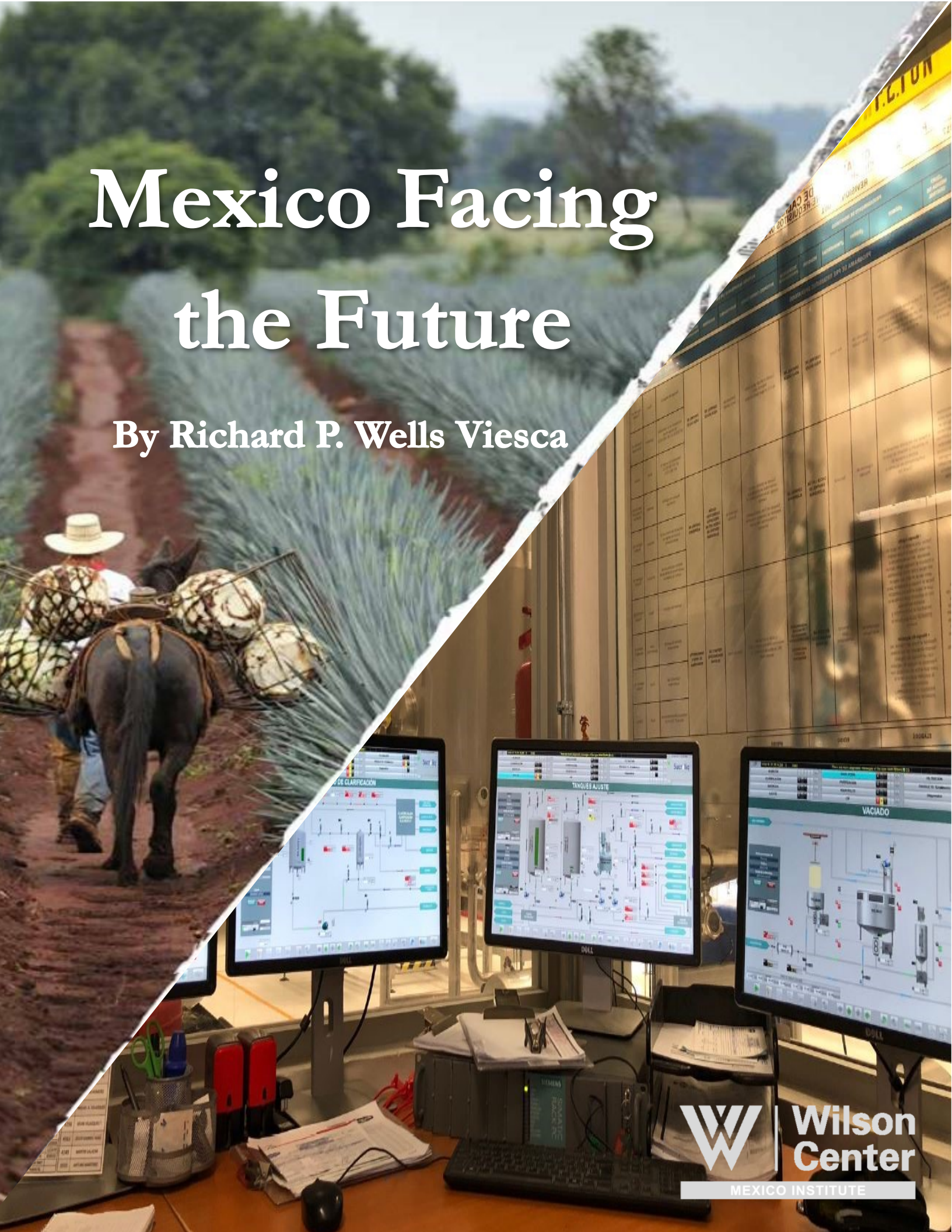
Mexico Facing the Future

By Richard P. Wells Viesca



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Dedication

To my grandchildren, Teddy, Ollie, Leah, Mae and Ella and all children of their generation. It is for their future that we must act today.

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I. Executive Summary

Mexico today faces an existential crisis that is unprecedented in its recent history. As with the four tectonic plates that underlie it geologically, four socio-economic tectonic plates that underlie Mexico economically and socially—its economic model, technology, society, and natural environment-- are shifting with consequences that are difficult to predict.

Mexico's basic economic model--integration in the global economy--provided steady, if unspectacular growth, across three decades, but it is becoming obsolete. Mexico played by the rules of globalization that, like American football, rewarded power and strength, but the new economic game is becoming more like a game of badminton that rewards quickness and agility.

Technological change is upending traditional business models built on returns to scale, efficiency and product improvement in global value chains. Paradoxically, increasingly centralized global technology platforms facilitate innovation and local and regional new market creation by linking the local to the global.[1] Technology is transforming the nature of commerce and of work. Products that Mexico produces are being supplanted by shared services. Routine manual and cognitive jobs, today the entry point to the middle class, are being displaced by automation, artificial intelligence and "gig economy" jobs.

Technology can create opportunities for small-scale local businesses, free humans from degrading, unsafe and backbreaking work and address important environmental concerns such as climate change, water scarcity and habitat loss. Nevertheless, a society that is already one of the world's most unequal risks becoming even more unequal as technology differentiates sharply among winners and losers. Technologies such as artificial intelligence, blockchain, robotics and gene editing will pose environmental, economic and ethical challenges that today are only poorly understood.

As with tectonic plates that affect its geology, the socio-economic plates that underlie Mexico socially and economically will shift, clash and overlap. We asked, "what if?" in scenarios of plausible futures for Mexico in separate projects for the Ministries of Environment and Education

[1] Increasing returns to scale in electronic markets result from the fact that serving the billionth digital customer is less expensive than serving the millionth customer. These and distributed manufacturing technologies enable smaller scale local businesses.

and for the Business Coordinating Council (Consejo Coordinador Empresarial). [2] Three key vulnerabilities emerged:

1. *Mexico is poorly prepared to compete in a future knowledge-based economy.*
    a. Knowledge and ideas will become more important to economic competitiveness than assets and resources, but Mexican companies are set up to compete on the basis of assets, efficiency, scale and resources. They have not created new businesses because they have not had to; their R&D annual investment has been minimal (0.2% of GDP annually). Five of the top ten Mexican companies in the 2019 *Expansión* list of largest companies in Mexico were also in the 1975 list; all but one existed in 1975. By contrast, seven of the ten most valuable companies in the world in 2019 did not exist in 1974.[3]
    b. Mexico's innovation ecosystems are weak. As noted in previous Woodrow Wilson Center studies, its great universities have not spawned regional innovation ecosystems --there are few entrepreneurial support systems; legal, cultural and bureaucratic obstacles prevent government-funded university research from being commercialized.[4] The current administration has discontinued the national institute for the support of entrepreneurs (INADEM). Change is coming, albeit slowly. The National Autonomous University (UNAM) recently accepted a proposal by its chemistry faculty to permit private partners to benefit economically from technologies developed through joint academic-private efforts, as permitted by the 2015 Ley de Ciencia y Tecnología. [5]
    c. The educational system fails to develop talent. Three of every thousand Mexican students who took the 2015 global PISA test in mathematics scored at the "high achievement" level; 182 Korean students and 65 United States students per thousand

[2] With the Ministry of Environment and Natural Resources (2015), the Ministry of Education (2016-2017), the Business Center for the Study of Sustainable Development part of the Business Coordinating Council, CCE 2017. These projects were undertaken under the previous administration. There are no signs to date that the current administration is addressing the problems. This paper is based on the research undertaken for these projects. The conclusions we draw in this paper from that research are, however, ours alone. They do not represent the views of those organizations.

[3] The oldest of the seven, Microsoft was founded in April 1975.

[4] See for example, Duncan Wood, Christopher Wilson, Alejandro Garcia, *Fostering Innovation in Mexico,* Woodrow Wilson Center, 2014; Santiago Gutierrez, *Innovation is a Job, not a miracle,* Woodrow Wilson Center, 2018; Viridiana Rios, *Innovation Happens in Mexico; It should happen more,* Woodrow Wilson Center, 2019

[5] Personal communication from Leopoldo Rodriguez

did so. The 0.03% high performing Mexican students, moreover, most often come from the wealthiest sectors of society: the strongest predictor of academic achievement among Mexican students is the socio-economic status of their parents.

2. *Mexico is highly vulnerable to the social and environmental consequence of the future.*
    a. Technology will exacerbate Mexico's already-extreme inequality. As cities and nations worldwide have found, technology, creates an elite of highly compensated winners but leaves behind those who do not participate in the new economy.
    b. Poverty will increase. In our analysis of high technology scenarios there was a hollowing out of the middle class as workers in routine manual and cognitive jobs become technologically unemployed or migrate to a low paid "gig economy" without a social safety net. In lower technology scenarios, extreme poverty increased.
    c. Mexico is vulnerable to extreme environmental impacts. Large parts of the north of the country are vulnerable to drought and its southern states are vulnerable to flooding with rising sea levels. Biodiversity, an underappreciated asset, is declining rapidly. Technology will bring new categories of environmental and social impacts some of which we can anticipate. Others, "unknown unknowns" associated with yet-to-be discovered or nascent technologies, will pose complex, unanticipated ethical and environmental challenges.
3. *Mexican public and private institutions are unequal to the challenges of the future.* Public and private institutions are not "future-ready." Public sector planning takes place at best on the basis of a six-year presidential term. The Plan Nacional de Desarrollo anticipates the future as a continuation of the present. Private sector institutions are little better. While some firms have sophisticated processes, "planning" all-too-often consists of projecting current forces into the future, ignoring the possibility of discontinuous geopolitical, technological, business, social and environmental change in the future.

