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Labor-based Innovation: The Advantage of Skills and Education

Innovación basada en el Trabajo: La ventaja de las habilidades y la educación



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I. INTRODUCTION: DIVERSITIES OF THE WORKFORCE

Western economies rely in great part on a constant stream of innovation in order for their economies to grow and prosper. It has become a necessity for most nations around the globe in order to be competitive. Historically, all of these innovations have relied on the development of new skills and have, albeit sometimes drastic changes to the labor force, resulted in a steady supply of employment parallel to changes in the nature of work. Labor and the changing demands and requirements to the labor force have been the common denominator of all if these developments dating back as far as the steam engine – and yet when we look at most of the economic literature and policy recommendations in recent years related to digitalization and innovation policy they are mostly focused on improving business environments, strengthening investment incentives and expanding university-industry partnerships (Campbell 2017, Ivascu et al. 2016, Huang & Chen 2017). Innovation policy is developed in the nexus between industry, government and university, but where does this leave labor, the active part that made all of these innovations in the past a reality?

Product innovation is a socio-economically crucial aspect of economic activity and society. Our very economic models are dependent on an ever-evolving drive forward and stagnation is essentially retraction. Innovations require process changes and therefore skills, training and education need to match these new requirements (Kohnke 2017). While innovation has always had extensive effects on the workforce



EXECUTIVE SUMMARY

Innovation has become a necessity for our economic models and new developments in science and technology are the requirement for progress and economic growth. Historically, the labor force has been able to adjust amidst transition difficulties to these new requirements, but the speed of innovation and of the adjustments needed is expedited in light of Industry 4.0 and the New Digital Era. Labor, however, continues to be the puzzle piece that makes innovations possible and products marketable. The innovation impact of a skilled labor force is obvious and evidenced by how regional developments have varied (especially after the 2007/8 crisis) along the cleavages of industrial sectors (manufacturing vs. services) and skills portfolios of the workforce. Regional diversities of innovation and skills are a key aspect that matter in workforce changes and requirements. Social partners play an important role in this context and a shared responsibility for education and training between employers and unions may serve as a solution to the possible blow of threats and changes to the workforce by new technologies. Long-term, foresightful industrial policy can assure workers skills match the needs of industry, a smoother and improved process in the value chain, and a better transition into manufacturing with advanced technologies.

RESUMEN DEL ARTÍCULO

La innovación se ha convertido en una necesidad para nuestros modelos económicos y los avances en ciencia y tecnología son requisito indispensable para el progreso y el crecimiento económico. Históricamente, la fuerza de trabajo ha sido capaz de ajustarse a estos nuevos requisitos a pesar de las dificultades en la transición, pero hoy en día la velocidad de innovación y de los ajustes necesarios se han acelerado con la Industria 4.0 y la Nueva Era Digital. El trabajo, sin embargo, sigue siendo la pieza del rompecabezas que hace que las innovaciones sean posibles y los productos comercializables. El impacto en la innovación de una mano de obra cualificada es evidente y se refleja en la forma en que los desarrollos regionales han variado (especialmente después de la crisis de 2007/8) en función de las divisiones de los sectores industriales (fabricación frente a servicios) y las distintas competencias de la fuerza de trabajo. Las diversidades regionales en términos de innovación y habilidades son un aspecto clave que influye en los cambios y requisitos de la fuerza de trabajo. Los interlocutores sociales desempeñan un papel importante en este contexto y una responsabilidad compartida de la educación y la formación entre empleadores y sindicatos puede servir como solución al posible impacto de amenazas y cambios en la fuerza de trabajo por parte de las nuevas tecnologías. Una política industrial a largo plazo y previsoras puede garantizar que las habilidades de los trabajadores coincidan con las necesidades de la industria, un proceso más ajustado y mejorado en la cadena de valor, y una mejor transición a la fabricación con tecnologías avanzadas.

since the First Industrial Revolution, policy making, welfare systems and education have – at least in the developed world – been able to cushion most of the effects, and with generational transitions actually positively impacted employment and working conditions.

