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Skills, entrepreneurship and new business models

Ways to rejuvenate the German industrial model

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Abstract

New business models are at the heart of the global competitive challenge. In several areas of manufacturing and closely related services industries, new market participants, business models and technologies lead to faster change in market conditions and the competitive environment. These developments pose new challenges for the successful German industrial system. Strategic treatment of innovation, a stronger focus on disruptive technologies or business models, organizational experimentation such as spin-outs to retain entrepreneurial employees, less intra-corporate bureaucracy in such ventures and the interaction with new business partners are key elements to master the evolving challenges. Entrepreneurship, new business models and innovation in rapidly changing markets should be fostered by focused approaches of management and general economic policies. This includes measures to facilitate to entrepreneurship education, an entrepreurial culture and corporate training.

Public policy should strengthen innovation and entrepreneurship through direct funding programmes for research and development of new products. This can be accomplished through a well-designed system of tax exemption of corporate R&D activities and by providing broad tax incentives for implementing new technologies in private investment, in particular by small and medium-sized firms. Public policy should also reform their systems of investment promotion by tax schemes or direct funding in terms of the definition of innovation itself. The same holds for fostering collaborative ventures and an innovation friendly treatment of collateral and liability issues. The goal is to establish a well-capitalized and effective system for innovation financing using private capital sources ranging from seed capital over venture capital up to investment into high tech companies.

Rapid expansion of modern broadband and 5G mobile infrastructure is absolutely essential for new business models and technologies in a broad range of industries. Fostering eGovernment initiatives is highly necessary to cut red tape in public administration. The legal framework improvements in areas such as data protection and use and liability law should reflect openness for new business models and technologies. In this context, a special focus should be laid on digital technologies in public, private and corporate education and training.

1 Introduction

New business models are at the heart of the global competitive challenge. In several areas of manufacturing and closely related services industries, new market participants, business models and technologies lead to faster change in market conditions and the competitive environment. For most companies, a thorough review of their competitive position and their business models has become a must. Management teams must cope with rapidly changing environments and tackle internal barriers to innovation rooted in long-standing organizational structures, business models and technologies. Quite often, well-known technologies are used in new combinations in new fields of business thereby changing the customer relationship, the product itself, the value chain or the methods of obtaining return on the operation (Gassmann et al., 2017; Gassmann/Sutter, 2017; Matzler et al. 2016; Hoffmann et al., 2016). Often, traditional branch borders fall apart, and the pace of change is driven by the rapid implementation of a data-driven business model with high scalability, the use of platforms, data analytics and crowd technologies (McAfee/Brynjolfsson, 2017).

Especially industrial companies must increasingly cope with the impact of new technologies and business models on corporate structure, organization, innovation management, network cooperation, financing and upskilling. The emergence of new competitors in many industries either from low-cost emerging markets or from digitally pioneering tech firms warrants a stronger focus on business performance and challenges than in previous periods. Options of internal adjustment have to be tested in many more companies. This requires an intense use of entrepreneurial spirits, skill formation and strategic planning.

Firms may be able to achieve this by incubating and encouraging spinouts driven by their own innovative staff rather than losing them to the start-up sector. Similarly, firms can more proactively support start-ups within their own corporate ecosystems and maintain some equity within experimental business models, or they cooperate with start-ups providing innovations and new technologies. Special organizational structures can help well-established and successful companies to allow for R&D, experimentation, market testing and the development of new business models. Note that in many instances, companies face the innovator's dilemma (Christensen, 1997), as many have been successful in their established branches for some 100 years or more without revolutionizing their business models.

This paper discusses what should be done if competition from market participants from other industries or start-ups using new business models and offering digitally created customer value, new services or new client interfaces is threatening revenue prospects[1]. It develops key elements of an agenda for an industrial ecosystem that relies on approaches to innovation that include new patterns of cooperation in networks, collaboration with new partners, a strategy of interacting with new players, start-ups or specialized companies, a different set-up in corporate finance reflecting a higher degree of risk and equity needs and a different set-up in terms of skills within the staff and the management teams themselves.

[1] Parts of the paper have been presented at two German-Italian conferences in autumn 2017 and have been revised and updated for this publication.

Section 2 briefly sketches some general features of cultural change driven by digitization and outlines some broader fields of action for structural reforms. Section 3 dives in questions of promoting entrepreneurship to foster the digital transformation. Section 4 looks a little bit deeper on the necessary skills for Industry 4.0, section 5 focuses on the very German aspect of vocational training as a core prerequisite for the supply of a skilled workforce. Section 6 summarizes the main recummendations.

2 The „Great Digital Transformation“: cultural change and policy approaches for structural reforms

Companies considering strategic approaches are doing this not primarily from a cost-reduction and efficiency consideration, but clearly with a view of creating new value added through improved products (both goods and services) and processes, new business models, and new return mechanisms. Digitization and the application of artificial intelligence can bring about numerous benefits in this regard but may also threaten traditional venues of returns. Companies must face these trade-offs head on and owners and managers must engage in sincere strategic debates. In family-owned firms, separation is not an issue. Strategic coherence may prove being a challenge, though.

