
- Use public procurement to promote open access, open data and open standards.
- The authorities should work together with stakeholders in e-commerce to improve consumer protection and determine what policy changes are needed to address the special circumstances of e-commerce, including for children and vulnerable or disadvantaged consumers.
- Encourage the creation of digital clusters in all regions in Austria.
- Continue to support venture capital investment and reduce tax and other disincentives for equity investments.

REFERENCES

- Acemoglu, D. and P. Restrepo (2016), “The race between machine and man: Implications of technology for Growth, Factor Shares and Employment”, *NBER Working Paper* No. 22252.
- Adalet, M. and D. Andrews (2016), “Insolvency regimes and productivity growth: A framework for analysis”, *OECD Economics Department Working Paper*, No. 1309.
- Aichholzer G., W. Rhomberg, N. Gudowsky, F. Saurwein and M. Weber (2015), *Background Paper: Industry 4.0 – Foresight and Technology Assessment on the Social Dimension of the Next Industrial Revolution*, Austrian Parliament, Vienna.
- Andrews, D., C. Criscuolo and P. Gal (2015), “Frontier Firms, Technology Diffusion and Public Policy: Micro Evidence from OECD Countries”, *The Future of Productivity Main Background Paper*, OECD Publishing, Paris.
- Andrews, D., C. Criscuolo and P. Gal (2016), “The Best versus the Rest: The Global Productivity Slowdown, Divergence Across Firms And the Role of Public Policy”, *OECD Productivity Working Papers*, No. 5, OECD Publishing, Paris.
- Arntz, M., T. Gregory and U. Zierahn (2016), “The risk of automation for jobs in OECD countries”, *OECD Social, Employment and Migration Working papers*, No. 189.
- Atluri, V., J. Cordina, P. Mango and S. Velamooret (2016), *How Tech-Enabled Consumers Are Reordering the Healthcare Landscape*, McKinsey & Company.
- Austrian Research and Technology Report (2016), *Report under Section 8 (1) of the Research Organisation Act*, Federal Ministry of Science, Research and Economy (BMWFW), Vienna.
- Bartelsman, E., E. Hagsten and M. Polder (2013), *Cross-country Analysis of ICT Impact Using Firm-level Data*, Eurostat.
- Bhatt, S. (2016), *How Digital Communication Technology Shapes Markets*, Palgrave Macmillan.
- Biagi, F. (2013), “ICT and productivity: A review of the literature”, *Digital Economy Working Papers*, No. 9, European Commission.
- Birkner, M., et al. (2016), *Digital Change – Fair and Just*, Vienna Chamber of Labour, Vienna.
- Blix, M. (2015), *The Economy and Digitalisation*, Confederation of Swedish Enterprise.
- Brynjolfsson, E. and A. McAfee (2014), *The Second Machine Age*, Norton.
- Bughin, J. (2016), *OECD Symposium on Innovation and Inclusive Growth*, Statement by Director of McKinsey Global Institute, Paris.
- Calvino F., C. Criscuolo and C. Menon, “No country for young firms? Start-up dynamics and national policies”, *OECD Science, Technology and Industry Policy Papers*, No. 29, OECD Publishing, Paris.

- Chamber of Labour (2016), *Digital Change – Fair and Just*, Vienna.
- Chaykowski, K. (2017), “Facebook focuses on small businesses with new World Bank, OECD Study”, *Forbes*, 17 January.
- Criscuolo, C., P. Gal and C. Menon (2014), “The dynamics of employment growth: New evidence from 18 countries”, *CEP Discussion Paper*.
- Eurofound (2016), *New Topics, New Tools and Innovative Practices Adopted by the Social Partners*, Publications Office of the European Union, Luxembourg.
- EC (2014), *Report on the Implementation of the Communication ‘Unleashing the Potential of Cloud Computing in Europe’*, Commission Staff Working Document.
- EC (2016), *Country Report: Austria 2016*, Commission Staff Working Document.
- EC (2017a), *Digital Single Market: Country Information Austria*, <https://ec.europa.eu/digital-single-market/en/country-information-austria>
- EC (2017b), *Developing a National Open Innovation Strategy: Five Lessons Learned from the Austrian Example*,
<https://ec.europa.eu/digital-single-market/en/news/developing-national-open-innovation-strategy-five-lessons-learned-austrian-example>
- European Parliamentary Technology Assessment (2016), *The Future of Labour in the Digital Era: Ubiquitous Computing, Virtual Platforms and Real time Production*, Vienna.
- European Service Innovation Centre (2014), *Summary Assessment of Upper Austria*, European Commission.
- Falk, M. and F. Biaggi (2015), “Empirical studies on the impacts of ICT usage in Europe”, *Digital Economy Working Papers*, No. 14, European Commission.
- Federal Economic Chamber (2016), *Austria’s Hidden Champions*, Vienna.
- Ford, M. (2015), *Rise of the Robots*, Basic Books.
- Future of Business Survey (2016), *Future of Business* (an interactive website), OECD, World Bank and Facebook.
- Gregory, T., A. Salomons and U. Zierahn (2016), “Racing with or against the machine? Evidence from Europe”, *Discussion Papers*, No. 16-053, Zentrum Für Europäische Wirtschaftsforschung.
- Hall B., F. Lotti and J. Mairesse (2012), “Evidence on the impact of R&D and ICT investment on innovation and productivity in Italian firms”, *NBER Working Paper* No. 18053.
- Help.gv.at (2017), *Internet für Senioren* (Internet for seniors),
[ahttps://www.help.gv.at/Portal.Node/hlpd/public/content/283/Seite.2830000.html](https://www.help.gv.at/Portal.Node/hlpd/public/content/283/Seite.2830000.html)
- Hüsing, T., W. Korte and E. Dashja (2015), “E-skills in Europe”, *Empirica Working Papers*, November, Bonn.

