The Digital Transformation Imperative

An IDB science and business innovation agenda for the new industrial revolution

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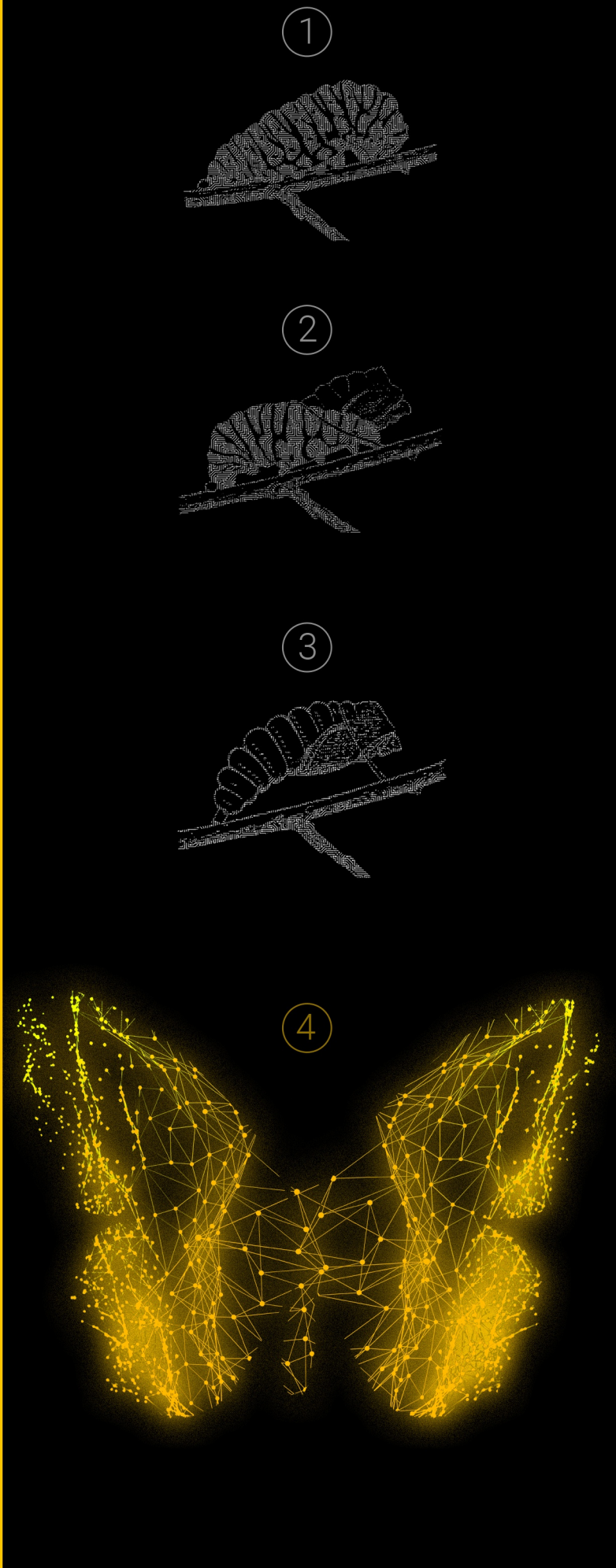

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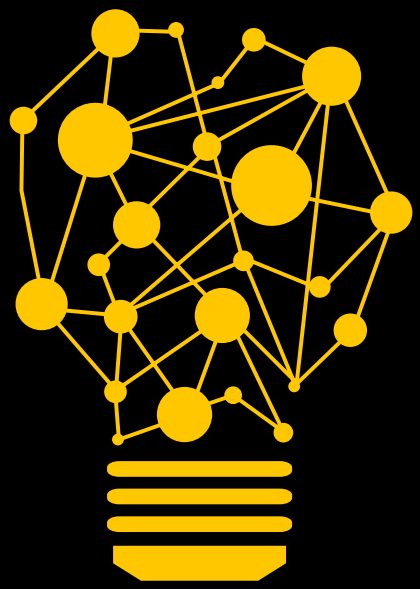
About this publication