Whereas new business opportunities stemming from process automation, robotics, improved logistics and predictive maintenance are being implemented first in large leading firms and global players and gradually in the first two layers of suppliers, some of the more recent advances must yet be tried and tested in well-established “mainstream companies”. Advances in several new technologies such as the Internet of Things or “Industry 4.0” (Gerbert et al., 2015), including sensors, Big Data Analytics, artificial intelligence, availability of low-cost and high-performance computing, as well as bionomics and genome editing have created new economic opportunities across a broad range of industrial activities. These technologies are suitable partly for platform approaches and partly require large changes to existing business models with high investments.

Many leading firms in a variety of branches have been developing highly integrated services solutions involving some complex industrial product in the centre of the value chain. The key competitive quality are digital approaches to redefine the use for the customer, to improve the value chain through much higher interaction and use of data and to change the way of getting earnings or to create new earnings potential itself. Usually, this works only if initial stages of delivering the product through e-commerce are already well established by companies (Gassmann/Sutter, 2017). But given the pace of change, fresh approaches to strategic business issues are required. This applies to the introduction of new technologies, changes to the business model and accompanying changes to a lot of horizontal and vertical business processes. A particular focus should be on artificial intelligence as it potential applications are very broad and far-reaching.

Artificial intelligence (AI) is expected to be the driver of the next industrial revolution. As physical machines did partially replace human workforce in the first industrial revolution, with AI it is possible to build systems that imitate and enhance humans´ cognitive capabilities. This will not only lead to totally new types of applications but also to new business models and ecosystems. AI has been identified as key technology for economic growth and welfare in the future, and various nations (China, France, Canada) have developed broad AI strategies supported by large investment plans. It is crucial for Germany's competitiveness in future markets not to fall behind and to develop and execute a fundamental and thorough strategy to exploit the power of AI and to invest in research, talent, start-ups and industries.

Not surprisingly, top-level management addresses company-internal barriers to innovation and risk-taking in established firms themselves more strongly than in the past decades (IW Cologne/Santiago, 2015). Strategic treatment of innovation, a stronger focus on disruptive technologies or business models, organizational experimentation such as spin-outs to retain entrepreneurial employees, less intra-corporate bureaucracy in such ventures and the interaction with new business partners are key elements. As global evidence has shown, in Germany there is often too strong a focus on hardware and the engineering dimension of products and too little a focus on new opportunities provided by new technologies for new business models combining existing technologies from other branches and applying them to new market segments.

However, strategic management should be more prioritized as a consequence of the digital transformation. Companies direct and enable their R&D departments to path-breaking technological developments rather than incremental improvements. Further, companies try to allow for stronger risk-taking by employees in those fields. This can take the form of allowing innovative or entrepreneurial employees to spinout ideas with the support of the mother company, thus retaining value and the employees in the corporate ecosystem. In very large companies, special organizational structures for innovative activities are being developed often in cooperation with new partners from outside the branch and innovation-oriented employees with detailed cross-disciplinary knowledge. Experimental approaches to new business models in well-targeted market segments via these approaches or spinouts need to be implemented in mid-size companies as well.

Business networks between the emerging start-up firms and existing small and medium-sized enterprises (SMEs) are to be encouraged and strengthened. Synergies by combining different disciplines are at the heart of innovation. Innovative companies in the digital sector and small or medium-sized companies in manufacturing industry should co-operate more closely in order to realize bilateral advantages. Networking and bundling of activities are beneficial to both parties. The different mind-sets and organizational structures of start-ups and SMEs could trigger valuable synergy effects. In many cities, new business centres are emerging that allow traditional and new market players to work together in new ways. This development should be encouraged further. Various national and EU programmes designed to alert SMEs to adopt best practices and enter new business opportunities exist already and need to be used more widely, too. Moreover, attractive exit options for founders should be strengthened.

The entrepreneurship and innovation culture is fostered by new initiatives, for example accelerators in citites with a vibrant start-up-scene like Berlin (T3n, 2016). New start-up companies are founded by entrepreneurs. These entrepreneurs are rarely pure scientists but often individuals with a technological or scientific background that have gained experience in business administration, specifically in the high-tech financing environment. Entrepreneurs are typically driven by the motivation to make money by establishing and running a company and taking it to a trade sale, or to a "stand-alone" performance, to translate their ideas into concrete technologies and products and see them "at work"and to work with talented and motivated individuals in an atmosphere that focuses on content and progress and allows for autonomy rather than organizational politics.

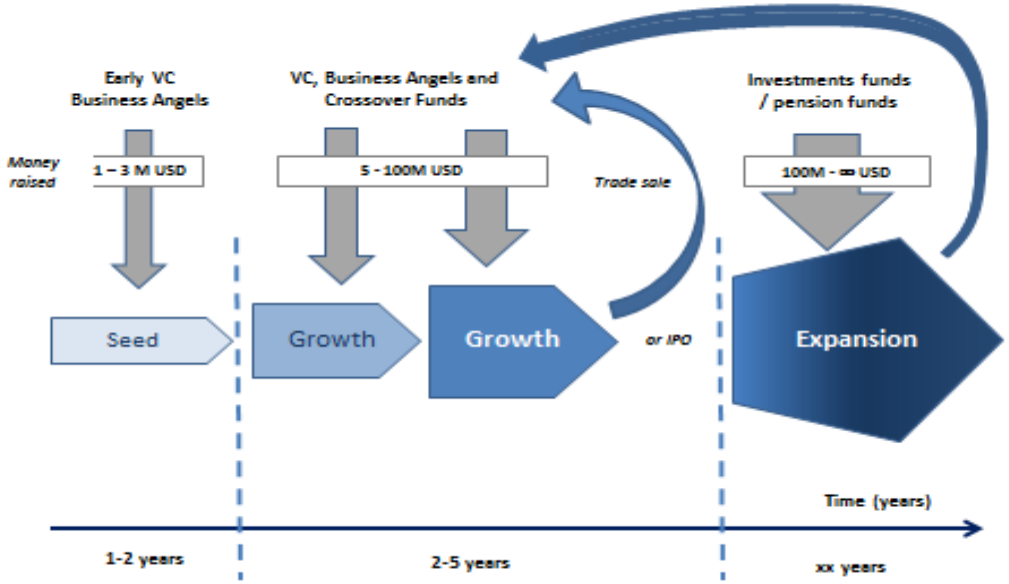
Younger entrepreneurs that missed to create a success story at first trial are typically given a second chance in the US environment. The Silicon Valley profits from young talents from all over the world. Start-up companies are melting pots of nations and races. Successful entrepreneurs are role models for generations of young students to follow their heels in turning good ideas into a successful business story (also Röhl, 2018). It is such an integrative, goal-oriented culture of hard working that creates success stories (box 1).