The Path Forward

The future will be challenging for Mexico, as it will be for all societies. Solutions must emerge from a national conversation that engages all sectors of society and all regions. Mexico will need to focus on its particular vulnerabilities in education, competitiveness, innovation, economic inequality and environmental sustainability. Sustainable growth cannot be defined by GDP alone. It must be measured by human social and environmental well-being as well.

Mexico must meet the needs of a hard-working, diverse and creative population but also a population divided by extreme inequality in well-being and opportunities, one that has lost faith that the economic system serves its interests fairly. It has important assets in its people and its physical, biological, cultural and ethnic diversity. It occupies a privileged geographic position, next door to the world's largest market, and its geology makes it one of the world's most mega-diverse countries. But its proximity to the United States has stifled domestic innovation and created a dangerous dependence on a single market. Its geology breaks it up into isolated enclaves, and its natural capital is threatened by climate change, deforestation and biodiversity loss. In a modern economy, ways must be found to leverage its diversity and natural assets as drivers of growth.

The choice is clear. Mexico can continue with business as usual—anemic growth, concentration of wealth in the richest sectors of society, deterioration of its natural capital and decreasing competitiveness in the global economy. Or, government, businesses, academic institutions and society can come together to embrace new technologies to spur inclusive economic models. They can bring about a "fourth transformation," that leverages the fourth industrial revolution[6] to address the interests of all society, not just of corporate shareholders.

We outline four categories of actions in "Path Forward:"

I. *Act now:* Build resiliency into institutions, social, economic and physical systems to address economic, social and environmental threats that are now inevitable.

II. *Invest in the future:* Make the investments in socio-economic equality, education, innovation, and competitive business models that leverage Mexico's significant human and natural assets and serve it well independently of what future emerges.

III. *Make bets for a better future:* Mexico must look ahead to identify opportunities to create a better future for all Mexicans, addressing social needs, leveraging Mexico's unique capabilities and establishing guardrails that prevent the potential negative manifestations of emerging technologies.

IV. *Monitor emerging trends systematically:* develop "radars to the future" in businesses, government agencies and that enable institutions to track and anticipate emerging trends that will determine their future,

[6] Fourth Industrial Revolution is the term coined by Klaus Schwab, executive director or the World Economic Forum to encompass the convergence of new technologies and business models in the 21st century.

II. Introduction: Mexico atop Four Socioeconomic Tectonic Plates

Geologically, Mexico sits atop four tectonic plates. Most of the country is physically located atop the North American, but its geology is affected by the movement of three offshore plates.[7] Across millennia, the movement of these plates has defined the physical, biological, ethnic and cultural diversity that are among Mexico's greatest assets today. Nonetheless, the movement of these tectonic plates has also created physical barriers that have complicated transportation, communications and agriculture, isolated communities from each other and created language barriers and disparities among communities. Periodically, throughout history, shifting tectonic plates have caused seismic events that have led to suffering and the loss of human lives.

Similarly, Mexico sits atop four socio-economic tectonic plates. The first two of these are independent variables driven, principally but not exclusively, by offshore forces. The second two are dependent variables (like the North American plate on which most of Mexico lies). They are affected by movement in the other two plates. Over the past three decades, these four plates reached an equilibrium of sorts:

1. **Economy**—integration in the global economy and adherence to the "Washington Consensus" since Mexico acceded to the North American Free Trade Agreement,
2. **Technology**—effective adaptation and implementation of process and product innovations supporting business models based on scale and efficiency,
3. **Demographics, poverty and inequality**—a young and growing working age population; a focus on meeting basic human needs with often-innovative public policies; a primary concern with economic growth as a solution for poverty, but growing inequality.
4. **Environment**—some important government policy innovations coupled with poor enforcement; business attitudes too often focused on environmental protection as a cost to be minimized and an impediment to competitiveness rather than as a competitive opportunity; natural capital not recognized as a strategic asset; distrust between the public and private sectors on policy;

[7] While with the exception of Baja California, Mexico is physically atop the North American plate, movement in the offshore Pacific, Caribbean, and Cocos plates impinges on its geology. Sometimes the Cocos Plate is considered subdivided into the Rivera Plate and the Cocos Plate.

These plates are not static; like their geological counterparts, they will overlap and clash. Their movement may be beneficial: businesses can discover new opportunities; workers can be freed from routine, backbreaking labor; new technologies can reduce greenhouse gas emissions and revitalize small local enterprises and agriculture; businesses can be revitalized and learn from the creative arts; cultural and biological diversity can reach global markets; the poor can gain access to reliable property registries and banking services.

Nonetheless, Mexican businesses and workers are unprepared to compete in a knowledge-based global knowledge economy: existing businesses will be disrupted; workers are likely to lose jobs to automation and shifting market demands, and inequality is likely to increase drastically; the "gig economy" may drive workers into low paid jobs without access to social safety nets. Existing environmental and societal challenges will be exacerbated, and today-unimagined new challenges will emerge.

This paper examines the opportunities and challenges facing Mexico in the coming decades. It draws on the research and findings of three projects examining scenarios of Mexico's future that The Lexington Group conducted in 2014-2015, for Mexico's Ministry of the Environment (Secretaría de Recursos Naturales y Medio Ambiente, SEMARNAT), and in 2017 and 2018, for Mexico's Ministry of Education (Secretaría de Educación Pública, SEP) and for the business coordinating council's (Consjeo Coordinador Empresarial, CCE) Business Center for the Study of Sustainable Development. The analysis and conclusions, however, are ours alone. (See text box)

In the following sections, we first describe socio-economic tectonics plates, as they exist today. We then pull together the findings of previous scenarios projects to identify three key vulnerabilities for Mexico facing a future knowledge economy. Lastly, we describe a possible path forward to meet the societal goals outlined in the current administrations Plan Nacional de Desarrollo in the context of the opportunities and challenges of rapidly evolving technology.

Five Projects Examining the Mexico's Plausible Future

In 2014-2018, The Lexington Group conducted five projects that used a scenario method to examine the implications of alternative plausible future for Mexico. The methodology was generally the same in all cases.

1. Three to four scenarios of plausible futures were developed based on background research and interviews with staff at the client and outside experts and stakeholders. Key questions in each case was, "What is your fondest hope?" and "What is your worst nightmare?"
2. Workshops were conducted with 80-100 staff or stakeholders in groups of 16-24 individuals. Participants were usually directors general (direct reports to the various sub-secretaries and directors who reported to them). The workshops had three components:
    a. Divergent thinking, traveling to the future: "You live in one of three (or four) plausible worlds in 2030. What policies would be important for Mexico in this world"
    b. Convergent thinking, back to the present: "It is the present day, given what you have learned about plausible futures, what actions would you take today?"
    c. "Pulling it all together," in plenary sessions participants prioritized the key learnings.

- Ministry of the Environment 2014-2015), "Future environmental challenges facing Mexico." Ministry staff examined the implications of future economic and social pressures for the environmental and natural resources (climate change, water, biodiversity and forests, marine life, waste) as they interacted with a range of socio-economic drivers (demography, poverty, industry, agriculture, tourism, urbanization). Key findings included: 1) a critical need for innovation if Mexico was to have just and sustainable future, 2) the need for modern energy, water and urban infrastructure, 3) the need for effective institutions for environmental governance.
- Ministry of Education, 2016-2017), "Public Education for of the Future." Ministry staff examined the future of education in light of technological and economic development. They examined how technology would change the skills students would need to participate in a 21st century economy. Students would increasingly need to interact with a knowledge economy driven by artificial intelligence, robotics and ubiquitous data. They would require new skills: "learning to learn" rather than rote learning, teamwork and collaboration, diversity and inclusiveness, initiative, creativity, problem solving, civics and ethical behavior.
- CESPEDES/CCE (Business Center for Sustainable Development Studies/Business Coordinating Council, 2017-2018). "Mexico Facing the Future and the UN Sustainable Development Goals." 81 representatives of major corporations, entrepreneurial businesses, business organizations, NGO's and academic institutions engaged in thinking about the meaning of the UN SDG's for Mexico in the context of a rapidly changing social, economic and technological future to 2030. Key findings included: the SDGs highlight Mexico's social and environmental vulnerabilities, action is urgently needed to address these vulnerabilities (particularly in innovation, infrastructure and institutions of governance), Mexico must revamp its education system to attain a just and sustainable future, Mexico's ethnic, cultural and biological diversity and its natural capital are key underappreciated assets and opportunities as it faces the future..
- PAOT (Attorney General for the Environment and Land Use for Mexico City) examined the environmental future of Mexico City. The project highlighted social and environmental vulnerability of Mexico City driven by the intersection of social and environmental pressures and environmental justice.
- Council of Mexican Business Owners (COPARMEX) "Future Entrepreneurial Opportunities." About 200 young entrepreneurs used scenarios to identify future entrepreneurial business opportunities.

III. The Socioeconomic Tectonic Plates Today

For context, we describe below how each plate is situated today. We will then look at the forces causing them to shift and Mexico's opportunities and vulnerabilities in the decades ahead.