The question remains whether this new wave of innovation, the rise of the Digital Era, will follow along the same pattern or whether it reflects a paradigm change in the nature of innovation. Industrialization and globalization came along with a diversity of different levels of development across the globe and innovation therefore varies between countries, societies, the strength of their industrial sectors and the products and product groups being manufactured (Hirsch-Kreinsen 2017, Rajnai & Kocsis 2017).

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Regardless of the types of industries, the products and the technology level of nations, the balance of skills that are available in society and those required for the available jobs needs to be maintained in order to achieve sustainability in economic development, innovation capacity and growth. Appropriate labor for the regional and industrial realities becomes a key for socio-economic growth and marketable innovations (Peluffo & Silva 2018, Vivarelli 2018). Labor can only develop industry and the innovation economy, and strengthen its innovative capacity when jobs are available in the region or country with the corresponding skill demands.

Without these jobs, skilled labor cannot contribute to socio-economic development and transitional costs are accrued (e.g. unemployment of skilled labor, see the example of Spain in the late 2000s and early 2010s, outward migration of skilled labor and abandonment of less innovative national environments). Innovation and labor policy are two faces of the same coin, each needed in sustainable industrial policy making. *Diversities of labor* and available jobs are therefore crucial for nations, regions and metropolitan innovation performance. Those very diversities allow for innovation in several industries, throughout the value chain and synergy of industries with new technologies.

2. ECONOMIC DEVELOPMENT BASED ON INNOVATION DEMANDS FOR SKILLED LABOR

New technological advancements offer a variety of opportunities for businesses and new product developments. New production methods offer cost cuts in the manufacturing process due to more

advanced industrial technology and allows companies to focus more on developing high-quality products and exploit the technologies to the maximum for their improvement. This process has accompanied most of technological advances since the Third Industrial Revolution, when electronic machinery was introduced in the manufacturing process. Throughout these changes, manufacturing jobs have already become more sophisticated and advanced – and turned the industrially employed craftsman into a blue-collar factory worker (Burmeister 2018).

In light of digital technology such as the Internet of Things (IoT), digital assistance systems and Artificial Intelligence (AI), this process is accelerated and boosted – especially in developed Western economies. Blue-collar jobs continue to be upgraded and the lines between blue-collar workers and shop floor white-collar workers relating to their skills are increasingly blurry (Christensen 2019). An increased number of university-trained labor in manufacturing such as engineers and technicians only added to this process and companies made a noticeable effort in attracting this labor that is required for their growth and innovation (Matkovićová & Szarková 2019; Kaur et al. 2018).

Innovation and new products are based on the appropriate labor for these sectors. And while this is a known fact when it comes to incremental innovation in product optimizations in the manufacturing process, it also shows that companies' growth as a whole are reliant to no small extent on the skilled labor they demand and attract. A highly skilled manufacturing labor force not only increases the nation's and industry's economic position in global markets – it is a competitive advantage.

It is worth noting the relationship between positive regional development and skill-based innovation: a strong manufacturing base (a *modern* manufacturing base, that is!) has shown to be a resilient strategy to maneuver economic crises and has proven to be less impacted by job losses and unemployment. A comparison on a smaller aggregate level (e.g. metropolitan areas), but within nations is worthwhile here and ensures that differences in development cannot be explained through different national policies (i.e. unemployment and reemployment measures, social welfare etc.). Data in the US – a national economy much more characterized by their high share in services (80%, versus 19% manufacturing³) than, say, Germany (69%, versus 31% manufacturing⁴) – shows that metropolitan

KEY WORDS

Skills; Trade
Unions; Continuous
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Technological Change.