It should be underlined, however, that Germany must not aim to copy the US environment which would not work for several reasons. Liquidity in German risk capital markets is far smaller (Röhl 2014, 2016b). Also, the long standing attitude of risk aversion cannot be changed overnight. On the other hand, German entrepreneurs have a good tradition of showing responsibility for long standing relationships to employees, investors and customers as well as for environment and high quality craftsmanship. It will be a challenging but rewarding task to define a German prototype of a high tech start-up along with a new role model of a high tech-entrepreneur that does not just imitate US role models but takes good European habits and traditions into account.

Box 1: The US Start up-System

There are some stylized key factors that enable and promote the appearance of new global champions like the GAFA-companies (Google, Alphabet, Facebook, Amazon). Since different types of companies require different amounts of capital, there are differences in the timelines how long this capital is "locked" in a developing company that is typically not profitable. Whereas IT companies have lower investment requirements at the beginning (single digit to low double digit million euros) and whereas the development cycles for software development are typically less than three years, biotechnology, nanotechnology or electro-mobility companies on the other side have much higher capital requirements: a typical biotech company needs 100 to 500 million euros for the development of a new drug if it goes all the way from research to market approval. However, the potential return on investment is reciprocal to the sums invested, at least for the average IT company the returns are substantially lower than for average biotech or other "hardware" based companies. This requires a sophisticated and balanced financing ecosystem with specialized players that focus on certain aspects of the innovation path. Dedicated seed and early stage venture capital (VC) companies provide the first single digit million rounds of investment, late stage VCs or "crossover" funds bridge late private stage and early public stage investment rounds. In addition, huge investment funds that typically manage money from life insurances or pension funds invest into publicly quoted companies with a market capitalization above 500 million US-dollars.

Figure 1: Stylized Life Cycle of Innovation Financing in the United States



Source: BDI / Confindustria, 2017

There are some features that are unique to this specific American start-up ecosystem of innovation financing, in particular:

- Early stage investors with a deep knowledge of science and technology.
- All early to mid-stage investments are performed as "equity" investments. Debt financing plays no role in this system since the credit rating of such start-up companies is typically inacceptable. The participation in shares allows the investors to participate in the full upside potential of the company.
- Since in the US the retirement arrangements are organized through private pension funds and insurance companies, there is a capital pressure to invest into such high yield – high risk investments besides traditional investment types such as public companies and bonds. This has created the huge US capital market from which such start-up high tech companies benefit.
- There are at least two exit channels for early stage investors available: a) the trade sale to a larger company or b) the IPO on the stock market, typically the NASDAQ. The IPO typically provides for higher returns and a public quotation may even ease the exit through a trade sale since the valuation is already provided by the market.

In sum, in the US there is a sophisticated system which provides capital from seed stage up to expansion to global leadership which offers benefits and returns to all player at different stages throughout the life cycle of a new company. In Europe, in contrast to the US, such a powerful and sophisticated system has not evolved. Europe does have only very few "iconic" (i.e. role model-type) IT, telecommunication or biotechnology companies with global leadership in a certain area.

Besides the focus on start-up-culture, Germany should carefully evaluate product market reform in highly regulated or publicly dominated market segments, especially in the service sector

(Koske et al., 2015). Efficient rules and regulations and competent administrative behaviour pertaining to starting new companies as well as to a firm's exit from the market are important elements in competitive product markets. Entrepreneurship thrives if product markets are regulated in a competitive manner. Since 2007, only modest pro-competitive product market reforms occurred in Germany (Koske et al., 2015). However, the number of recommendations on product market reforms from the OECD and other advisory bodies remained pretty large (e.g. OECD, 2018a, Country Report Germany). In a number of sectors, either a strong role of the state as owner or a restrained role of the private sector as a consequence of regulation are still relevant. This plays a role in sectors such as transportation, finance, telecommunications, local government services or the regulated professions in Germany (Röhl, 2016a, for a discussion of local government services). In sectors such as transport and health, it is clear that technology is now far ahead of regulation and that old-style regulation is becoming a growing obstacle to innovation. Given the scope of technology, a more experimental regulatory phase is essential to learn what degree and type of regulation is appropriate to the new technologies (Federal Ministry, 2017).