Iansiti, M. and R. Levien (2004), *The Keystone Advantage: What the New Dynamics of Business Ecosystems Mean for Strategy, Innovation and Sustainability*, Harvard Business Review Press.

Invest in Austria (2017), *How young international companies can profit from the start-up package*, Austrian Business Agency, Vienna.

Koske, I. *et al.* (2014), “The Internet Economy – regulatory challenges and practices”, *OECD Economics Department Working Papers*, No. 1171, OECD Publishing, Paris.

Maihiro Group Austria (2015), Ten Years of Maihiro Austria, company website:http://www.maihiro.com/uploads/media/150717_PM_Ten_years_of_maihiro_Austria.pdf

McKinsey (2016a), *Digital Europe: Pushing the Frontier, Capturing the Benefits*, McKinsey Global Institute.

McKinsey (2016b), *The Age of Analytics: Competing in a Data-Driven World*, McKinsey Global Institute.

Metropole (2017), “Work Council for Food Delivery Service”, 26 April.

Moazed, A. and N. Johnson (2016), *Modern Monopolies: What It Takes to Dominate the 21st Century Economy*, St. Martin’s Press, New-York.

Musset, P. *et al.* (2013), *A Skills beyond School Review of Austria*, OECD Reviews of Vocational Education and Training, OECD Publishing. <http://dx.doi.org/10.1787/9789264200418-en>

Nowotny, E. (1993), “The Austrian social partnership and democracy”, *Department of Economics Working Papers*, No. 1, University of Vienna.

OECD (2007), *Economic Survey of Austria*, OECD publishing.

OECD (2010), *The OECD Innovation Strategy: Getting a Head Start on Tomorrow*, OECD Publishing.

OECD (2011), *Cloud Computing: the Concept, Impacts and the Role of Government Policy*, unclassified document by the Committee on Digital Economy Policy, Paris.

OECD (2013a), *Economic Survey of Austria*, OECD Publishing.

OECD (2013b), *Supporting Investment in Knowledge Capital, Growth and Innovation*, OECD Publishing.

OECD (2013c), *OECD Privacy Guidelines*, in OECD Privacy Framework, OECD Publishing, Paris.

OECD (2014), *Wireless Market Structures and Network Sharing*, unclassified document by the Working Party on Communication Infrastructures and Services Policy, Paris.

OECD (2015a), *Digital Economy Outlook 2015*.

OECD (2015b), *Economic Survey of Austria*, OECD Publishing.

OECD (2015c), *New Skills for the Digital Economy*, OECD Publishing, Paris.

OECD (2015d), *Recommendation of the Council on Digital Security Risk Management for Economic and Social Prosperity*, Paris.