PALABRAS CLAVE

Habilidades;
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por las habilidades.

areas characterized by a large share of employment in the services sector have shown significantly lower employment and GDP/capita throughout the 2007/8 financial crisis and have come out of the crisis far weaker and at lower growth rates than metropolitan areas characterized by manufacturing (see figures 1 and 2 below). This is, in a way, nothing surprising: In financial crises people avoid or limit their use of services – they save first on restaurants, hotels, etc. –, but when their car or fridge or stove breaks it becomes unavoidable to purchase a new product, nor is it avoidable even in times of scarcity, to cure a disease with the adequate medicine. Similarly to the continued demand for high-quality machinery and equipment even throughout crises, skilled labor continues to be in high-demand, and such a labor force continues to be more resilient than lower skill (and usually lower paid) labor.

Figure 1. Time Series Analysis for US Employment Rate

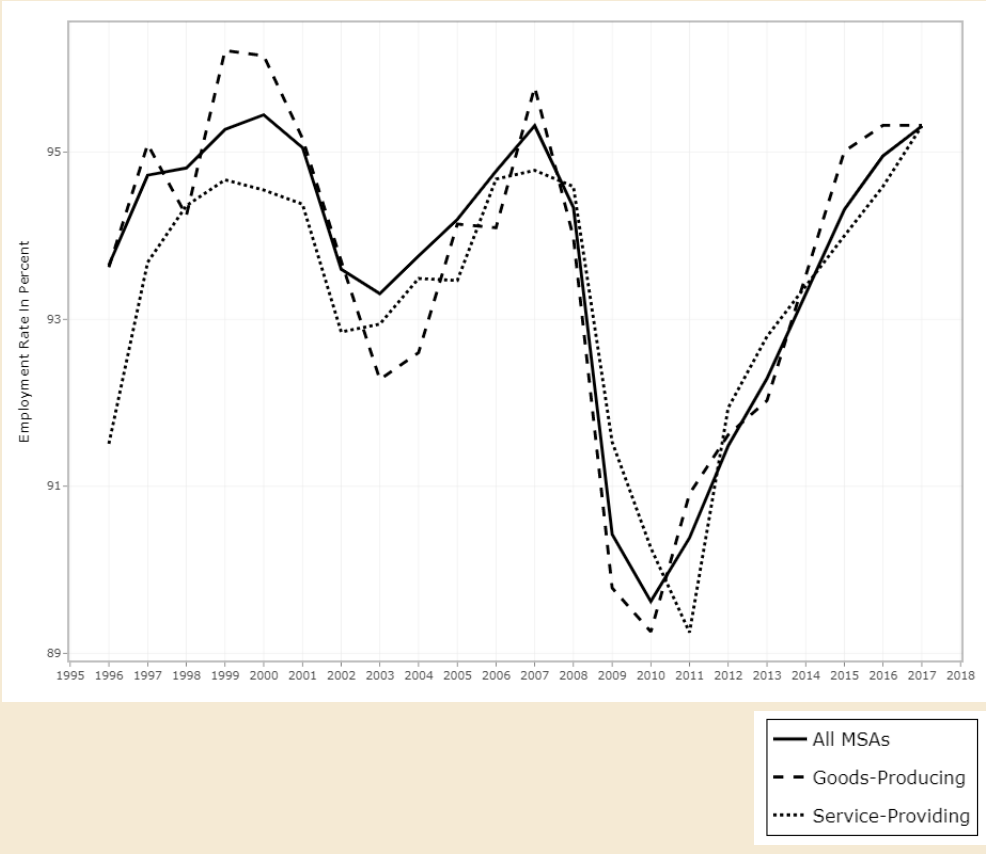
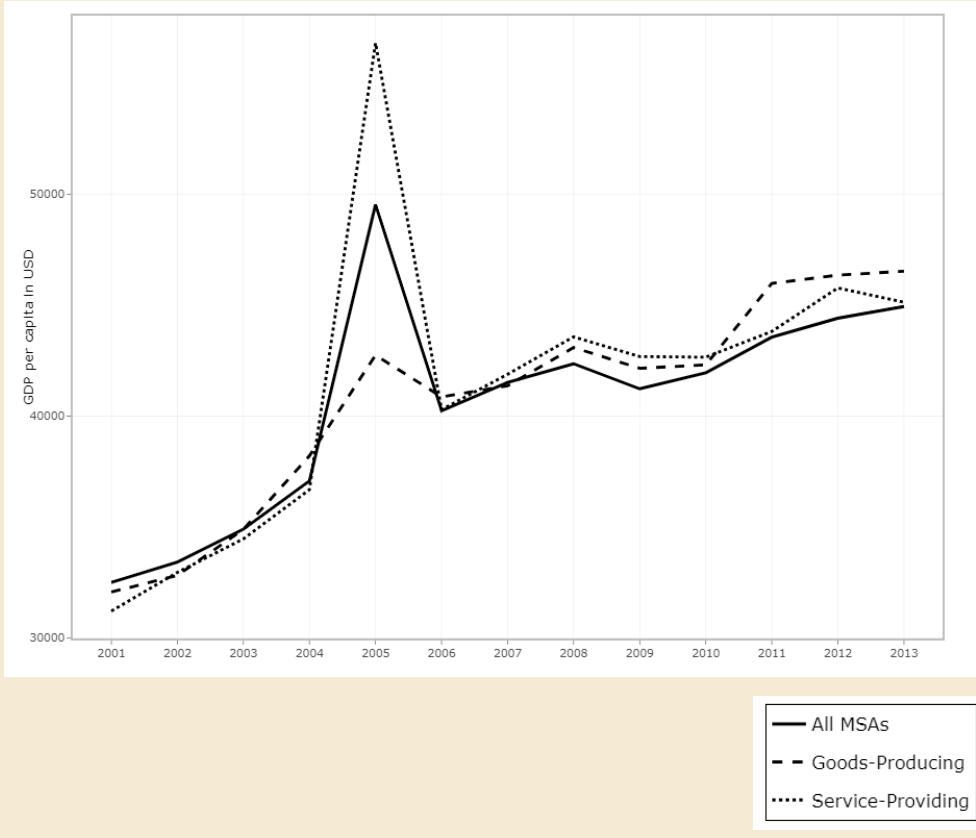