Innovation policy must use a broad mix of well-designed policies promoting innovation, not only in terms of using new technologies, but also in fostering the development of new business models of delivering products to society. Encouraging and strengthening companies in their efforts of doing so requires a balanced set of specific public policies. Public policy should strengthen innovation and entrepreneurship through directly funding programmes for research and development of new products, through a well-designed system of tax exemption of corporate R&D activities (Berger et al, 2017, 52) and by providing broad tax incentives for implementing new digital technologies in private investment. This is of particular importance for small and medium-sized firms which need to quickly adapt to the productivity developments and the digital capabilities of national or global frontier firms. Appropriate policy measures can involve simple means like faster or immediate depreciation of capital investments in research and experimental equipment or infrastructure.

Rapid expansion of modern broadband and 5G mobile infrastructure is absolutely essential for new business models and technologies in a broad range of industries. In Germany, Fostering eGovernment initiatives is warranted, too. Digital infrastructure is of rapidly increasing importance. Germany is lagging behind, the uptake of fast broadband services is still below EU-average, as are digital public services. In the latter area, Germany is ranked 14th out of 28 (Europäische Kommission, 2018). The low level of digitization of the administration has severe consequences for companies. To accelerate administrative procedures, therefore, is of major relevance. In Estonia, a pioneer in the field of digital administration, it takes around 20 minutes to register a new company; in Germany more than 10 days can pass (World Bank, 2017, 87). Improving connectivity, e.g. the availability of fast and cheap broadband connections, boosting digital skills and the use of online services, e-commerce, cloud services and digital public services rank top on the agenda of speeding up digital infrastructure in Germany.

Public policy should clearly address the provision of cyber security. Public infrastructure becomes ever more facetted, including not only physical features like the broadband coverage. Firstly, cyber security is the safety belt of the digital society, essential for prosperity and peace

in the EU and by this very nature part of the necessary public infrastructure (Engels, 2017). By supporting cyber security as a vital strategic interest of the EU; national governments and companies simultaneously have to keep pace with the development of internet crime. In order to succeed, however, responsibilities and resources have to be assigned quickly and clear deadlines for implementation should be set – otherwise the strategy could prove too weak once again.

Standard setting in the digital field has to be promoted. The public, semi-public and private standard setting processes must be fostered. Without the legal infrastructure of standards coping with data loss at system interfaces becomes prohibitively expensive. The likelihood of adopting standards increases with the existence of a corporate digital strategy, the level of turnover and the number of partner companies. The absence of standardization acts as a brake on digitization. While standards are indispensable for digital transformation, companies only start adopting them when they are already at an advanced stage in the process.

The legal framework improvements in areas such as data protection and use and liability law should reflect openness for new business models and technologies. Another infrastructural pillar is the completion of a digital single market with a single European data space. Data should flow across national borders. National rules such as the German Data Retention Law should be opened up, incentives to share data should be set in a way that innovation and competition will increase, and data portability and interoperability, e.g. between cloud service providers, should be increased. Other legal aspects, such as liability for damage caused by autonomous systems – like autonomous cars – must also be revised.

3 Promoting entrepreneurship in public policies

Following the Coalition Treaty as of February 2018, Germany seems to be willing to engage in a more coherent strategy for the financing of new companies. Unfortunately, this does not include yet, for instance, promoting private pension systems with the right to invest in all stages of the corporate development cycle and an investor friendly public technology market (Roland Berger/IEF/BVK, 2018; OECD, 2018b). Entrepreneurs need a pan-European high tech stock exchange similar to NASDAQ. The United States (and potentially only Israel as a more recent example) have been very strong in establishing novel companies with breakthrough technologies that turned out to elicit massive changes in certain fields of the economy. Classical examples for such “disruptive” start-up companies that became global leaders are the GAFA-companies in the IT sector while Genentech, Amgen, Celgene and Gilead had a similar disruptive role in the biopharmaceutical sector and Tesla has paved the way for electro-mobility.

New firms, start-ups and their financiers should receive beneficial taxation treatment as in the majority of other OECD countries, including France, Austria, Switzerland and the U.K. The goal is to establish a well-capitalized and effective system for innovation financing using private capital sources ranging from seed capital or venture capital up to investment into public high tech companies. The share of SMEs active in continuous R&D activity has fallen in Germany in the

recent years and investment in new machines and new technology is seen by many as inadequate. While start-up-activity in the two German "hotspots" Berlin and Munich is on the rise, the number of new companies overall is receding in Germany. Additionally, only few new companies are technology-driven (Murmann, 2017).

To address these problems, firstly a R&D tax incentive should be introduced in Germany. Up to now, R&D policy in Germany has not made use of R&D funding through tax credits while direct funding programmes have only a limited reach to companies. The effectiveness of R&D funding through tax credits has been demonstrated in numerous international studies (European Commission, 2017a). The positive effects are particularly marked in the case of SMEs. The level of the tax credit should be proportional to the level of R&D personnel costs. Even businesses with no profit-tax liability – e.g. start-ups and SMEs in a restructuring phase – could benefit regularly from the cash-flow effects of this form of tax relief.

Secondly, company investment in new technology could be boosted by more favourable depreciation rules. Thirdly, taxation rules for young companies (e.g., up to five years old) should be simplified (including "Ist-Besteuerung in der Umsatzsteuer", i.e. actual taxation instead of imputed taxation). Forthly, ending the restrictive treatment of loss carry forwards is overdue. The Act on the Further Development of Tax Loss Carryforwards for Corporations (Gesetz zur Weiterentwicklung der steuerlichen Verlustverrechnung bei Körperschaften), which was passed in December 2016, slightly improved financing incentives. More needs to be done.