A) Economic models: competing in the national and global economies

Since its accession to the North American Free Trade Agreement (NAFTA) in December 1994, Mexican economic policy has adhered faithfully to the precepts of the "Washington Consensus"—openness to the free movement of goods and capital, deregulation, and stable macroeconomic policies. (In general, the current administration has continued to adhere to these precepts). In the global economy, Mexico has benefited from a hard-working, well-trained, inexpensive workforce supervised by managers and executives trained in efficient management practices. The result has been steady, if not spectacular, economic growth. This growth has resulted in the gradual creation of a middle class working in manufacturing and services coupled with significant economic and regional disparities among regions that do and do not participate in the global economy.

McKinsey Global Institute attributes Mexico's low growth in economic productivity to the existence of "two Mexicos"—one a productive "modern" Mexico with a well trained workforce that participates in the global economy and the other a Mexico of micro and small, informal, companies that employ the vast majority of the population in low productivity, low wage jobs.[8]

For our purposes it is more useful deconstruct McKinsey's "modern" Mexico into realms of business activity based on returns to scale, markets, strategy and the locus of decision-making. In the "modern" Mexico, economic activity operates primarily in the first of two economies described by the economist W. Brian Arthur in an important 1996 article in *Harvard Business Review*.[9] This is the economy of diminishing returns to scale, known to every student of microeconomics. It rewards resources, scale and efficiency. Mexico today is not a significant participant in the other economy, the economy of the future, where the global technology platforms operate. This economy is characterized by increasing returns to scale. It rewards early movement, agility and speed. Physical assets become an encumbrance.

[8] McKinsey Global Institute, *A Tale of Two Mexicos, Growth and Prosperity in a two speed economy*, March 2014
[9] W. Brian Arthur, Increasing Returns to Scale and the New World of Business, *Harvard Business Review*, July-August 1996. The increasing returns economy is described in an earlier book, *Increasing Returns and Path Dependency*, University of Michigan Press, 1994

W. Brian Arthur on Diminishing Returns to Scale

Our understanding of how markets and businesses operate was passed down to us more than a century ago by a handful of European economists—Alfred Marshall in England and a few of his contemporaries on the continent. It is an understanding based squarely upon the assumption of diminishing returns: products or companies that get ahead in a market eventually run into limitations, so that a predictable equilibrium of prices and market shares is reached….

Marshall's world lives on a century later within that part of the modern economy still devoted to bulk processing: of grains, livestock, heavy chemicals, metals and ores, foodstuffs, retail goods…

W. Brian Arthur, Increasing Returns to Scale and the New World of Business, *Harvard Business Review*, July-August 1996.

The Woodrow Wilson Center 2014 report, *Fostering Innovation in Mexico*, uses a typology of companies put forward by the economist David L. Birch, "The big companies, elephants, are slow and not very innovative," he said, "Then there are a large number of very small firms—mice—that run around but fail to develop. And then the gazelles...small firms that grow quickly and create employment." [10] This typology generally characterizes Mexican companies, but the gazelles are few and far between. Within the Arthur's world of diminishing returns, Mexican companies operate in six categories of economic activity.

The first three categories are the realm of the elephants:

Major, very large, national companies that dominate their sectors in national (and some international) markets.[11] About thirty of the 50 largest companies in the *Expansión* list of the largest companies in Mexico are Mexican companies. [12] These companies dominate economic activity in Mexico. Most have been in existence in some form for over 75 years and are in essentially the same business today as they were in the 1970's. They have been remarkably stable: five of the companies in *Expansión's* list of the ten largest Mexican companies in 1975 are also in the 2019 list, and all but one existed in 1975. By contrast, only one of the world's 10 largest

[10] Woodrow Wilson International Center for Scholars, Mexico Institute, *Fostering Innovation in Mexico*, 2014.

[12] *Expansión*, June 2016, "Las 500 Empresas mas Grandes de México."

companies in 1975 is on the 2018 list, and seven of the largest companies in the world 2018 list did not exist in 1974.

The largest Mexican companies tend to be in basic goods and secondary sectors where transport costs and resource access favor local or regional producers, (energy, chemicals, cement, steel, food and beverages) or where local knowledge and regulatory access give an advantage to local companies (retail, infrastructure, telecommunications, finance). While individual company strategies differ, their strategies are based on financial prowess, market dominance, local and regulatory knowledge and access, efficiency and process improvement. They build oligopolistic advantages in mature markets through access to markets, barriers to entry, scale, low input costs, resources and efficiency.

These companies may be government-owned (PEMEX, CFE, INFONAVIT) or the products of the privatization of formerly state-owned companies. Others descend from businesses established by entrepreneurial families in the late 19th and early 20th centuries in Monterrey and Mexico City, having grown from regional beachheads in basic products into sophisticated global powerhouses. Some, such as Grupo Bal, have leveraged their financial resources to become conglomerates in a wide array of industries. Others, such as Bimbo, have concentrated on a single sector. In some cases, such as Cerveceria Cuauhtémoc, they are now part of multinational companies with substantial equity participation by the original owners in the multinational parent company.

In global markets the very large Mexican companies have often become successful multinational companies. As Donald Lessard and Rafael Lucca have pointed out, they have succeeded in leveraging the appropriate knowledge and experience gained competing in their home country to extend their scope internationally (Cemex, FEMSA, Bimbo, Alpha, Grupo México). Importantly, they have also been able to co-evolve outside of Mexico, mixing homegrown knowledge with learning from new environments.[13] Nevertheless, while operational control has devolved to their host countries, strategic control remains firmly ensconced in Mexico City or Monterrey.

International corporations operating in Mexico. Conversely, major global corporations operate in Mexico to access the Mexican (and in some cases international[14]) market, supplying retail and

[13] Donald Lessard, Rafael Luca, Mexican Multnationals, Insight from CEMEX, MIT Sloan Research Paper No 4721-08, October, 2008

[14] Increasingly, there exists an opportunity to access international markets through bilateral trade agreements.

commercial and industrial products and services to Mexican consumers and businesses. They are active in virtually all sectors and include global corporations from retail markets (Walmart, Costco) to chemicals (BASF, Bayer, Dow, Braskem) to pharmaceuticals, (Pfizer, Sanofi, Merck, Novartis, Johnson and Johnson) transportation (Ford, GM, FCA, VW, Volvo) technology (IBM, Huawei, Dassault Systems,), finance (CitiBanamex, Santander), consulting (McKInsey, Bain, BCG, PwC, Deloitte), to the recently opened energy markets (Iberdola, Shell, Exxon).

The international companies operating in Mexico make important contributions to the economy as responsible economic actors, but their main business is supplying products and services designed and developed abroad to the Mexican market. While they adapt their products, services, and operations to the Mexican market through their Mexican subsidiaries, their core technologies and capabilities are based in their home countries. Local operational control is often strong, but strategic control remains firmly in Detroit, New York City, Minneapolis, Paris, Frankfurt, Bilbao, Santander or Shenzhen. They are subject to the desires of their home country management and global shareholders and (increasingly) to pressure from governments in their home countries.

Suppliers to global value chains. Since NAFTA, a major arena of economic activity has been participation in global value chains in transportation, aeronautics, technology, manufacturing, agriculture. These companies are descendants of the "maquiladoras" (companies with special tax treatment that operated in Mexico prior to NAFTA, using local labor, receiving inputs from outside the country and selling abroad exclusively). They have been major beneficiaries of Mexico's participation in the global economy.

Mexican suppliers to the auto industry as well as the large global auto companies make up an important component of the 500 largest companies in Mexico. Several of the largest companies in Mexico (Nemak, Magna, Proeza) supply the automobile industry. They, and General Motors, Fiat Chrysler, Volkswagen, Nissan, Honda, Ford, and Toyota are all among the 50 largest companies in Mexico.

The top tier companies, seldom located in Mexico, are responsible for overall product design marketing and distribution. In some cases, local suppliers participate in, and compete on, the basis of component design. But most compete on low margins, cost effective production of components,

leveraging a well-trained inexpensive labor force.[15] They compete internationally and source their capital and inputs internationally. Whether they are Mexican or foreign owned, their Mexican "management" focuses on operations, human resources, community relations, regulatory know-how and logistics. Key investment, location, technology and product design activities are taken by their top tier value chain customers or by home country decision makers.

Mexico discovered with the "China shock" of China's accession to the World Trade Organization in late 2001 that value chains are vulnerable to closure as another country becomes more attractive as a site for operations. Mexico recovered from the China shock by offering global supply chains more proximate, reliable manufacturing capabilities at a competitive price; they remain subject, nevertheless, to the whims of the global economy. It is instructive that companies such as Delphi Automotive Systems in Ciudad Juarez, which successfully weathered the "China shock," did so in large part because they had significant local design and R&D capabilities that were not easily transferred.

Potential and real gazelles:

Potential gazelles—Below the top 50 companies (ranked 51-500 in the *Expansión* list) there is a group of large to mid-sized companies that compete in the Mexican market and have also made forays into international markets. In some cases, they are subsidiaries of the very large companies. About half of the companies ranked 51-500 by *Expansión* are Mexican. They tend to be more diverse, and often younger, than the companies in the top 50. They include additional sectors, particularly services (entertainment, restaurants and lodging, software, commerce, insurance). Market dominance and size are less important among these firms, but local knowledge remains important. They tend to be good at exploiting niches, but do not invest heavily in R&D.

[15] As a recent McKinsey Report, *Globalization in Transition; The Changing Face of Global Value Chains*. Points that global value chains themselves are in transition: shifting from trade in goods to trade in services, (and embodying more services and R&D in goods traded) focusing more on intra-regional trade where proximity to markets and R&D centers is important, and moving away from low labor cost.