Figure 2. Time Series Analysis for US GDP per capita in USD



High value-added manufacturing based on skilled and educated labor – as evidenced by this empirical example – is not only a means for national growth and economic prosperity, it can almost be seen as a strategy to safely sail the waters of economic crises, recession and economic downturn. Increasing the share of industrial manufacturing and maintaining it sustainably (socially, economically and environmentally) can therefore be seen as a successful industrial and economic policy, especially since these industries are most likely to employ high-skilled workers in safe, well-paying jobs.

3. INDUSTRIAL HISTORY AND EXISTING INDUSTRIAL RELATIONS

Economic development follows specific historic path dependencies: Economies with already highly developed industrial and service

sectors provide a basis for further development and in light of new technological advancements through Industry 4.0, the cost of transformation varies for countries, regions and industries depending on their current level of development.

Existing industrial and research structures provide specific ecosystems that need to match with the newly emerging opportunities from new technologies and sectors. While companies and their strategic decision-making on the use of new technologies at the plant level can attract skilled labor from outside as well (Qiu & Wang 2018, Czaika & Parsons 2017, Cerqua & Pellegrini 2020), their immediate success is accelerated if these new technologies are met with an already existing skilled labor that merely needs to be upskilled to a small extent for the use of new technologies. Labor plays an important role in this context. Where high-skilled labor is scarce, it may be more beneficial for companies to invest in highly automated manufacturing. This shows that companies and labor alike have an interest in a highly skilled labor market. For companies it provides an added determinant in their own success and can significantly accelerate the effect of new technologies; for the labor side it provides safer jobs since high-skilled workers are less likely to be made obsolete by new technologies. Employers are a strong beneficiary of a well trained and educated workforce with direct impact on their own profit and success of their products. Employers should therefore share the interest in training and education measures and have an interest in expanding upon existing employer-sponsored training.

This also shows a need for proactive and foresighted policy-making to support this clear advantage of skilled labor to the resilience and success of sustainable manufacturing economies: There is a clear relationship between existing training agreements between the social partners and the need for public policy. Where employer-sponsored trainings are still rare (such as in the US), they need to be implemented and supported with the adequate legal frameworks.