The 2014 publication "The New Imperative of Innovation" laid out the Inter-American Development Bank's (IDB's) framework for the support of science, technology and innovation (STI) in Latin American economies. It was based on an official document of the Bank, but it was reviewed and edited to turn it into a more accessible and effective tool to communicate the institution's perspectives and priorities in those sectors. That official document was updated in 2017. Most of the original content and structure of the original were left in place, but a number of additions were introduced, reflecting both the latest experience and policy research carried out by the Bank, as well as the considerable technological and economic changes that emerged after the original document was written. Thus, a full new publication replacing "The New Imperative of Innovation" was unnecessary. However, in order to highlight the key novelty introduced in the new version of the IDB update, we now release "The Digital Transformation Imperative."* The most important new element added to the Bank's framework for STI — the implications of the unfolding digital revolution — is presented as both an opportunity and a risk for the Latin American and Caribbean (LAC) region should rapid adaptation to change and accelerated catching up fail to materialize.

* This publication is based on the updated version of the "IDB Innovation, Science and Technology Sector Framework Document", which was released in October, 2017, co-authored by Juan Carlos Navarro and José Miguel Benavente.



Introduction

Taking full advantage of the opportunities brought by the digital economy requires transforming LAC's productive sectors and firms. Digital technologies such as the Internet of Things, robotics, artificial intelligence, machine learning, big data and cloud computing, along with increasing connectivity, are transforming the economy and production processes into what is called the Fourth Industrial Revolution.

In this publication we outline the implications of the unfolding digital revolution, highlighting it as both an opportunity and a risk for LAC.

The adoption and use of digital technologies are key to transforming our productive sectors and business models

We first define digital technologies and the revolution they are bringing about, highlighting the revolution's implications for business and the economy. The second and third sections expand on these issues, first commenting on worldwide technology trends and then providing an overall landscape about the extent to which business models, production processes, firm innovation and other key features of the economy are being transformed and even disrupted by the impact of digital technology. The fourth section completes the discussion of the economic impacts of digitization and explores other key implications for human capital formation, regulatory frameworks and scientific activity; the issue of risks and potential downsides of the digital revolution for employment and market structure is also introduced. The fifth section discusses how all these accelerated changes represent a formidable challenge for LAC economies, one that comes with large potential opportunities for leapfrogging as well as for a serious risk of falling further behind in terms of productivity and innovation. A final section introduces the priorities that will preside over the IDB's operations, research and technical assistance activities in light of the main issues explored in this document.

The digital revolution: What is it all about?

A key driving force behind the creation of a knowledge economy has been the exponential growth in the volume and speed of information generated by the expansion of Information and Communications Technologies (ICT), as well as the exponential proliferation of connected devices, many of them smart or able to interact among themselves or with human beings. Beyond the original possibilities created by the advent of personal computers and Internet connectivity in the last decade of the 20th century, the recent combination and convergence of digital technologies — such as a machine learning, mobile devices, sensors, blockchain, artificial intelligence and the Internet of Things — has spearheaded innovations that are having powerful impacts across industries other than the ICT industry itself, leading to the notion of a new industrial revolution embodied in the digitalization of the whole economy and the prospective digital transformation of all industries.[1]

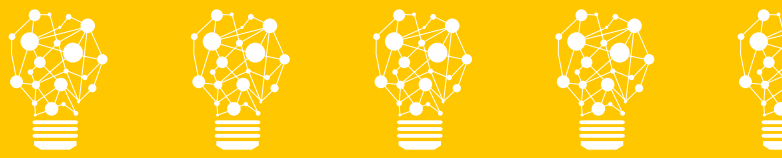
Indeed, given that digital technologies substantially lower the cost of information storage and transmission, their diffusion throughout the economy reduces intermediation and the uncertainty and transaction costs associated with economic interactions, a phenomenon perfectly illustrated by the potential application of blockchain technology both in the financial sector (Ketterer, 2017) and beyond.