The Changing Face of Globalization

Skepticism about the benefits of globalization has been on the rise not only among populist movements, but also among serious economists. In an important recent article in *Foreign Affairs* magazine, the Harvard economist Dani Rodrik (the Ford Foundation Professor of International Political Economy at the John F. Kennedy School of Government at Harvard University and President-Elect of the International Economic Association) reconsiders globalization. He argues that the "hyper-globalization" that characterized China's admission to the World Trade Organization and NAFTA was based on a too-optimistic vision of its political and economic benefits and an insufficient concern for its negative domestic consequences. Like the gold standard in the late 19th century, hyper-globalization subordinated domestic policies to promotion of international trade. Not-coincidentally the gold standard, like globalization since 1990's gave rise to populist movements among the losers from globalization:[1]

> "A government on the gold standard had to fix the value of its national currency to the price of gold, maintain open borders to finance, and repay its external debts under all circumstances. If those rules meant the government had to impose what economists would today call austerity, so be it, however great the damage to domestic incomes and employment.
>
> That willingness to impose economic pain meant it was no coincidence that the first self-consciously populist movement arose under the gold standard. (p.28)

As was the case in the late 19th century, today the losers from globalization are asserting themselves. Rodrik does not discount the net benefits of globalization, but he argues for an arrangement closer to the Bretton Woods regime after the Second World War that allowed flexibility for national governments to cushion its impacts on negatively affected domestic constituencies.

Independently of political-economy arguments put forward by Rodrik, McKinsey Global Institute reaches six conclusions that have important implications for Mexico:[1]

1. "Goods producing value chains have become less trade-intensive" as producing nations such as China are consuming a greater share of what they produce. For Mexico, this trend suggests that its participation in global value chains can shift to supplying the national market as global markets become less dependent on the products it produces.
2. Importantly, "services play a growing and undervalued role in global value chains." Trade in services is growing 60% faster than trade in goods. "Telecom and IT services, business services, intellectual property services and intellectual property charges are growing two or three times faster." McKinsey further suggest that the intangible value of these services is understated in available data. Mexico is primarily a purchaser not a supplier of these services. Their growth suggests an important opportunity and vulnerability for Mexico.
3. "Trade in labor cost arbitrage is declining." The share of labor cost arbitrage, particularly in manufacturing, is declining. This trend will be magnified by robotization and artificial intelligence. For Mexico, this will mean that low labor costs will become a decreasing factor in global competitiveness.
4. "Global value chains are growing more knowledge intensive." R&D, intangible assets, software and intellectual property are growing in their share of trade. This trend could pose problems for Mexico whose investment in R&D and knowledge is minimal.
5. "Value chains are becoming more regional and more global." Until 2012 the cross-global component of trade dominated; since 2012 intraregional trade has grown more rapidly. Mexico is already highly dependent on the U.S. but could look to Central and South America.

Gazelles—Entrepreneurial companies, a new generation of entrepreneurial business leaders is emerging. They have been supported by national government (CONACYT, Instituto Nacional del Emprendedor, INADEM, now defunct) and state government organizations, by university-based entrepreneurship organizations as well as by individual investors and business foundations. Although the number and scale of these companies is small compared to the total economy, they have an important demonstration impact. Business schools, universities and entrepreneurship development programs are increasingly preparing new generations of students focused on entrepreneurship.

Few entrepreneurial companies in Mexico have grown into market-dominant companies. A 2017 Inter-American Development Bank report, *Technolatinas, Latin American Firms Riding the Technology Tsunami,* lists 123 Latin American technology firms with valuations greater than $25 million.[16] Of these 48% were Brazilian, 18% were Argentine. Only 14% were Mexican. The Mexican firms, moreover, tended to be older: 36% of the Mexican firms were founded prior to 1995 as compared to 5% of the Brazilian firms. An August 2019 listing by CB Insights, a market intelligence platform, of global "unicorns" (privately held start-up companies with valuations of over US$ 1 billion) contains 393 companies worldwide. Most are in the U.S., China, Europe with smaller numbers in non-China Asia, and Africa. Only four are in Latin America. Two of these are Brazilian and two are Columbian. There are no Mexican unicorns.[17]

The mice:

The "other" Mexico: informal, small and micro enterprises. Lastly, there is an important universe of small and micro enterprises with 50 or fewer employees. These account for 99% of firms, about 55% of employment and generate 23% of wages.[18] The majority of these are not entrepreneurial startups with an intention to grow, but rather what might be best described as "disguised unemployment," firms that exist because other employment is not available for their owners. As Santiago Levy and others have pointed out, this sector of the economy is not always informal, but

[16] InterAmerican Development Bank, 2017, *Technolatinas, Latin America Riding the Technology Tsunami.*
[17] CB Insights, $1B+ Market Map: The Worlds 390+ Unicorn Companies

[18] Hector Ruiz Ramirez, La Estratificacióm de la Micro, Pequeña y Mediana Empresa en Mexico, II Congreso Virtual Internacional Desarrollo Económico, Social y Empresarial en Iberoamérica (Junio 2017)

it is notably unproductive. Levy argues that labor and capital are misallocated as a consequence of well-intentioned social policies. Rather than "Schumpeterian competition" where capital and labor flow to more productive firms, government subsidies and perverse incentives reward employment in unproductive firms (or penalize employment in productive firms) and channel labor and capital to inefficient firms.[19]

B) Technology and innovation

In the January-February 2015 issue of *Foreign Affairs*, the Harvard Business School student of innovation, Clayton Christensen and his colleagues wrote an important article, "The power of market creation; how innovation can spur development." The authors described three forms of innovation:[20]

1) *Process efficiency:* innovations focused on the cost side of the income statement reduce inputs for the same or greater output. While these innovations increase companies' bottom lines and hence their shareholder value, they are not necessarily good for workers or communities. Christensen argues that efficiency innovation may be necessary to enhance competitiveness, but taken alone it will not produce sustainable economic growth
2) *Product and service improvement:* innovations that focus on improving existing products or services to maintain or increase their competitiveness with rival products. These innovations add "bells and whistles" or represent real improvements (today's automobiles are safer, more fuel efficient and more comfortable than their 2000 counterparts). Nevertheless, they displace existing products and services. They may protect or increase a firm's market share, but not the total market. They do not of themselves create new markets and lead to true economic growth.

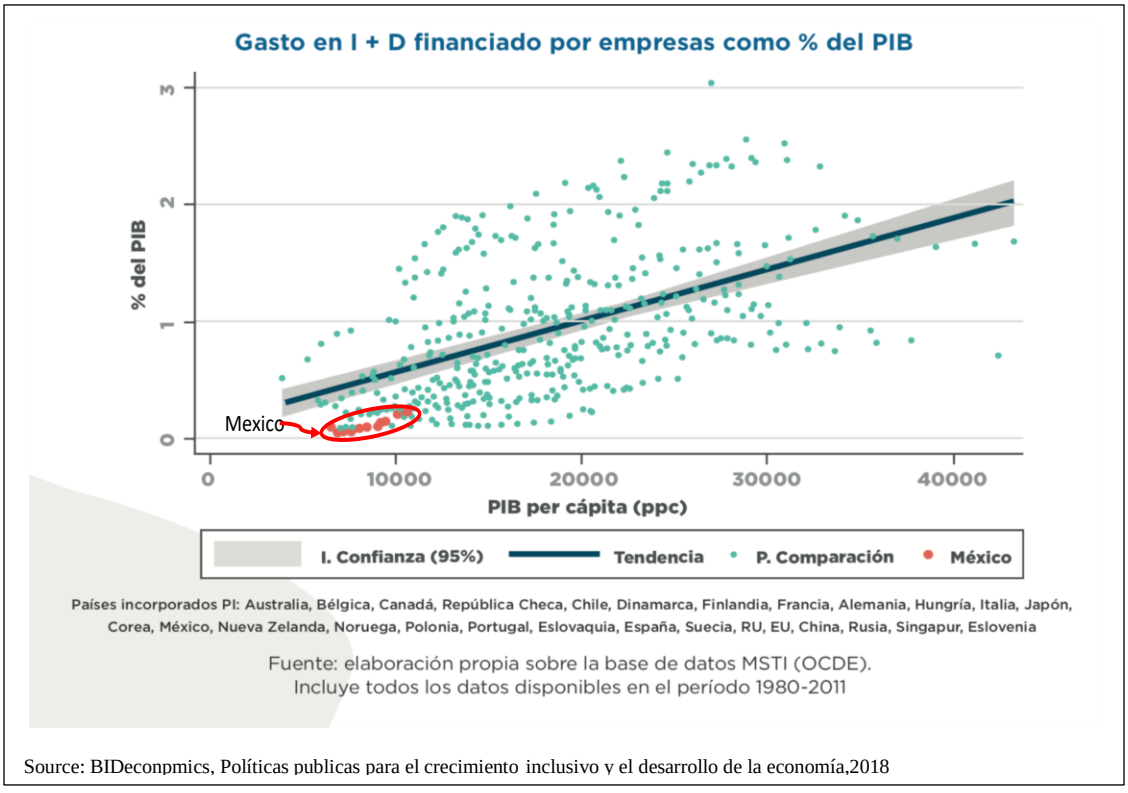
[19] Santiago Levy, *Under-Reward Efforts, The Elusive Quest for Prosperity in Mexico*, Interamerican Development Bank, July 2018.