Skilled workers are an asset to any company and a skilled labor force presents a competitive advantage for nations, regions and clusters (Täube et al. 2018, Vassiliadis 2019). Strengthening the labor force means strengthening the performance of the nations in global comparison, resulting in an increased ability to attract new investments and increasing productivity. However, employer-sponsored trainings in the US have decreased from 19.4 percent in 1996 to 11.2 percent in 2008 and government spending on labor

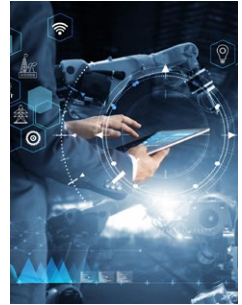


policies has consistently decreased over the last 30 years, with the exception of the final years of Obama’s presidency (Maxim & Muro 2019) – a trend that should be turned around quickly and incentivized more than ever before in order to ensure that workers are not left behind.

A look at the German case offers a good insight, since the education and training infrastructures are well developed, agreed by the social partners and embedded in national law. Depending on the states, the *Bundesland*, German workers are entitled to up to 10 days of continued education for which employers are legally obliged to continue paying a full salary and educational courses attended in this context are paid by the employer⁵.

Where such education and training channels and infrastructures already exist, it will be significantly less friction in the process of adapting to new technologies – a perspective that is reflected in the much more positive prognosis for the German labor market in global comparison. A study from the ifo Institut from 2018 suggests a decrease in employment in all of Germany until 2030 of only 4.8 to 5.5 percent (ifo Institut 2018: 59). And while this prognosis may be a little too positive, it is in no way comparable to the prognosis made for the US labor market by a study by McKinsey from 2017 that estimates 60% of jobs will experience a reduction of 30 percent of working hours by 2030 (McKinsey Global Institute 2017: 27). These variations are explained by a number of factors:

First, the US labor force is significantly lower-skilled than the German labor force. The dual vocational training system with in-depth and lengthy apprenticeships in Germany ensures that workers enter the work force with an already high degree of industry-specific knowledge and are consistently updated in their training through the afore-mentioned employer-sponsored education embedded in German labor law. In the US system, apprenticeships and industry experience prior to entering the workforce are rare and most are less than 6 months in duration. The McKinsey report shows that occupations requiring only a high school degree (like most traditional manufacturing jobs in the United States) are more than 200 percent higher at risk of being automated than occupations requiring a college degree (McKinsey Global Institute 2017: 30). Being dismissed, this labor cannot contribute to innovation and will continue this way because of the lack of training.



Second, social partnership is a crucial aspect of industrial relations in Germany. While the position of labor is in its very nature one that is more reactive than active, social partnership provides a platform for exchange and discourse, rather than conflict, one for compromise in times of crises, rather than clash. A clear example is the temporary reduction of working hours in the manufacturing sector during the recession after the 2007/8 financial crisis (Obermeier & Kühl 2016). It allowed for workers to keep their job, with a reduction of working time and a reduction in monthly income reflecting the hours worked, rather than a wave of skilled workers being let go into unemployment, burdening the social welfare system, losing momentum in their own education and training that is applied to industry and making a re-entry into the workforce for older workers more difficult. Had these workers been dismissed, their unemployment would have not only stressed the welfare system, it would have also meant a significant loss of innovation capacity in industry that instead could be reactivated the moment the economy changed into an upturn. The exchange and discourse in social partnership committees and parity boards played a large role in the decision to go this route and successfully played out in the eventual upturn post-recession and the continued success (and foresightful company planning) of the German manufacturing sectors (Tortorella et al. 2018, Nangoya et al. 2020, Bradley et al. 2016).

Third, industrial policy in Germany is focused on a strong foresight and policy makers are well aware of the competitive advantage that the skilled worker provides for Germany in global comparison – ensuring that this remains the case is a sustainable industrial policy strategy. Industrial policy is not merely an economic policy that focusses on manufacturing, it is rather the overlap in the venn diagram between economic, education, labor, social welfare and healthcare policy (Audretsch & Lehmann 2016). It is not simply a policy made for industry, but rather based on the knowledge that the model of our society is based on industrial development. A policy addressing these challenges must therefore have an equally holistic approach.