This new industrial revolution is embodied in the digitalization of the whole economy and the prospective digital transformation of all industries

[1] The widespread impact of digital technology across industries and social activity worldwide and particularly in advanced economies has been the subject of a series of reports (OECD, 2017; WEF, 2017). A comprehensive treatment of this subject focused on LAC is still pending and this document advocates for the Bank to become proactive in undertaking such task.

Moreover, recent advances in many domains of knowledge, such as biology, new materials, electronics and nanotechnology, among others, have been made possible because of this digital revolution, and venture capital (VC) flowing to the leading scientific fields and industries reflect the dominant, cross-cutting impact of digital technology.

Today we observe exponential speed in the creation of new knowledge and the almost infinite potential applications not only in the production process but also oriented to solve problems that affect humanity. Health, climate change, urban development and space exploration are reflections of the great complementarity that exists between the digital developments and the traditional sciences. Likewise, many of the advances in applied solutions, some of them based on natural resources and other inputs abundant in the Latin American region, offer the possibility of generating competitive advantages based on knowledge, innovation and digitalization.



Recent technology trends

A main contention of this document is that LAC economies, for the most part, lost a golden opportunity to leapfrog in terms of innovation when they failed to join the ICT and Internet revolution in a timely manner. Not only the benefits of this revolution have arrived late to the region, but, to this date, most countries exhibit lags in basic indicators such as broadband access and computer density in the population.

The term "Industry 4.0" refers to an ongoing fourth industrial revolution driven by a variety of digital technologies. The core revolutionary effect comes from the combination of the previous ICT/Internet revolution with intelligent machines (more precisely, a confluence of artificial intelligence, machine learning, advanced robotics and big data analytics). Technologies such as 3D printing and low-cost sensors that have made possible a growing Internet of Things are also closely associated, as well as emerging digitally enabled business platforms and models, such as Uber or Netflix. Beyond all this, new materials resulting from advances in bio and nanotechnology and synthetic biology are also connecting with digital technologies, with far reaching impacts on productivity, employment, trade and the environment (OECD, 2017). Visible manifestations of these changes are already observable in sectors such as transportation (autonomous vehicles) and finance (blockchain). Gene editing and DNA-based data storage could be around the corner.

"Industry 4.0" refers to an ongoing fourth industrial revolution driven by a variety of digital technologies

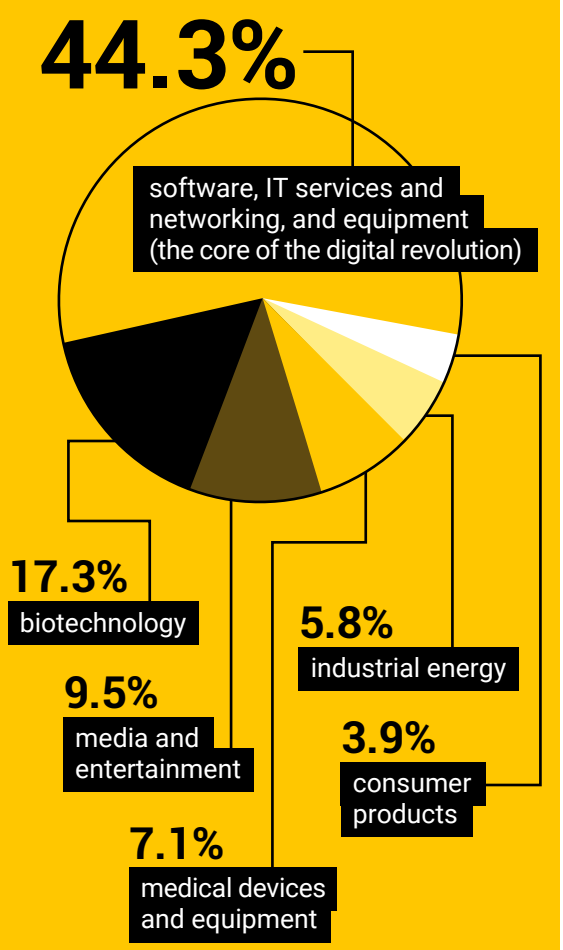
As the new digital revolution starts to unfold around the world, there is a risk in repeating this story. Anecdotal information points to widespread awareness of the potential and risks of digital and bio technology. Technology foresight exercises, using methodologies such as technology road mapping, are spreading across LAC, although it remains to be seen whether the results translate into concrete plans and outcomes.