[20] *Bryan C. Mezue, Clayton M. Christensen, and Derek van Bever, Foreign Affairs Jan Feb, "*The Power of Market Creation; How Innovation Can Spur Development" Christensen has since extended the argument in a book**,** Christensen, Clayton M.; Ojomo, Efosa; Dillon, Karen (2019), *The Prosperity Paradox: How Innovation Can Lift Nations out of Poverty*, New York, New York, USA: HarperBusiness,

3) *New business and market creation:* Christensen argues that economic growth comes only as a consequence of new market creation: supplying products and services that address previously unmet customer needs or needs that were previously ineffectively addressed.

We asked 17 business participants (including representatives of some of the largest companies in Mexico) in a workshop conducted as part of a project for CCE whether they could name a new market that their companies had created in the recent past. None of them could name one. There were frequent mentions of efficiency improvements and some mentions of product improvements, but none of new market creation. The data confirm this appreciation. Research and development expenditure is minimal in Mexico compared to virtually any peer group. According to a 2018 Interamerican Development Bank report, *Políticas para el crecimiento inclusivo y desarrollo de la economía,*[21] Mexican investment in R&D is less than 0.5% of GDP; over 60% of this is government investment. Private R&D expenditure, therefore, is about 0.2% of

Figure 1. Mexican Private Sector R&D Investment Compared to Other Countries 1980-2011



Source: BIDeconpmics, Políticas publicas para el crecimiento inclusivo y el desarrollo de la economía,2018

[21] BIDeconomics, *Políticas para el crecimiento inclusivo y desarrollo de la economía,* IInterAmerican Development Bank, 2018. Note that the comparator Group in the IDB study is primarily among knowledge intensive countries.

There are many theories of why Mexican companies do not invest in new market creation. In the discussions we conducted in the CCE project, companies cited obstacles in the cost of and access to capital; potential funders, by contrast, argued that "the funds are there; what is missing is investment-ready projects." Others argue that university-based innovation ecosystems are weak and restrictive intellectual property rules restrict the commercial use of university research (or lax enforcement of intellectual property rules discourages invention). In an interesting Woodrow Wilson Center monograph, Santiago Gutiérrez makes the case that the source of the absence of innovation is a management failure. CEO's have failed to adopt disciplined, structured management processes and have not prioritized the long term over the short term. Family-owned firms, which generate a surprisingly high 85% of GDP in Mexico, are not necessarily more long term focused and innovative than publicly owned firms; like publicly held companies, they too lack management processes that foster innovation.[22]

There may, however, be a simpler explanation: *Mexican companies do not innovate because they do not have to; their business models do not require innovation.* New business creation is not an important business necessity. The absence of innovation does not pose an existential threat to Mexican businesses. If there was a real need for business innovation, funds would become available; projects would be developed; workarounds would reward academic researchers for university-developed intellectual property; managers would adopt innovation-focused processes.

Business decision makers—owners and shareholders and senior executives— have done well with a business model that focuses on resources, efficiency, scale and oligopolistic competition. Consumers have benefitted from inexpensive access to products and services developed abroad; owners and managers of companies working in global supply chains have prospered; workers in formal jobs have, at a minimum, had middle class entry jobs and lifestyles. None of these accomplishments required business-creating innovations. But the economy has failed to create decent, productive jobs for a growing workforce. As we will note below, this model is unlikely to serve Mexican business well in the future.

[22] Santiago Gutierrez, *Innovation is a Job, Not a Miracl*e, The Woodrow Wilson Center for Scholars, 2018. In my own anecdotal experience consulting to major Mexican companies, I have found them to be highly receptive to structured management processes focused on continuous improvement processes such as Plan-Do-Check-Act, but more reluctant to think in terms of discontinuous improvement.

C) Demography, Poverty and Inequality

The consequence of a business system focused on efficiency rather than innovation has been a growth rate that has stagnated at around 2%. As Santiago Levy points out, that growth rate has been achieved due chiefly to increases in labor and capital inputs, not to increases in labor productivity.[23] A low growth rate has constrained Mexico's capacity to provide jobs and decent lifestyles for a still-growing working age population.

Demography: Demographically, today Mexico benefits from a "demographic bonus." A young and abundant working age population supports a comparatively small non-working population consisting of young people below working age and a still-small population of retirees. From 2005 to 2019 the economically active population grew 22% from 46 million to 56 million.[24]

Migration has historically served as a safety valve for excess labor during times of economic downturns. According to the Pew Research Center, about 11.2 million Mexican-born immigrants lived in the United States in 2019 compared to a resident population of 122.5 million.[25] (This figure is down from the 11.6 million noted by the Migration Policy Institute, possibly reflecting a less accepting political climate in the U.S.). In addition to important contributions to their countries of destination, emigrants are an important (though now declining) source of income for Mexico. Many small towns have benefitted from remittances from family members living abroad as their main source of income. Remittances from the U.S. peaked at US$ 29 billion in 2006 and have declined to US$ 22 billion in 2013 due to the combined effects of the financial crisis and a declining first-generation Mexican population in the United States.[26]

Ethnicity: Mexico's geology and history have made it ethnically more a salad with distinctive flavors than a homogenous melting pot. According to INEGI seven percent of the population speaks an indigenous language, but the average does not reflect regional realities: in the southern states of Oaxaca, Chiapas and Yucatan this figure is about 30% while in the northern states it is less than one percent. While a rich cultural resource, this ethnic/linguistic diversity complicates

[23] Santiago Levy, Unrewarded Efforts,
[24] INEGI 2019, Empleo y Ocupación
[25] Pew Researh Center, Fact Tank, "Key Findings About U.S. Migrants" June 2019
[26] Pew Research Center, "Remittances to Latin America Recover, but not to Mexico." November 15, 2013

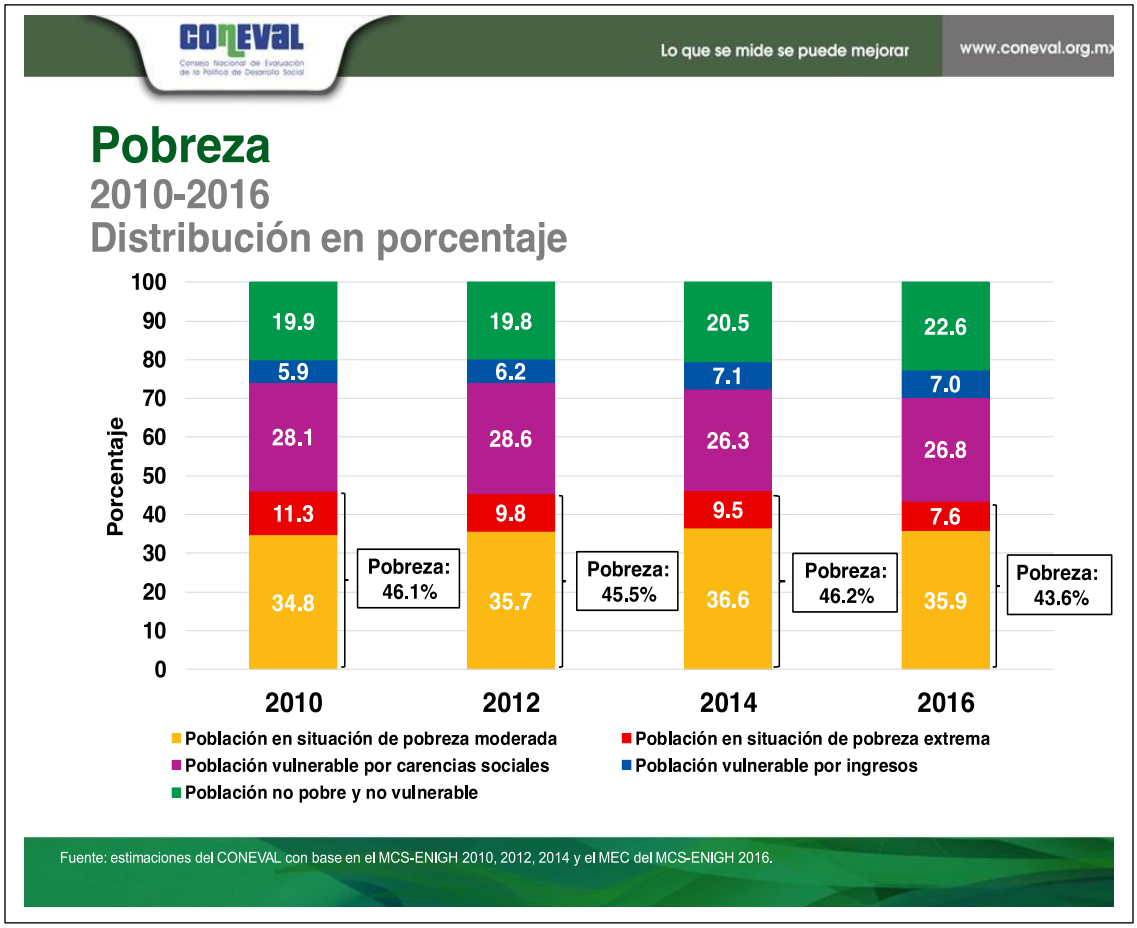
the provision of quality education to all groups of the population (the former administration had as a goal providing education in Spanish, English and the students' native languages).