It is important to note that the reduction of working hours in the prognosis from McKinsey does not necessarily imply a reduction of workforce through automation. Where increased and improved technology applications provide new business and profit opportunities to companies, working hours could be reduced for workers while providing them with a salary that is commensurate with the increased



profit and skills profile required from them. Labor can only develop its innovative capacity in employment. And while this might be a more short-term solution with limited applicability as technologies become even more advanced in the decades to come (say, for example, 2050 and onwards), for now companies and labor alike have the shared interest of keeping the innovation potential within the company and ensuring a high employment all the while applying new technologies. New technologies and developments in innovative processes open windows of opportunities depending on the existing infrastructures on the ground. These windows appear and change over time and they are regionally and sectorally path-dependent. But the example of Germany (similar to other Central and Northern European countries), with its strong social partnership system, shows that these transitions can be significantly simplified and eased when employers and unions are working together to ensure a sustainable future of manufacturing. Windows of opportunities for innovation and regional development appear and change over time. They need to be used promptly when they arise in order to develop the highest innovation capacity. A highly skilled labor force can also adopt to diverse processes of innovation and turn these into positive socio-economic development and prosperity.



4. THE LOCALITIES OF TALENT: THE PROBLEM OF MISMATCHING AND POLARIZATION

When new technologies find application in companies, qualifications change and skilling and training is needed – so much is agreed between academia, policy and social partners. Qualifications are one of the most prominent challenges when it comes to digitization. The changes in the required skills are not just a challenge for workers, who need to go through courses and receive industry-applicable knowledge both before entering the workforce and then as continued education, but they also have strong impacts on societies, especially in developed countries: A strong skills shortage and an increasing skills misfit are common problems of the labor market (McGowan et al. 2017). Where medium skills used to be a safe ticket to the middle class, skills misfit and the changes due to increased global division of labor threaten the middle class and could cause a potential precarization of mid-skilled workers. Ensuring that fitting and attractive jobs are available locally to match the existing skills in the

work force is therefore crucial for a sustainable industrial policy.

In most developed economies, one can witness an increased polarization of skills demand: while the design and manufacturing of high-quality products increasingly requires engineers and highly qualified workers, at the same time, there is also a continued and growing need for private and personal services that often require less skill to perform (such as cleaning, laundry, maintenance, etc.). Since the increased global division of labor and a relocation of mass production plants to the developing world and emerging markets, medium-skilled workers are less in demand in most of the developed world.

Modeling the existing qualifications in Western European societies show that they differ greatly in distribution from those needed (Sandulli & Fernandez, 2019). Well established educational systems (and in some cases apprenticeship programs) means that a large share of the society has at least medium skills, and a relatively small share of the population has low skills. While this might be a good sign for educational systems, it also points to a problem of supply and demand: The overproduction of a medium skilled workforce means that there is a large share of this group struggling to find a job to match their qualifications—they are overqualified for the lower-paying low-skill jobs and they are not skilled enough to fill the skills shortage in the higher qualification jobs. With industrial work and design losing its appeal to younger generations in Western economies, the problem of skills shortages has arisen in higher-skilled jobs. In response, both companies and governments in Europe have taken measures to make industrial jobs more appealing, i.e. by giving out specific scholarships for STEM subjects and guaranteed job offers after successful apprenticeship programs (Hirsch-Kreinsen 2017).

This tier of mid-skilled workers who could potentially fall into precarious situations due to the skills polarization is an issue that must find its policy match now and it must be addressed through training and education. Given the shared interest of employers and unions in a high-skilled labor force, social partnership becomes even more important and allows for strategy that is building the skills transition from the existing mid-skilled to the much needed high skilled workforce. Unions and employers need to be strongly involved in the parallel policy process to ensure that this transition does not leave certain groups behind (such as women, people of color, people with disabilities, etc.). Developing the skills amongst the labor force is



therefore not just a social policy initiative but can rather be seen as an economic policy that boosts productivity and regional (and national) competitiveness.