A quick snapshot of which technology sectors are innovating more rapidly and hold the largest potential around the world can be approached by observing which industries attract the most VC.

Figures are available for the largest VC market, the United States, in 2015. They show that software, IT services and networking, and equipment, all at the core of the digital revolution, are by far the sectors that draw the strongest attention from technology savvy investors: 44.3 percent of VC investment went into these technology areas. Digital-related industries are followed by biotechnology, with 17.3 percent, media and entertainment, with 9.5 percent, medical devices and equipment, reaching 7.1 percent, industrial energy, 5.8 percent, and consumer products, 3.9 percent.[2]

VC investment in digital industries

VC investment in the United States in 2015 went into these technology areas:



Source: Martin Prosperity Institute (Hallet, 2017)

Catching up with the fast pace of change in digital industries is becoming a challenge even for advanced economies and their largest companies. LAC will have to overcome distinctive barriers such as scarcity of talent knowledgeable of critical technologies such as Artificial Intelligence and data analytics, as well as limited broadband penetration. But there are also unprecedented opportunities: the global availability of commercial platforms such as Amazon or Alibaba can also facilitate a jumpstart to emerging business ventures in the region, in ways that would have been inconceivable a decade ago.

These figures also point to the importance not only of digital technologies, but also of other innovation-intensive areas in which, it could be argued, LAC holds high potential and even some strong foundation: biotechnology, medicine and creative industries. A trend toward the blurring of the boundaries among sectors and critical technologies (digital and bio, for instance), may turn out to be a factor facilitating catching up for LAC innovators.

Catching up with the fast pace of change in digital industries is becoming a challenge even for advanced technologies

[2] Figures based on an analysis of 4,154 VC investments in the United States in 2015 by Martin Prosperity Institute (Hallet, 2017).

The digital transformation of economic activity

The digital economy increases the organizational capacity of firms to codify knowledge that otherwise would remain hard to store, organize, transmit and use, accelerating learning and producing, in the process, very large volumes of information (big data) that create unprecedented opportunities to understand and make decisions both for the government and for the private sector. Production processes can be more easily decentralized, locating different components of the same processes in different countries based on the comparative advantages of each economy, resulting in major reconfigurations of global value chains (Lach, Bartel, and Sicherman, 2005). This development is illustrated by the fact that, according to recent estimates, the value of the world's trade in information has recently surpassed the value of the world's trade in physical merchandise (McKinsey, 2016).

The digital economy also facilitates a higher degree of customization, opening up new possibilities for developing countries to exploit emerging niches through e-commerce technologies. ICT applications now shorten the distance between producers and users: buyers and sellers located in different cities, regions and countries can share information on their needs and products, reducing information asymmetries and entry costs in markets (Perez, 2008). This, in turn, leads to an increase in the volume of transactions, generating more output from the same set of inputs and thus higher productivity levels (Chen and Dahlman, 2005).

Today, new platforms like Uber and Airbnb have signaled the potential of organizing work and consumer services in ways that can be highly efficient and appealing to both suppliers of services and consumers, through the use of digital platforms. Intermediaries in the travel industry are struggling to adapt to competition from these new ventures, banks may very well be next in line, and disruption[3] in other industries is very likely to follow.

The value of the world's trade in information has recently surpassed the value of the world's trade in physical merchandise

[3] Disruption does not refer to technological breakthroughs or inventions but rather to innovations that, usually based on technology (but also on new types of business models based on such technology), enable new entrants in a particular industry in such a way that dominant or well-established firms are eventually — and often rapidly — replaced. The concept lies at the heart of the latest wave of entrepreneurial activity and start up proliferation around the world (Christensen, 1997).