Poverty: The glass is half full: an overall reduction of poverty. INEGI and Coneval (Consejo Nacional de Evaluación de la Política de Desarrollo Social) use a multidimensional measure of poverty that is one of the most sophisticated in the world.[27] As shown in Figure 2, in 2016 43.6% of the population was poor or extremely poor because it fell below the economic threshold for poverty and lacked basic social amenities. A further 26.8% are vulnerable because, though they are above the income threshold for poverty, they lack basic social amenities (education, housing, nutrition, health and social services) and 7% have access to basic social amenities but are below the income line for poverty. Only 22.6% are not vulnerable either in terms of income or in terms of access to social amenities.

Since 2010, poverty has decreased gradually. Total poverty (extreme and moderate) has declined from 46.1% of the population to 43.8%. Most notable has been a 32% reduction in extreme poverty from 11.3% of the population in 2010 to 7.6% of the population in 2016 (moderate poverty has increased slightly as individuals moved from extreme to moderate poverty). The percentage of people who are not vulnerable either for income or access to basic social amenities has increased by 12% from 19.9% of the population to 22.6%.

[27] Mexico has one of the world's most sophisticated systems for measuring poverty and inequality. Based on the principles developed by John Rawls and Amartaya Sen, it measures poverty and inequality in terms not only of income but also of the capabilities and opportunities that enable all members of society to contribute to and benefit from participating in society. The availability of these data enables a more detailed analysis of poverty than is possible for most other countries. This system is described by the Centro de Estudios Espinosa Yglesias (CEEY), *Informe de Movilidad Social en Mexico* and it is the basis, coupled with data from INEGI, is the basis for the description below.

Figure 2. Poverty in Mexico



The glass is half-empty: enormous disparities in income and opportunities. In very simplified terms, the moral and political philosopher, John Rawls, defined a "just" society as one whose members would design if they were blinded by a "veil of ignorance" that prevented them from knowing what position they would occupy in that society (whether they would be rich or poor, talented or not, able or disabled, male or female, dark-skinned or light skinned, living in the north or south). Since the members of society would not know what position they would occupy, they would design a society that was fair to all members. Inequalities would be permissible, but only to the extent that all members of the society, and particularly the most marginalized members, benefitted from them.[28] The economist, Amartaya Sen, extended Rawls' thinking, defining

[28] John Rawls, *A Theory of Justice*, Harvard University Press, 1971.

"development as freedom" (the title of his major book)[29]. A developed society would be one whose members had freedom and capabilities necessary to participate effectively in societal decision making and to better themselves through talent and effort. By either measure, Mexico is an unjust and underdeveloped society.

According to the OECD, incomes are more concentrated in the top income decile in Mexico than in any of its peer countries in the OECD (Chile and southern and eastern European OECD members). The average income (after transfers and taxes) of the wealthiest 10% of the population is approximately 21 times higher than the average income of the poorest 10%. Among the OECD peer group, the wealthiest 10% make 8 times as much as the poorest 10%. Globally only Colombia and Brazil have a greater disparity than Mexico between the incomes of the richest and the poorest deciles.[30]

This concentration is even more pronounced at the very highest income levels. According to research based on tax records and census data by Sebastian Sandoval, a student of the French economist, Thomas Pikkety, the richest 1% of Mexicans controlled 13.2% of national income in 2009. This share decreased slightly to 12.4% and 13.0% in 2010 and 2011 respectively, but it recovered to 13.6% in 2102 (a higher fraction than any country except Columbia, Argentina and the USA). Incomes among the top 0.01% are even more concentrated. In 2012, the wealthiest 0.01% received about 3.2% of national income, a higher fraction than any country except the USA in Sandoval's study (US, Canada, Colombia, Spain, Argentina, Uruguay, France). Strikingly, over half of the income of the top 0.01% accrued to 709 individuals in the top 0.001% (1.7%).[31]

Social mobility is very limited: According to a report by the Centro de Estudios Espinosa Yglesias (CCEY *Informe*), a child born in the lowest quintile of the population by income has just a 3% of reaching the highest quintile in his or her lifetime and a 49% chance of remaining in the lowest quintile.[32] Conversely, a child born in the highest quintile has a 57% chance of remaining there and a 2% chance of falling to the lowest quintile. Among the middle three quintiles, mobility is

[29] Amartaya Sen, *Development as Freedom, Development as freedom* (1st ed.). New York: Oxford University Press 1999

[30] OECD *Country Economic Surveys, Mexico, Overview*, January 2017 p 26

[31] Sebastián Sandoval Olascoaga, *The Distribution of Top Incomes in Mexico: How rich are the richest?* Public Policy and Development Master's Dissertation Paris School of Economics, 2017, p.6

[32] Centro de Estudios Espinosa Yglesias, *Informe Desigualdad Social en México, 2019.*

greater, *but it is greater in a downward direction than in an upward direction*. A child born in the middle (3rd) quintile has a slightly greater chance of moving down to the 1st or 2nd quintiles than up to the 4th or 5th. A child born in the second poorest quintile is more likely move down to the lowest quintile than to stay in her parents' quintile or to move up.[33] Additionally:

- Regional disparities in economic mobility are very significant. In the south, a child born into the lowest economic quintile has a 67% chance of staying there and just a 2% chance of moving to the top quintile while in the north he or she would have a 23% chance of staying in the lowest quintile and an 8% chance of moving to the highest quintile.
- In all regions, women are more likely to stay in the lowest quintile and less likely than men to migrate to the highest quartile. Likewise, persons with darker skin color have a lesser chance of moving to higher income quintiles.
- A child born into the highest income quintile is 5.8 times more likely to complete high school than a child born into the lowest income quintile. According to senior SEP officials we interviewed in 2017, the strongest predictor of a child's educational achievement is his or her parents' educational achievement.[34] The CEEY study confirms this perception: the children of parents with no education are only 5% likely to complete college. (There is also good news here: they are only 8% are likely to remain, as their parents did, without any education and they are most likely to complete primary or secondary school).
- Job mobility is limited. Workers tend to migrate slowly up a job skills ladder (from agriculture to low skilled manual labor to high skilled manual labor, to commerce, to low skilled non-manual jobs to high skilled high skilled non-manual jobs). Workers leaving an agricultural workforce tend to go into manual jobs. Only 5% move into low skilled non-manual work and 3% to high skilled manual work. The CEEY *Informe* suggests that the absence of labor mobility goes beyond educational achievement: even children with higher educational levels than their parents tend to remain in their parents' job categories. (Paradoxically, as we will discuss below, this situation could have a silver lining as automation primarily threatens high skilled manual and low skilled non-manual jobs)

[33] Centro de Estudios Espinosa Yglesias, *Informe, Movilidad Social en México, 2019, 19*
[34] Interviews with senior SEP officials conducted as part of the research for the Sep project.

Mexico's new president, Andrés Manuel Lopez Obrador (AMLO), addresses the frustration of a population that has witnessed decades of highly uneven growth. It is possible to disagree with the solutions that the administration has proposed, but the vision of the purpose of economic growth in the *Plan Nacional de Desarrollo* is difficult to take exception to:

> Economic growth, increased productivity, and competitiveness are not ends in themselves; rather they are means to achieve a superior objective: the overall well-being of the population.

The *Plan Nacional de Desarrollo* goes on to state that with the "Fourth Transformation,

> We should demonstrate that without authoritarianism, it is possible to create a national direction that modernity can be achieved from below excluding no one and that development does not have to be at the expense of social justice.[35]

D) Environmental sustainability

In 1996, The Lexington Group supervised a survey of corporate environmental management practices in Mexico for the World Bank. In all but the largest companies closely associated with foreign partners, the concept of environmental management was unknown. When survey interviewers from the Tecnológico de Monterrey asked to speak to the "person in charge of environmental issues," they were often directed to the janitor.[36]

The glass is half-full: today there is much greater business awareness of the need to manage environmental issues than there was three decades ago. Most large companies have well established corporate environmental departments; many have certified their environmental systems to ISO 14001 or other international standards; some are taking important initiatives in areas such as water conservation, energy efficiency and renewable energy.[37] The Business Coordinating Council (Consejo Coordinador Empresarial) has an active business center for the study of sustainable development (Centro del Sector Privado de Estudios en Desarrollo Sustentable, CESPEDES), and many companies are certified as *Empresa Socialmente Responsable*, which includes an important element of environmental responsibility.

[35] Presidencia de la República México, *Plan Nacional de Desarrollo. 2019-2024, p.6.*
[36](The Lexington Group, *Corporate Environmental Management in Mexico, Report on a Survey, 1996),*
[37] For excellent examples of Mexican corporate environmental initiatives in Latin America see, Daniel C. Esty, editor, *The Labyrinth of Sustainability*, Anthem Press, 2019.