Previously, we argued that skilled labor is important for this development in the realm of human capital – as a competitive advantage. But it becomes even more important in this context as a catalyst for regional economic development and prosperity. The regional distribution of fitting skilled labor to fill the positions in industry is a challenge: High-tech and skill-intensive manufacturing is predominantly clustered around large metropolitan areas and thereby attracting a great amount of skilled labor into the cities (Hilpert 2019a; Sandulli & Fernandez 2019) – as evidenced by the ever-rising urbanization rates (see for example the prognosis for the US to rise from 82 percent in 2018 to 87 percent in 2050⁶). When urban areas attract skilled workers, those same workers are drained from the more rural areas. Regionally mismatching skills and regions that are characterized by strong income polarization can long-term not provide the needed environments for such economic development: where the skilled labor is missing, and workers are paid poorly, building an infrastructure for innovation and economic development becomes increasingly difficult (Täube et al. 2018). Especially in a country as wide spread as the United States, this becomes a challenge and a worsening of the divide between well-developed cities with skilled workers in well-paying jobs and less developed rural areas with few opportunities due to the lack of high value-added industries and a dominant low-skill, low pay and high precarity service sector (Giannakis & Bruggemann 2019, Braesemann et al. 2018).

When this urban-rural divide worsens, policy is called for action that goes beyond just training and education: existing welfare systems need to be reexamined, infrastructure must be boosted to improve connectivity from urban to rural areas, and incentives need to be created for companies to consider settling and skilled labor to find jobs in rural areas.



5. SOCIETIES AND POLICIES PROVIDING A CULTURE OF EDUCATION AND MODERNIZATION: ISLANDS OF INNOVATION INDICATING DIFFERENT SOCIETAL STRUCTURES

The increasing urbanization and agglomeration of high-value added industries in metropolitan areas creates centers of change, centers of skilled labor, Islands of Innovation (Hilpert & Lawton Smith 2013). By attracting and reproducing such highly-skilled labor, these unique metropolitan and regional centers provide for constant modernization of skills and competences and thereby attract companies to settle. These urban areas enter an upwards spiral of innovation: Companies settle in urban areas because there is more skilled labor, jobs created attract more skilled labor from the surrounding areas, making the metropolitan region thereby even more attractive for companies to invest, expand and settle.

What is created is a unique innovation ecosystem where skilling initiatives, public-private partnerships, investment, business opportunity, economic development and prosperity interact with each other like clockwork, fueled in large part by the skilled labor and its innovation potential (Hilpert 2012, Hilpert 2019b). The diverse innovation developments (based on regionally existing structures, sectors, industrial specializations etc.) correspond with the opportunities for the development process and potential new applications.

And while these innovation hubs grow and prosper and develop into dynamic cities with a growing population of high skilled, well paid labor, they are also a symptom of the simultaneously declining rural areas that are deprived of innovation capacity through labor, detached in regards to infrastructure and “brain drained” (Peluffo & Silva 2018). So what is a sustainable policy in this context? It is hard to argue against these excelling centers that Islands of Innovation present – they are modern, diverse, well connected and highly educated. But their development and prosperity are relying also on the attraction of skilled labor and knowledge resources of rural areas – smart young people from rural areas come to the cities to pursue their education and often stay because of the availability of fitting jobs. And while one could argue that an increasing number of people lives in cities so those are the areas that should prosper most, those people in rural areas need to have solid opportunities locally and must not fall behind. Inactive and underpaid labor burdens welfare systems and other societal problems; there are plenty of examples from the



United States such as the opioid crisis in Kentucky and West Virginia showing the issues related to precarious work, high unemployment and industries that moved away from rural areas (Ghertner & Groves 2018).

From a policy and regional development perspective it is advisable to invest into strategies that create a “brain circulation” rather than “brain drain” from rural areas to cities. Skilled labor must be put into positions where their innovation potential can flourish and bring prosperity to rural areas, down the value and supply chain and into more medium to high-tech industries.