In the digital era generally — even though these phenomena are still far from being adequately understood – the economy is becoming primarily information flows and software, which seems to be leading to increasing knowledge spillovers, lowering of entry barriers, larger opportunities for challenging the incumbents in many sectors and, to use Schumpeter's classical terminology, exponential growth of opportunities for creative destruction. Competition itself may be moving from a price, volume or cost rivalry among companies to the struggle to disrupt the core products and business plans in any given economic sector.

The way research and innovation take place in firms shows signs of radical transformation due to the digital economy. Traditional R&D departments in large companies still exist, but there is a clear trend in the direction of appealing to open innovation — often by setting up start up incubators under the tutelage of the large corporation — as a response to the accelerating pace of technological change and the accumulation of unprecedented amounts of information.

In the digital era, the economy is witnessing exponential growth of opportunities for creative destruction

In sum, digital transformation of traditional industries is likely to advance at a fast pace with considerable effect on investments in innovation (WEF, 2017). Clearly, the digital technological revolution shows all signs of being transformative, rather than just one of so many technological developments.

Wider implications and risks

The advent of the digital economy has had systemic repercussions. Thus, it has increased the importance of the innovation climate in several ways. Digital technology is influencing corporate innovation and R&D in such a way that it is moving away from traditional laboratories to corporate venturing – namely, relying on startups outside the corporation for the provision of innovation. This, in turn highlights the importance of business incubators and accelerators. Digital entrepreneurship is directly behind the emergence of entire new business models based on sharing, matchmaking, disintermediation and open innovation.

These new business models are creating pressing demand for new regulations: should Uber cars be regulated in the same way and to the same extent as the overregulated taxi services all over the world? Shouldn't all — including traditional taxi companies — be deregulated? Similar questions could be asked of the hotel industry, commercial banking and other sectors. And, even as regulation remains an analog activity, it needs digital expertise and awareness if it is to adapt to these phenomena. All this speaks to the renewed relevance of the innovation climate.

Digital technologies also have the potential to unleash a whole new set of challenges and opportunities for human capital formation and utilization. Digital literacy for the whole population becomes a must, and, to some extent, so do coding skills among workers; add to this the ability to interact with intelligent machines and to operate in work environments shaped by digital platforms (such as those typical of new sharing economy business models), and the mass delivery of high-quality education through Massive Open Online Courses (MOOC) and other digital platforms. The market for human capital formation, in a context like this, is likely to go through a period of disruption in the near future.

Digital technologies also have the potential to unleash a whole new set of challenges and opportunities for human capital formation and utilization

In the area of scientific research, digital technology seems to have the potential to change the rules of the game. Open science, bringing an unprecedented level of sharing of results and databases, has started to challenge the traditional organization of scientific journals and publications. Public policy will need to adapt accordingly.

Yet innovation has its costs. The labor market shows a growing "skills bias" both in developed and developing economies, signaling that jobs growth will be in those occupations that involve sophisticated handling of symbols, information, and analysis. The most dynamic industries are those that can be classified as knowledge intensive, and all economic activities, even the most traditional, are increasingly influenced by technology and innovation, and this has been the case for the better part of the past two decades (OECD, 2000).

The transition to a more innovative economy requires a closer look at how labor markets are affected and also how traditional sectors may react to technical change. For example, a never before seen delinking of job creation and technological progress (think about the consequences of a general adoption of autonomous vehicles on professional drivers, or the advent of smart, networked, self-repairing parts and materials on mechanics, engineers and maintenance workers, or about the effect of generalized blockchain transactions on lawyers, bank employees of public notaries, just to mention a few).