Furthermore, the EXIST-programmes should be expanded, since they are characterized by rather low numbers of supported start-ups. In Germany, the number of entrepreneurship and entrepreneurship research professorships at universities has risen to approximately 130 in recent years (Röhl, 2016b). A federal programme supports entrepreneurial activity from university staff. Nevertheless, entrepreneurial activity of academic staff and students is far lower than in the United States. Many students aim for positions in established companies or government, as the entrepreneurial culture remains underdeveloped and risk-aversion is high.

Recent initiatives in Germany to improve EXIST and INVEST programmes, to bring about the third High-Tech Gründerfonds funded by public and private players and to start Coparion as a large public co-investor are laudable steps. Better tax rules for some of those programmes would be clearly beneficial as well. In addition, ERP funds of KfW are designed to help start-ups, often in combination with credit support from EU programmes. In Germany, KfW will strengthen the promotion of private VC funds devoted to second-phase start-ups by a separate subsidiary devoted to co-investment in due course. More policy attention will have to be devoted to encourage institutional investors to invest in such funds, to provide for stronger incentives and to use public co-investment from either the EIB, national promotional banks or other public resources more consistently.

Public policies must reflect the changing nature of investment and economic activity in the wake of digitization and adjust the instruments of investment promotion accordingly. A correction of their business model, however, does pose an even bigger problem as banks find it increasingly difficult to fund on intangibles, patents, new business model ideas and similar others that are

difficult to collateralize (Thum-Thysen et al., 2017). The provision of equity and debt to well established firms engaging in a mid-sized capital markets must cope with higher degrees of uncertainty, bank capital regulation not well suited for the treatment of immaterial goods (patents, software, design, organizational capital), collateral issues in banking on digital value chains and public polices of investment promotion designed for equipment or construction but not for new business models and softer factors.

Governments and national banking systems should be looking at both banking and policy adjustments required to make their financing systems fit for a growing number of non-traditional investment needs. Public policy should also reform their systems of investment promotion by tax schemes or direct funding in terms of the definition of innovation itself, the types of corporate activities viable for support, the role of collaborative ventures (perhaps requiring joint applications), the treatment of collateral and liability issues in a digitizing economy and several other parameters that were fit for the classic manufacturing world but do not work well today. Also, public policies should aim at allowing more freedom to invest in public, pre-IPO and early stage private companies.

Policies pertaining to industrial start-ups should be reviewed thoroughly. Often, up-front R&D, prototyping and production costs will have to be covered by external funds for many years. Investment promotion and VC funding is still ill-suited to manage several years of rather high up-front expenditure until an industrial start-up becomes commercially viable. Improved start-up funding by better tax treatment, public co-funding (national and EU-wide) and higher levels of co-investment in private funds by national and EU promotional banks is crucial. Also, a favourable tax treatment of established companies that form entrepreneurial high-tech spinouts would facilitate a trend to equity investing by the existing corporate sector.

In Germany, public policies should be adjusted in several very specific regulatory and tax issue areas in order to facilitate industrial start-ups (BDI, 2016). A stronger involvement of specialized private investors (business angels, anchor investors), institutional investors and pan-European VC funds is needed. Governments should set themselves ambitious goals for the provisioning of VC capital as per cent of GDP. A clear target should be set up. Venture capital‘s (VC) share of gross domestic product should be doubled to 0.06 percent by 2025 – compared to 0.03 percent of GDP now. Compared to other countries, too little support is provided by private funding sources in Germany for start-up funding in the early phase, and particularly during the growth phase.

The German Commission of Experts calls for more commitment from private players, especially from large enterprises (EFI, 2018). For example, in the context of the High-Tech Gründerfonds III, private players could contribute a much larger share of funding than in the case of its predecessor funds. Potential anchor investors – e.g. life insurers – are often hesitant because of restrictive regulations in this segment. For this reason, the framework conditions for institutional investors in Germany should be designed in such a way that investments in VC funds that finance innovative growth businesses are supported, and the emergence of recognised anchor investors is facilitated.

Additionally, the introduction of targeted research funding for start-ups may contribute in a special way to managing digital change. Up to now, the concerns of start-ups have not been sufficiently taken into account in R&D funding. Extending the EXIST programme by adding a further research component which is based on the established EXIST start-up grants gives those supported an opportunity to finance staff that might be required for short-term research needs that crop up in the course of building their company. In the existing funding programmes greater efforts should also be made to extend support to young companies that are already established on the market.

While programs to support company establishment are inexpensive and attractive, the real issue is the provision of capital in the growth phase to SMEs trying to bring products to the market. Successful entrepreneurs with market impact evolve into high-growth companies needing adequate financing. It is not sensible to encourage a generation of entrepreneurs only to have a large number immediately when larger capital sums are required. This means that in addition to early stage capital, it is essential to address growth capital as well as incentives for company formation.

The barriers to get external capital from banks are rather low for companies in Germany, due to the extremely low interest rates. But new companies without collateral have often difficulties in obtaining bank loans or lease finance. Especially technology-oriented enterprises have to rely on equity, which is much more difficult to obtain (Röhl, 2014). Consequently, Venture Capital investments are still far too low in Germany and most European countries compared to the US and Israel (Röhl, 2018). While some changes for the better have been decided on in the last four years, a VC-legislation that could bring about a dramatic change is still pending.