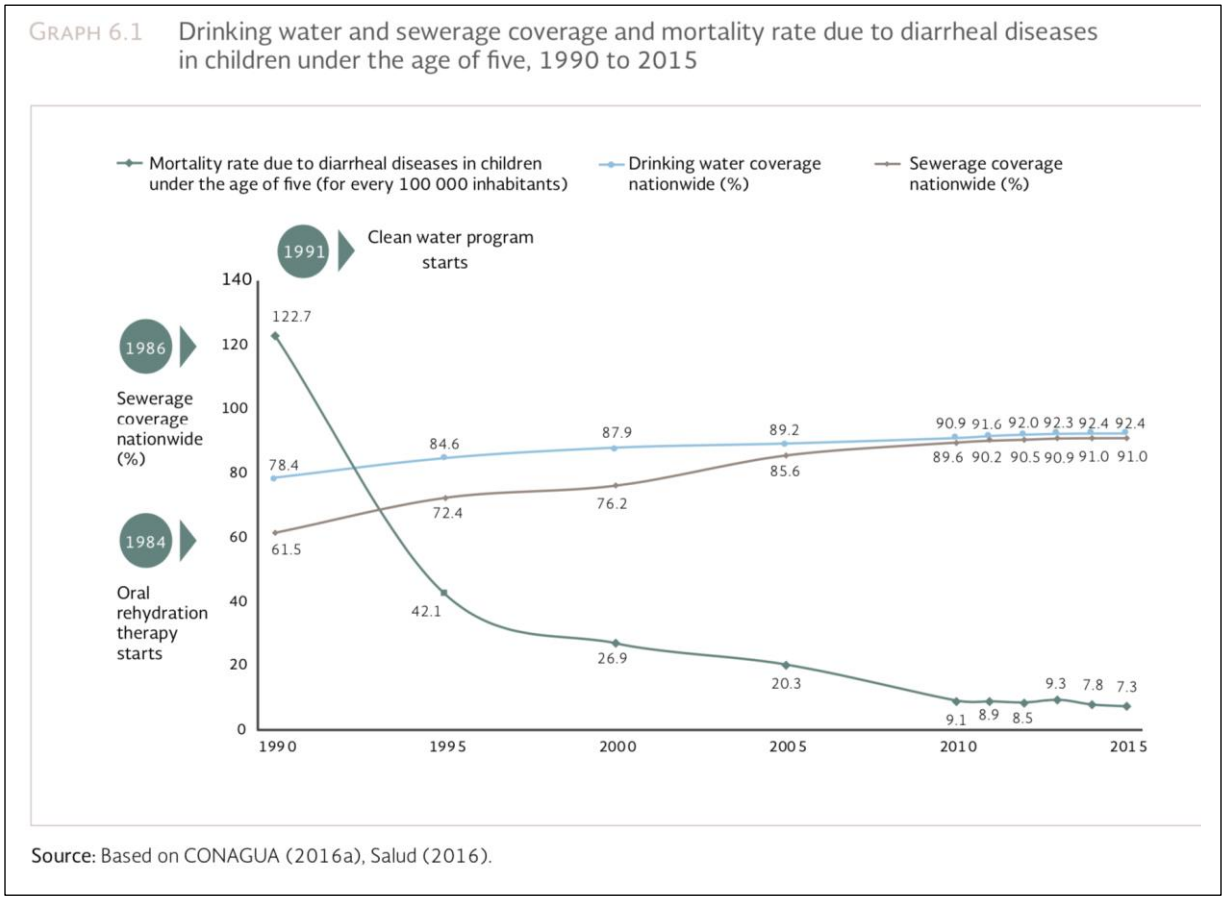
Mexico established a modern environmental agency, SEMARNAT (Secretaría de Protección Ambiental y Recursos Naturales[38]), in the 1970's following up on the 1972 UN Conference on Sustainable Development. In contrast to the US Environmental Protection Agency whose mission is exclusively environmental protection, it encompasses both environmental protection and natural resource conservation. The Ministry has developed a comprehensive, and sometimes innovative, program of environmental protection (for example, its Licencia Ambiental Única and Industria Limpia programs). It has one of the few carbon tax laws in the world, albeit a minimal one, and until recently environmental regulatory enforcement has improved.

Additionally, to México's credit, past administrations have taken climate risks and biodiversity loss seriously in international arenas. It was instrumental in developing the "bottom up" approach used to reach the Pairs Climate Accords in 2015, and it has been a leader in uniting megadiverse countries in calling attention to biodiversity loss.

Drinking water quality and access have been major areas of improvement. According to CONAGUA's (Comisión National de Agua, National Water Commission) 2017 compilation of Statistics on Water in Mexico, between 1990 and 2015 coverage of tap water services increased from 78.4% to 95.3%, access to sewage and basic sanitation services increased from 61.5% to 95.3% and, most notably, child mortality due to diarrheal diseases decreased from 122.7 per 1,000 live births to 7.3 in 2015 (Figure 3).

[38]Originally, the Ministry was named Secretaría de Protección Ambiental. Recursos Naturales Pesca (SEMARNAP, but its name changed in 1994 when it lost oversight of fisheries to the Ministry of Agriculture. Prior to SEMARNAP, environmental responsibilities were distributed among ministries.

Figure 3. Drinking Water and Sewerage Coverage and Mortality Rate Due to Diarrheal Diseases in Children under the Age of Five, 1990-2015



The glass is half-empty: Nevertheless, Mexico is highly vulnerable to the impacts of climate change, and environmental vulnerabilities are increasing, not decreasing, despite some strong, but intermittent efforts. Large areas in the center and north of the country are vulnerable to extreme water shortages and the south is increasingly vulnerable to flooding and hurricanes. The past three decades have witnessed important biodiversity losses including among iconic species such as the monarch butterfly and the "vaquita marina" (the world's smallest and most endangered marine mammal, indigenous to the Gulf of California) that have been diminished or pushed to the brink of extinction, victims of habitat loss, poor management and increased pesticide use.

According to the 2013 Programa Nacional Forestal (PNF) component of the 2013-2018 Plan Nacional de Desarrollo, in 2013 Mexico had about 138 million hectares of forested land. These include highly important formations such as jungles and mangroves. In the period 2005-2010

Mexico lost on average 155 thousand hectares of forest land yearly, primarily to agriculture but also to tourism, urbanization and to climate change. This figure is a substantial improvement on the rate of loss in the period 2000-2005, which was 235 thousand hectares per year.[39] The PNF also notes that human populations living in forested areas are particularly vulnerable socio-economically. They are twice as likely as to be illiterate as the population as a whole, 60% as likely to have completed primary education, 40% as likely to live in housing with dirt flooring and three times as likely to lack access to electric energy. These conditions are conducive to a subsistence economy that contributes to deforestation.

Although drinking water quality has improved, water supply is a critical issue in the north and central parts of the county. Important problems remain beyond disinfection and diarrheal disease. Naturally occurring arsenic and fluoride contamination in the north central part of the country remain unaddressed as do chemical and byproduct pollutants such as trihalomethanes.

Perhaps most disturbingly, environmental problems are not part of the public agenda. The current government does not appear to be making the environment a priority. The 2019 *Plan Nacional de Desarrollo* makes scant reference to the environment. Its focus on major infrastructure projects such as the Tren Maya and on national energy independence through the fossil fuels, moreover, creates substantial environmental threats.

While private sector companies have taken important steps in improving their environmental practices, the primary approach to the environment has been one of seeing it as an operating cost to be minimized and a matter of legal compliance rather than as a strategic opportunity. Mexico has enormous natural capital resources but protecting these has too often been seen as a cost of business rather than as an opportunity to develop sustainable business that leverage natural capital.

It is not clear at this time how the AMLO presidency will address energy and environment issues. The current government came into office with a strongly nationalistic stance, focusing on development of Mexico's fossil fuel resources, skeptical of foreign investment and discounting renewable energy as expensive and unreliable. The symbol of these policies has been the administration's proposed Tabasco refinery, which critics suggest will become an expensive white elephant. Shortly after coming into office, Mexico canceled a scheduled clean energy tender for

[39] Plan Nacional de Desarrollo; Programa Forestal
http://www.conafor.gob.mx:8080/documentos/docs/4/5382Programa%20Nacional%20Forestal%202014-2018.pdf

non-hydro renewable energy capacity, which was fundamental to Mexico's ability to meet its commitments under the Paris Climate Accords.[40] Meanwhile, international investors have been losing confidence in Mexico as an investment target, including for pipelines to import less expensive and less contaminating natural gas from the U.S., and developing Mexico's abundant renewable energy resources. This loss of investor confidence in energy investment in Mexico could affect the development of renewables as well as traditional energy sources.

Recently, there have been encouraging signs of shifts in the government's position. In August 2019, Mexico's utility company (Comisión Federal de Electricidad, CFE) signed an agreement, brokered by Carlos Slim, with utility companies to restart completion of cross border pipelines for natural gas importation. Whether this will mean a retrenchment in the Administrations hard line position of energy independence through reliance on the fossil fuel industry is unclear.

[40] *New York Times,* April 11, 9019, "In Bid to Halt an Energy Slide, Mexico turns to a trusted supplier: Mexico"

IV. How Prepared is Mexico to Compete and Flourish in the Future?

The Lexington Group's studies for SEMARNAT, CCE, and SEP used scenarios of the future to examine how shifts in the socio-economic tectonic plates that underlie Mexico might affect it in the future. As with tectonic plates, we can know socio-economic plates are shifting, but we cannot predict with any certainty when and where these shifts will manifest themselves.