The transition to a more innovative economy requires a closer look at how labor markets are affected and how traditional sectors may react to technical change

The generalization of "scale without mass" companies, in which firms valued in the multi-billion dollar range and with global influence can gather their whole workforce in a medium-sized meeting room (think about the miniscule size of the WhatsApp workforce, as revealed by its recent acquisition by Facebook for US$19 billion). The apparent possibility of digital innovation creating conditions for the capture of rents beyond the traditional dimension of this phenomenon, in a world where the winner gets everything and the runner up almost nothing (think about Amazon, a first mover in the field of e-commerce, which has become the dominant player, by far, in the industry) and others (see OECD, 2017).[4]

Growing complexity in the technological and economic landscape now makes predictions and long-term planning harder. The most capable and sophisticated companies and governments around the world are struggling to stay abreast of such complexity. The challenge for developing economies is to foster awareness of the complexity and respond in a context of limited resources.

Growing complexity in the technological and economic landscape makes predictions and long-term planning harder

[4] The other side of the coin, namely the potential of innovation and digital technology as a tool for social inclusion, is also of paramount importance.

A critical challenge for LAC

Given the unprecedented dimension and speed of technological change, a major concern has to do with the preparedness of developing countries, and LAC economies in particular, to adapt in a timely and constructive fashion to the emerging digital economy. At a time when all over the world fundamental questions are being debated having to do with how accelerating technological change will affect the content of education and training (the "new skills", somehow still less than fully defined, required for the digital economy), universal access to broadband is considered a given and new business models are fast gaining prominence. In this context, the region is plagued by underperforming education systems, limited broadband coverage[5] and a majority of firms that are not engaged in innovation activities, much less in digital transformation.

Access to new ICT by LAC countries has been late and partial, as illustrated by all available indicators, such as the number of personal computers, Internet access, and access to broadband.[6] This lag is particularly important when analyzing the effects of innovation on productivity, since ICT is a general-purpose technology that has a cross-sectional impact on all economic sectors. As stated above, advanced uses of ICT have not spread throughout the vast majority of small and medium enterprises (SMEs) in LAC. Two specific issues are worth highlighting. First, severely underdeveloped broadband infrastructure and regulation constitutes a major constraint to productivity growth in the region, particularly in the service sector, which is critically dependent on digital technology for innovation. Second, it is challenging for such advanced uses of ICT to reach a critical mass in any economy in the absence of a well-developed software industry. With the exception of a few success stories in a limited number of digital hubs in Argentina, Brazil, Mexico, Uruguay and a few others, the software industry in the LAC region has not reached the necessary level of development.

A major concern has to do with the preparedness of LAC economies to adapt in a timely and constructive fashion to the emerging digital economy

[5] A detailed and comparative perspective regarding the current state of broadband access in LAC countries can be found in the Broadband Development Index built by the Bank (Zaballos and Rodriguez, 2017).

[6] Several specific factors hamper the spread of broadband use, and are worth mentioning: lack of coverage, high prices, low quality, and lack of skills among individuals, firms and public agencies to use related services.

Only one ICT adoption indicator is excellent in LAC: the market penetration of cell phones, which has reached saturation levels among the adult population across the region. This sector has benefited from accelerated technological innovation and cost reductions in the industry worldwide, and more advanced and private-sector friendly regulation, but marketing and business model innovations, such as the use of pre-paid phone time, are widely considered to have made the difference in the rapid rate of adoption. Even if success in access to critical mobile communication technology so far has failed to translate to other ICT areas, the growing importance of mobile services and applications and their economic impact on almost every sector of the economy provide a key platform for innovation in the region.

Policy responses to this state of affairs have also had important limitations. Several countries have put together ambitious national digital agendas (Colombia is a particularly outstanding model), but for the most part, current ICT policies in the region show a strong bias toward the development of e-government, particularly in the areas of financial management, procurement, and the management of tax and revenue systems, at the expense of a lack of necessary focus on the need for programs that enhance the capacities of the private sector to adopt and use digital technologies.

There is a lack of necessary focus on the need for programs that enhance the capacities of the private sector to adopt and use digital technologies

Even though digital transformation in the private sector may very well become driven by private investments — as, for instance, in the case of the expansion in recent decades of mobile telephony — the experience accumulated in the early stages of development of the ICT industry — the advent of computers and connectivity — points to a significant risk for LAC economies in terms of reaching a position to benefit from current technological change.