Administrative costs for start-ups should be lowered, the time for starting a business shortened, the access to public venture capital funding eased and the opportunities of eGovernment for reducing bureaucratic procedures should be used. The administrative obstacles for start-ups are large by international comparison and must be reduced (Worldbank, 2017). A starting point could be the project known as Point of Single Contact. However, this project still needs to be efficiently implemented in order to give start-ups access to all necessary information and procedural rules of the public administration. Furthermore, it is vital to take the specific interests of young companies into account in the design and implementation of funding programmes. Possible scope for discretion should be used generously in favour of young companies.

A regulatory environment encouraging entrepreneurship can be seen as main ingredient to bring about more new enterprises, besides an entrepreneurial culture and favourable taxation. In the yearly international “Doing Business” report by the World Bank (2017), Germany has fallen back in recent years in the ranking for starting a new business, as other countries have introduced reforms to alleviate the regulatory burden. Germany now ranks at 113th place. Still, nine application procedures are necessary taking on average 10.5 days. As it seems to be impossible to reduce the number of required procedures, efforts should focus on bundling the necessary bureaucracy at “one-stop-shops” as Points of Single Contact for entrepreneurs.

Since Germany is lagging behind its main competitors in the areas of eGovernment and digitization, the potential offered by eGovernment must be fully utilised. It is insufficient to augment existing procedures with online capabilities. Instead, entirely new simplified routines have to be created for eGovernment to develop its full potential. Best practice examples from other countries like Estonia do exist to look for advice in this undertaking. Besides Estonia and the Scandinavian countries, Austria is an EU country with a political system similar to Germany and the same language that is ranking above Germany in eGovernment services, providing better practice examples for Germany (European Commission, 2017b).

Finally, a new entrepreneurial culture should be encouraged using the potential of already existing entrepreneurs. Several steps are important: Teaching entrepreneurial culture is important. Providing role models for young students, scientists and engineers is even more important. Strengthening an alumni culture at EU-universities by inviting entrepreneurs to spread their spirit in evening talks could become a means to “infect” students to take their fate into their own hands. Work on the perception of entrepreneurs as key drivers of welfare and progress is necessary. Rewarding entrepreneurship through prizes, public laudations and positive media stories is important. Entrepreneurial MBA-like training could be incorporated into higher degrees. This means funding places for at least 20 per cent of PhD candidates in the MBA system as part of the overall training system. Germany desperately needs a new narrative of successful high tech entrepreneurs. Journalists, internet bloggers and other media professionals should work together to help defining EU-wide role models of entrepreneurship.

4 Emerging skills for Industry 4.0

The quality of an education and training system can best be judged by the results it produces for young people and companies through its performance across key success criteria. Roughly seven million young Europeans between the age of 15 and 25 are neither training nor working (NEET). On the contrary, the low level of youth unemployment in countries with dual training systems is striking: in 2017 Germany had the lowest youth unemployment rate with 7.2 percent (EU average: 20.3 percent), followed by Austria (10.6 percent) and Denmark (10.8 percent) - also countries with dual training systems.

Representative surveys of German companies on the prevalence of digitised models of doing business and their impact on skill requirements and human resource management suggest: four-fifths of the companies are computerized, but only a minority of companies (20 percent) is digitized, so that at least products and processes are mapped digitally. Only 2 percent of the companies have at least partially implemented processes that decide autonomously and independently (IW Consult, 2018, 58). A small vanguard of four per cent of German businesses not only deal intensively with digitization in all areas of business, such as finance, HR, sales, transport, production, procurement/purchasing departments, but also deem the internet highly significant for a variety of different purposes, such as recruiting, and using cloud services or data exchanges between machines and devices within the firm and beyond the boundaries of the company.The prevalence of doing business more digitally is more likely in service industries that are closely affiliated to manufacturing and provide services for other companies (B2B).

Companies belonging to the group of advanced businesses exhibit interesting features: The proportion of employees working with the internet and exploiting its potential for professional purposes is larger in advanced firms than in less advanced firms (IW Consult, 2018, 325ff). Moreover, the workforce is typically composed of a larger proportion of young and highly skilled people. Employees of digitised companies are increasingly expected to have a good command of IT and online skills, and this trend will continue to be relevant. The same applies to occupation- and firm-specific skills that can be acquired, maintained, transformed and expanded by learning on the job and with increasing work experience. But there is still a big divide between large companies and SMEs concerning the use of digital technologies (Demary et al., 2016).

The efficient and effective application of digital technologies requires a profound occupation-specific qualification. In addition, workers should be able to plan and organise their tasks on their own while cooperating and smartly communicating with colleagues and external collaborators. Digitised companies are aware of the need for pre-emptive action to empower employees to deal with challenges as they arise. The companies are not only more engaged in the policies and practices of developing employees' skills on the job, but also provide more formal training than conventional firms do.

Under the auspices of Industry 4.0, there is an intense debate as to how the German education and training system can remain attractive in competition with programmes offered by tertiary institutions when it comes to digital transformation. This is important because specialist staff are already in short supply (Burstedde et al., 2018). Addressing the challenges arising in an increasingly digital world will require an overhaul of current employment and skills policies. The overarching aim of all acitivities should be to prevent a "digital divide" for pupils, apprentices, students and companies.