- OECD (2016a), *Skills Matter, Further Results from the Survey of Adult Skills*, OECD Publishing, Paris..
- OECD (2016b), *Automation and Independent Work in a Digital Economy*, Policy Brief on the Future of Work, June.
- OECD (2016c), *Stimulating Digital Innovation for Growth and Inclusiveness*, Background Report, 2016 Ministerial Meeting on the Digital Economy, OECD Publishing, Paris.
- OECD (2016d), “The Global Productivity Slowdown, Technology Divergence and Public Policy: A Firm Level Perspective”, Global Productivity Forum Background Paper, Lisbon.
- OECD (2016e), *Skills for a Digital World*, Background Report, 2016 Ministerial Meeting on the Digital Economy, OECD Publishing, Paris.
- OECD (2016f), *OECD Reviews of School Resources: Austria 2016*, OECD Publishing, Paris.
- OECD (2016g), *Ministerial Declaration on the Digital Economy: Innovation, Growth and Social Prosperity*, (“Cancùn Declaration”), OECD Publishing, Paris.
- OECD (2016h), *Key Facts About the Survey of Adult Skills (What is Assessed)*, OECD Publishing, Paris.
- OECD (2016i), *Recommendation of the Council on Consumer Protection for E-commerce*, OECD Publishing, Paris.
- OECD (2016j), *Consumer Protection in E-commerce: OECD Recommendation*, OECD Publishing, Paris.
- OECD (2017a), *Key Issues for Digital Transformation in the G20*, Report to G-20, OECD Publishing, Paris.
- OECD (2017b), *Going Digital: Making the Transformation Work for Growth and Well-Being* (Forthcoming), OECD Publishing, Paris.
- OECD (2017d), *Getting Skills Right: Financial Incentives for Steering Education and Training*, OECD Publishing, Paris.
- OECD (2017e), *Enabling the Next Production Revolution*, OECD Publishing, Paris (forthcoming).
- OECD (2017f), Indicators of Product Market Regulation Homepage, <http://www.oecd.org/eco/growth/indicatorsofproductmarketregulationhomepage.htm>
- OECD (2017g), *OECD Open Government Data Website*: <http://www.oecd.org/gov/digital-government/open-government-data.htm>
- Ortmann, U. and B. Gohlke (2014), *Leitfaden Technologieakzeptanz: Konzepte zur sozial- und humanverträglichen Gestaltung von Industrie 4.0*, University of Bielefeld, mimeo.
- Pantea, S., F. Biagi and A. Sabadash (2014), “Are ICT displacing workers? Evidence from seven European countries”, *JRC Technical Report, Digital Economy Working Papers*, No. 7.
- Pellizzari, M., F. Biagi, and B. Brecko (2015), “E-skills mismatch: Evidence from International Assessment of Adult Competencies (PIAAC)”, *JRC Technical Reports, Digital Economy Working Papers*, No. 10,.

- Peneder, M., J. Bock-Schappelwein, M. Firgo, O. Fritz and G. Streicher (2016), *Österreich im Wandel der Digitalisierung* (Austria in the process of digitalisation), WIFO, Vienna.
- Roland Berger Consultants (2014), *Industry 4.0*.
- Saia A., D. Andrews and S. Albrizio (2016), “Productivity spill-overs from the global frontier and public policy: industry-level evidence”, *OECD Economics Department Working Papers*, No. 1238, OECD Publishing, Paris.
- Scarpetta, S. and A. Wycoff (2016), “Digitalisation and Future of Work, Introductory Remarks”, Meeting of the OECD Global Parliamentary Network, October.
- Schröder, C. (2016), *Herausforderungen von Industrie 4.0 für den Mittelstand*, Friedrich-Ebert-Stiftung, Bonn.
- Specific-Group Austria (2017), Customer Relationship Management Tools, company website: <https://www.specific-group.at/en/strategy/strategy-themes/customer-relationship-management-tools/>
- Spiezia, V. (2015), “New skills for the digital economy”, mimeo, Vienna.
- Spiezia, V. (2016), “ICTs and jobs: complements or substitutes? The effects of ICT investment on labour demand in 19 OECD countries”, *OECD Economic Studies* (forthcoming).
- Stehrer, R. and R. Stöllinger (2013), *Positioning Austria in the Global Economy: Value Added Trade, International Production Sharing and Global Linkages*, FIW- Research Report No. 2, Vienna Institute for International Economic Studies, Vienna.
- Tellis, G., S. Stremersch and E. Yin (2003), “The international takeoff of new products: The role of economics, culture and country innovativeness”, *Marketing Science*, Spring.
- Torggler, M. (2008), “The functionality and usage of CRM systems”, *International Journal of Electrical, Computer, Energetic, Electronic and Communication Engineering*, Vol. 2, No. 5.
- Van Ark B. (2016), “The productivity paradox of the new digital economy”, *International Productivity Monitor*, No. 31, Fall.
- WEF (2016), *The Future of Jobs and Skills*, World Economic Forum.
- World Bank (2016), *World Development Report: Digital Dividends*.
- World Economic Forum (2016), *The Global Information Technology Report 2016*.
- Ziemann V. (2017), “*Inclusive labour Markets in the Digital Era : the case of Austria*”, *OECD Economics Department Working Papers*, No. 1431, OECD Publishing, Paris.