A partial list of public interventions will likely include: (i) investments aimed at improving the population's level of digital literacy; (ii) government support for the digital transformation of firms and sectors, particularly in the case of SMEs; (iii) support for accelerated development of digital ecosystems and support of digital start-ups; (iv) improving the supply of specialized human capital for the ICT industry and all sorts of digital applications in digital business services, and digital platforms; (v) regulatory reforms aimed at accommodating the requirements of the sharing economy and other consequences of digitally based business models; and (vi) investment in broadband infrastructure, so that all the rest of policies can bear fruit.

Public interventions may include

1 improving people's level of digital literacy

2 support for the digital transformation of firms and sectors

3 support for accelerated development of digital ecosystems and start-ups

4 improving the supply of specialized human capital for the digital revolution

5 regulatory reforms for digitally based business models

6 investment in broadband infrastructure

The emerging imperative of the digital transformation of the economy

Emerging technological developments such as artificial intelligence, machine learning, blockchain and fintech, 3D printing, sensors and big data have unleashed a strong wave of innovation characterized by disintermediation, matchmaking, sharing and innovation through open models and platforms. Such developments are having a profound effect on business models, market dynamics in a variety of industries, manufacturing processes, trade and service delivery, which is already being felt in LAC economies.

The IDB should spare no effort in keeping pace with the latest developments of these technologies and their effect on labor, financial and commodity markets, as well as on science, manufacturing, business innovation and social innovation. Based on such understanding, the Bank should accompany governments and the private sector in timely positioning themselves to take advantage of this technological revolution and to mitigate its negative effects.

As a consequence, the IDB will prioritize the following activities:

- **Advance a deliberate knowledge agenda aimed at understanding the digital economy and its impact across the region.** This includes technology foresight studies, diagnostics, pilot programs involving policy instruments adapted to the presence of digital technology, a better understanding of factors that would improve private sector participation in the digital economy, data collection and policy analysis. Support from the Multilateral Investment Fund regarding piloting new programs is expected to play a role here.[7]

- In light of the findings of such knowledge agenda, **engage governments and the private sector in the development of projects that take full advantage of the possibilities of the digital economy** in the services, manufacturing and natural resource sectors, with a focus on resolving market failures that prevent the private sector from spontaneously keeping pace with the ongoing digital transformation of industries.

- **Exploit the potential of open digital innovation and platforms** in areas such as scientific research, business innovation, technology commercialization and talent development.

- **Support investments in digital infrastructure,** such as broadband coverage, speed and affordability.

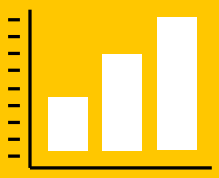
- **Focus on investments in human capital for the digital economy at all levels,** including engineering, technical and vocational education and overall digital literacy.

- **Prioritize support for entrepreneurship in the area of digital technology and the development of digital ecosystems,** particularly at the local, city level.

[7] In light of the framework described in this document, key questions to be explored are: What are the impacts of the digital revolution on the economy? How is it affecting firm and market behavior? How is it affecting the way researchers research and firms innovate? What are the factors that may prevent LAC from reaping the benefits of the digitalization of the economy worldwide? How to reach reliable estimates of the potential costs and negative effect to be expected in the region from automation and a whole set of emerging digital technologies?

Key questions to be explored

What are the impacts of the digital revolution on the economy?



How is it affecting firm and market behavior?

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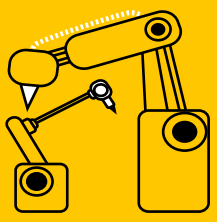

How to reach reliable estimates of the potential costs and negative effect to be expected in the region from automation and the whole set of emerging digital technologies?

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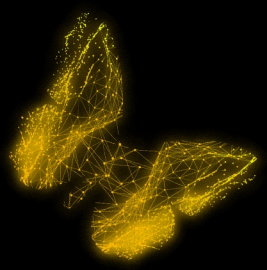
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