There are some key priorities for skill policies to facilitate take-up of the opportunities of a digitized economy. To begin with, cultural change should begin at an early point in life – that is, already at school. Initial education should equip all students with basic ICT skills as well as solid literacy, numeracy and problem-solving skills to use ICT effectively. Many of these skills are acquired also outside education and training institutions – for instance, in the workplace – emphasising the need to recognise skills acquired outside formal channels. All teachers have digital competences and can convey them. Digital education offers are checked on a regular basis to see if it's up-to-date. Teachers should use digital learning platforms in a responsible manner in order to obtain systematized information on the learning progress of the students and to obtain the best individual support.

Education and training systems need to better assess and anticipate changing skill needs in order to adapt programmes and pathways offered and guide students and apprentices towards choices that lead to good outcomes. Big data can be harnessed to complement labour market information systems and monitor changing needs. All learners must be able to use competently digital media and be able to participate in the digital world in a self-determined and responsible manner. As a matter of course, all learners also use digital media for educational purposes.

The use of skills at the workplace, including reading, numeracy and problem solving in a technologically-rich environment, varies substantially across countries. A key factor driving this variation is the use of high performance work practices such as teamwork, work autonomy, training, flexible work hours, etc. Thus it is important to promote better work organisation and management practices within firms and across the economy, as well as fostering the skills needed to support these practices. Training for workers to keep up with new skill requirements is crucial and requires offering better incentives for workers and firms to re-skill and up-skill. At the same time, the diffusion of "on-demand" jobs on digital platforms puts increasing responsibility on individuals for managing their own skills development.

Ensuring high-performance digital infrastructures has high priority. All educational institutions in Germany must be connected to the gigabit network via a broadband connection and cloud solutions, have uniform interfaces and compatible interoperable offers for learning with digital media. Educational institutions should have centralized IT infrastructures, where they have access to resources for operation and maintenance. Bring your own device (BYOD) as a way of accessing learning with digital media should be used more often to ensure the participation of all students. Cloud technologies enable interdisciplinary deployment as well as multidisciplinary application scenarios. A school and possibly cross-country school cloud should become the core element of the digital school in the 21st century.

For the higher education system, barriers between faculties, especially engineering and computer sciences departments, should be removed, e.g. by implementing combined MBAs for higher degree students. Up to now, co-operation across faculty boundaries is very limited at German universities compared to the US and UK, hampering efforts to develop Industry 4.0-technologies. Additionally, barriers between theory-oriented education in computer science departments at German universities and software development education, based mainly at Technical Colleges (Fachhochschulen), should be removed. To the contrary, in leading American universities like Stanford or the MIT, 40 to 50 percent of start-ups are focussed on developing new software – a research and education agenda largely ignored at German universities.

Massive open online courses (MOOC) are an appropriate way to teach basic informatics and software skills. Online courses are a very effective way to teach classes on entrepreneurship particularly to those who have already entered the labour market or are at a later stage of the education system. This applies especially to the mostly young refugees that have entered Germany during the last years, and who often come from a culture that is characterised by high numbers of self-employed people (Röhl, 2016b). To strengthen entrepreneurship education at universities, MOOCs should be used to reach more students. A similar approach should be used to teach basic skills in informatics and data sciences.

5 A special focus on vocational training

Vocational training ought to be more attractive for young people, and the provision of basic competences in reading, writing and numeracy has to be improved. The skills that young people acquire in the training should be better suited to the actual needs of the companies, especially

when it comes to facing the digital transformation of our economies. Training regulations are formulated in a manner that is technology-neutral and open-structured. This enables companies to familiarise trainees with the latest technologies and processes.

In Germany vocational training seems to be highly valued in society. Nearly every second student in each annual cohort enters Vocational Education and Training (VET). But currently there is a strong trend towards university education threatening the status of VET. It becomes increasingly clear that the learning of training content in the real working environment prepares better for the job than the purely theoretical concentration with the future job. However, there is no single silver bullet for the design of the vocational education and training. Policy makers and companies in Germany must tailor their qualification setup for the digital economy, providing a sufficient level of technical proficiency, enough Science, Technology, Engineering, Mathmatics (STEM) qualifications, a good match of vocational and academic expertise and a fluent permeability between both of them.

Vocational training must be made more attractive by offering digital-assisted education. Professionally relevant digital competencies are acquired and are continually refreshed as part of the training and further training. Degrees of digital-assisted learning offers are equivalent to face-to-face training measures. The quality of digital education offers is ensured and easily understood by the users, e.g. by means of quality labels or signets. Digitization also opens new opportunities for innovation in learning infrastructure. Again, MOOCs and OERs (open educational resources) already offer opportunities to learn for many workers. Quality proved OER should augment didactically elaborated and tailor made vocational training programmes.

Germany's formal system of qualifications largely ranks those who have completed advanced vocational training, e.g. qualifying as a Master or Technician, on a par with university graduates with a bachelor's degree. Evidence shows not only that further vocational training ensures considerable career advancement over a first vocational qualification but also that those with advanced vocational training do indeed reach approximately the same income levels as those with a university degree. The majority of companies value the competences of those with advanced vocational training sufficiently to pay this group salaries roughly comparable to those of bachelor graduates (Flake et al., 2017).