Where skilled labor is developed, process innovations are common and develop their full capacity when applied not only in one plant, one branch of a company’s production, but rather throughout the production process and into the supply chain. Companies that produce within a regionalized cluster with suppliers relatively nearby in less metropolitan areas therefore are often the most innovative – and in doing so they also provide jobs to medium-skilled workers down the supply chain, services, and retail.

A widespread collaboration between companies, regions, countries and continents is based on a diversity of factors: a) companies develop industry-specific competences (in no small part regionally effected by their workforce) and engage themselves in related and fitting projects with collaborators, b) the exchange of personnel to take advantage of knowledge and skills acquired elsewhere contributes to opportunities for innovation and provides for a richer innovation ecosystem and c) these ecosystems of innovation provide diverse opportunities for collaboration based on synergies between suppliers and regional collaborators.

A more circular innovation ecosystem with knowledge flows throughout the regions is much more inclusive of rural areas – but it does require a functioning and maintained infrastructure. This creates a common interest of companies, labor and policy makers alike: Boosting infrastructure provides investment and new business opportunities for companies, sustainable, decent work for labor and provides tax payers and relieves welfare systems for governments.



6. CONCLUSIONS

The stress of digitization needs to be met with smart policy making that takes into consideration the necessity of reform in economic,

social, education and welfare policy –an action plan for future work in the innovation economy. What we have shown is that there is no one scenario for how digitization will impact our economies and societies. The effects are diverse and the solutions are multifaceted. What remains clear through the empirical data is:

First, manufacturing based economies face crises better and more resilient than those based in services. Nations, regions and metropolitan areas are therefore advised to invest resources and effort into developing their manufacturing bases and attracting business and investments in this sector.

Second, a high-skilled workforce is more resilient towards the risk of automation through digitization and, somewhat ironically, so are low-skill workers because their labor is cheap and not economical to be automated. Medium skills are over-supplied and under-demanded in most modern industrial societies. Education and training solutions need to leverage the existing decent level of training and build upon this to supply the high-skilled workforce that is demanded in industry. Therefore, skills and education as well as continued employment of skilled labor is a contribution to continued, sustainable innovation. The skills that are needed now will vary from those needed in the decade to come—flexibility in education, both academic and non-academic (i.e. through apprenticeships) is therefore crucial. Where social partnership and industrial relations are weak, employer-sponsored trainings need to be incentivized and enforced by the adequate legislative framework in order to maintain the competitiveness and the capacities of existing industries.

Third, cooperative models with a strong focus on social partnership are more resilient in global comparison because they ensure more long-term perspectives and allow for collaborative efforts such as continued education that address newly arising skilling needs of innovative industries. Social partnership and parity models are more important than ever. The success of this transition greatly depends on the willingness to compromise, to develop solutions that boost our economies and distribute wealth, one that develops our cities into centers of innovative human capital without the precarization and weakening of the skills basis of more rural communities. Where there is more revenue and profit made, it is only natural to re-invest part of this capital into the sustainable future of work and ensuring a strong manufacturing-based middle class. Well-paid workers have a stronger purchasing power and in today's consumerism centered



systems, create a circular boost from worker, to society to companies. The comparison of the US and Germany shows that socioeconomic development relies to no small degree on the corresponding workforce that creates a climate for innovation and allows companies to be more competitive in global comparison. Diversities of skills in the labor force when compared across nations, regions, and metropolitan areas, help to understand and take advantage of divergent opportunities that emerge with new technologies and their varying degrees of application in industrial manufacturing.



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NOTES

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3. Data from 2017: "Field Listing: GDP – Composition, by Sector of Origin". Central Intelligence Agency World Factbook. Central Intelligence Agency.
4. Data from 2017: "Europe :: Germany". The World Factbook. Central Intelligence Agency
5. See bildungsurlaub.de for more information.
6. United Nations Department of Economic and Social Affairs (2018)