Overall, however, since both groups are in themselves very diverse, neither can be said to have consistently better income prospects. Rather, the results depend on numerous additional factors such as subject area, the tasks actually performed and the sort of qualification obtained. But still further progress in terms of permeability between vocational and academic training has to be made, providing more opportunities for upward mobility and career perspectives. Guiding principle should be, that VET is not considered to be a second choice for many youths if they do not have the possibility to go to university. It is important to conscientise the population about the significance of VET. Vocational guidance needs to be strengthened as it can contribute to the dissemination of knowledge about the career perspectives with VET. It is no deadend but an equally viable path to jobs, career and income (Flake et al., 2017).

Some structural aspects in Germany's dual system are on the table: Youth and their parents find a vocational training programme particularly appealing if it leaves the door open for further education. Vocational training is especially successful if it keeps up with the constant changes of the working world. Adaptability to current trends and permeability to tertiary training are crucial. This is an important signal for young persons and emphasises the value of VET certificates. Lastly, the modernization of training regulation must address the requirements of digitization. The quality in the vocational schools has to be ensured, the digitization firmly established and workplace-based cooperation must be strengthened. The vocational schools have to be appropriately equipped, their independence is to be strengthened. Further training has to secure the digital competences of apprentices and teachers.

Especially at secondary schools, a comprehensive career guidance system should be established in order to inform young people and parents about attractive career- and development perspectives based on dual vocational (initial) training within higher vocational training. It is thus possible to reduce the high number of university drop outs and possible resulting economic disadvantages. The recognition of competencies acquired in the other educational sector, in accordance with transparent and comprehensible criteria, is to be implemented quickly in all institutions. The opening up of higher education institutions for vocationally qualified people without highschool degree (Abitur) is to be pushed forward, the proportion of students without a high school diploma has to be increased.

A comprehensive offer has to be developed for young people, who are interested in both theoretical and practical knowledge (higher vocational training). They should be offered a combination of upper secondary education and vocational training to acquire a double qualification, consisting of a degree of dual vocational (initial) education (for example journeyman, specialist) and the general university entrance qualification. The aim of higher vocational training is to ensure further professional training in step with actual practice-oriented learning and to offer a deeper level of professionalism even without a university education that is more application-oriented. In order to be able to achieve higher vocational training, the training and further education regulations must be coordinated structurally and in curricular terms within the framework of the Vocational Training Act and the Handicrafts Regulation.

There is a clear need to develop new learning places in times of digital transformation. Vocational training and competence centers should be able to turn into higher education institutions. They should cooperate with application-oriented universities, offering joint learning formats (e.g. digital learning offers) or the exchange of lecturers. In this way a continuous innovation and technology transfer, especially with regard to the digitization of the economy, should be pushed. Quality assurance is guaranteed by a national standard, which also covers the qualifications of the teaching staff.

In order to be able to quickly implement innovations from research and development, e.g. in the field of Industry 4.0, into SMEs, the institutional, legal and educational policies for dual study courses need to be professionalized. In addition, the establishment of clear standards can ensure quality on the one hand and the practical relevance for the labor market and in-company vocational training on the other hand. The concept of the training-integrated dual studies fulfils

these essential conditions: the combination of a study at a university or academy with a practical vocational training in the company. But the equivalence of professional and academic education must be acknowledged monetarily as well. Therefore, existing scholarship schemes and the "Meister-Bafög" should be extended in order to provide financial support for the participants in higher education courses.

6 Ten recommendations for a viable industrial ecosystem

The following ten recommendations – addressing company leaders as well as decision makers in economic policy – are essential to secure the viability of the successful German industrial ecosystem in the future, given the challenges of digitization, demographic change and rising competition:

1. Companies should consider a strategic treatment of innovation with a stronger focus on disruptive technologies or business models. Organizational experimentation such as spin-outs to retain entrepreneurial employees, less intra-corporate bureaucracy in such ventures and the interaction with new business partners are key elements.
2. Entrepreneurship and new business models and innovation in rapidly changing markets should be fostered by focused approaches of management and general economic policies to strengthen entrepreneurship education.
3. Governments should carefully evaluate product market reform in highly regulated or publicly dominated market segments like the liberal professions and communal services and shift public policies to a pro-competitive market environment.
4. Public policy should strengthen innovation and entrepreneurship through direct funding programmes for research and development, through a well-designed system of tax exemption of corporate R&D activities and by providing tax incentives for implementing new digital technologies in private investment, in particular by small and medium-sized firms.
5. The rapid expansion of modern broadband and 5G mobile infrastructure is absolutely essential for new business models and technologies in a broad range of industries.
6. Fostering eGovernment initiatives is highly necessary to cut red tape in public administration and speed up procedures in public administration.
7. The legal framework improvements in areas such as data protection and use and liability law should not impede new business models and technologies by ex ante-regulations.
8. New firms, start-ups and their funding should receive beneficial taxation treatment in a variety of ways as in several other OECD countries. The goal is to establish a well-capitalized and effective system for innovation financing using private capital sources ranging from seed capital over venture capital up to investment into high tech companies listed at the stock exchange.

9. Initial education should equip all students with basic ICT skills as well as solid literacy, numeracy and problem-solving skills to use ICT effectively. All educational institutions in Germany must be connected to the gigabit network via a broadband connection and cloud solutions, have uniform interfaces and compatible interoperable offers for learning with digital media.
10. Vocational training must be made more attractive by offering digital-assisted education. New learning places should be developed. Further progress in terms of permeability between vocational and academic training has to be made. The mutual recognition of competencies acquired has to be improved quickly.

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