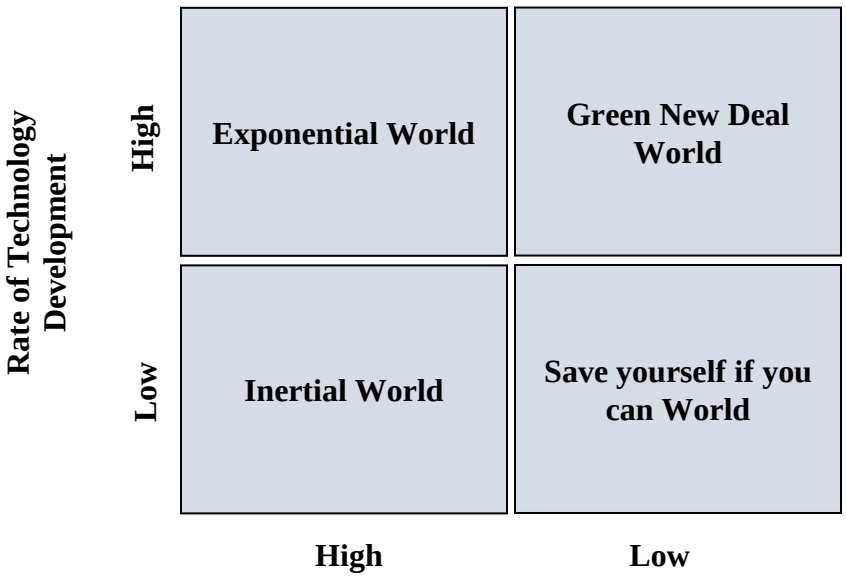
Scenarios suggest plausible futures. They are a tool to think about, to anticipate, but not to predict the future. They enable decision makers to ask, "what if?" But they do not describe a preferred future; rather they require decision makers to think about futures they would not prefer but which they may have to face. They immerse participants in plausible future worlds--to consider whether they are prepared for future challenges, to stress test current strategies and to devise new strategies.

Our analysis takes as a starting point the state of the socio-economic plates as they exist today as described in the previous section. We then superimpose plausible futures on present conditions. In designing the scenarios, we used two "axes of uncertainty" exogenous to Mexico over which Mexico (or for that matter any nation) has littler control, but which will fundamentally affect its destiny. These two axes correspond to the two "socio-economic tectonic plates" that we argued above are driven primarily by independent variables external to Mexico:

- *The development of the global economy:* will the global economy maintain a fundamental orientation to the free movement of goods, services and capital that has characterized the past three decades? Or will nations, responding to increasing populist pressures, retrench from globalization, becoming increasingly autarkic and protective of domestic industries and workers, slowing growth in the global economy?
- *The future of technology:* Will the projections by "techno-optimists," (for example Peter Diamandis and Ray Kurzweil) of exponential technological progress prove correct? Or will countervailing tendencies, for example, the end of Moore's law;[41] obstacles to the achievement of "artificial general intelligence;" (artificial intelligence that is indistinguishable from human intelligence) societal resistance to gene editing, loss of privacy, cyberwarfare and cybersecurity, regulation of "big tech") stall technological development?

These two axes of uncertainty yield four plausible worlds. (See text box)[42]

Figure 4. Plausible Futures for Mexico



[41] Moore's law postulates that the number of transistors on a microchip (that is its computing power) doubles every two years while its cost is halved. It proved a remarkable predictor of progress from 1975 to 2015, but progress has since slowed and according to Moore himself will ultimately end.
[42] For resource reasons, the Green New Deal scenario was not elaborated in detail for the CCE Project.

All three projects held workshops where participants received “histories of the future” for their assigned scenario. Each group was asked to “live in 2030” and develop strategies to address the needs of their assigned world. They then reconvened in new groups that included individuals that had “lived” in each of the other scenarios and returned to the present world to consider what Mexico should do today given what they learned about plausible futures.

Rather than focusing on the specific policy recommendations that came out of the projects, this section focuses on three key vulnerabilities that participants identified in the shifts in the socio-economic tectonic plates that define Mexico and could be critical as Mexico attempts to adjust to an uncertain global context and to inevitable technological change. It is not an exaggeration to say that if these shifts are not attended to, Mexico could become a failed state.

Four Plausible Futures to around 2035

The objective of scenarios was to provoke thinking of how factors outside Mexico's control would affect its future. Most of the projects used four scenarios:

I. *Exponential World*—the techno-optimists were right. Key developments—the continuation of Moore's law and advances in achieving artificial general intelligence (effectively indistinguishable from human intelligence) enabled a technologically driven world. Machines substituted for humans in most routine manual and cognitive tasks, autonomous vehicles became prevalent outside rural areas. Using digital "apps" it became possible to substitute shared "skills, stuff and space" for products. Technology controlled by huge platform players enabled small players to compete with major institutions in commerce, banking, manufacturing and transportation. Nevertheless, technology had its clear downsides: in Mexico middle class entry jobs were lost to automation as machines replaced workers in routine manual and cognitive tasks; lacking an alternative, workers drifted to the "gig economy" at lower wages and without social safety nets: ubiquitous use of data gave rise to "surveillance capitalism" by those who controlled the data; economic and political power concentrated in a few monopolistic companies. While a technological/service economy had a lower greenhouse gas footprint, it gave rise to unanticipated environmental challenges; social and economic inequality increased dramatically.

II. *Business as usual world*—As the French say, *plus ça change, plus ça reste le même*--technology stalled: Moore's law officially ended, and cybersecurity and privacy concerns increased skepticism about a move to a technological world. Changes in governments in the United States and Europe overcame populist nationalism and the global economy continued to stumble along at about 3% per year. In Mexico, value chains were maintained, and the economy continued to grow steadily, if unspectacularly. The AMLO administration had made extreme inequality unacceptable and inequality continued to decrease, and poverty was reduced. Nevertheless, little was done globally or in Mexico to address the declining state of the environment. The environmental catastrophes foreseen by the UN panels on climate change and biodiversity with their attendant impacts on the economy now seem inevitable. Most experts anticipate major unavoidable decreases in economic growth and human well-being.

III. *Save yourself if you can world*—technology stalled as Moore's law ended and government and private hacking took down all but the most secure private and government data systems. Trade disputes turned into trade wars and in some cases into actual hot wars. The global value chains, on which the Mexican economy depended, were decimated. What businesses survived the global upheaval, focused on "doing more with less," primarily by cutting wages and jobs. The results were massive economic migrations and a return to subsistence agriculture as urban and rural workers invaded the countryside to scavenge for food for their families. There were two silver linings: 1) it was no longer possible for business or government to ignore the problems they faced together; "grand coalitions" designed to address economic collapse were formed within and across nations, 2) decreased economic activity gave rise to lower greenhouse gas emissions and the day of reckoning with climate change was postponed.

IV. *Green World*— "Green" parties in the United States and Europe were victorious and China took an environmental leadership role. Degrowth policies, that put technology at the service of human wellbeing and the environment ahead of economic growth became the norm. The positive environmental effects are undeniable. Nevertheless, in developing nations, where jobs were important, the "green economy" did not create a sufficient number of jobs to compensate for the jobs lost by the traditional economy.

A) Key Vulnerabilities

We found three key vulnerabilities:

1) *Mexico is poorly prepared to compete in a future knowledge-based economy.*
2) *Mexico is highly vulnerable to the social and environmental consequences of future sustainability trends*
3) *Mexico's public and private institutions are unequal to the challenges of the future.*

1) Mexico is poorly prepared to compete in a future knowledge-based economy.

Competitiveness in technology-oriented scenarios will key on the ability of an economy to create new businesses and to ensure the resiliency of existing business. The Mexican economy, based on resources and efficiency, with weak innovations systems and an education system using 20th century methods, is poorly positioned to compete in a knowledge-based global economy.

a) *An economy based on resources, scale, efficiency, and product innovation will need to undergo a fundamental transformation*

In two of the four scenarios (Exponential World and Green World) the global economy is characterized by rapid technological change where a key factor in national competitiveness is the ability to innovate and create new businesses. In Schumpeterian creative destruction, new businesses will be created, and old businesses will be destroyed. Products (vehicles, computers, lightbulbs, residences, offices, fashion items, music, data storage and analysis) will become shared services. The "gig economy" and automation will transform the nature of work. Talent will replace assets and resources as the key source of competitive advantage, and it will flow freely (and often virtually) to where it is most rewarded. Four interlocking "economies" will prevail:

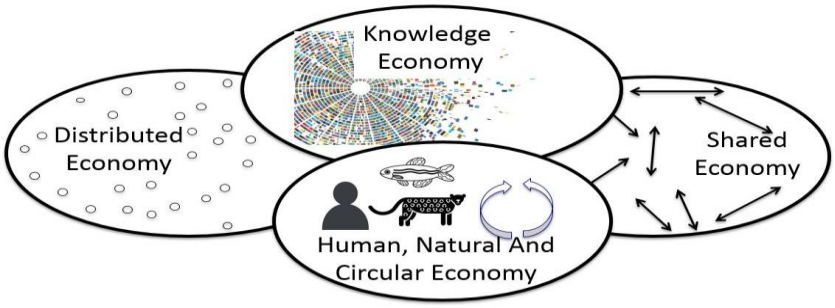
i. *A knowledge economy where knowledge and ideas are more important to economic competitiveness than are physical assets.* What you know will be more important than whom you know and what assets you control. Human intelligence will collaborate or be challenged by autonomous artificial general intelligence. Increasing returns to scale will prevail. Serving the billionth digital customer will cost less than serving the millionth customer.

ii. *A shared economy –"stuff, space, and skills" will be shared.* Individual workers and customers will be connected through ubiquitous "apps" and share knowledge, skills, data, working and living spaces and possessions. They will build trust through ratings in sharing platforms and find new ways of working in what has become known as the "gig economy." Access to shared technological capabilities will undermine the competitive advantage of assets, scale and resources.

iii. *A distributed economy where new technologies enable decentralization of economic activity.* Renewable energy generation and storage, manufacturing (3-D printing and synthetic biology), transportation (drone vehicles and airplanes), and record keeping and storage (blockchain) will make scale less important than resiliency and agility. Creativity and diversity will become more important than consistency and homogeneity.

iv. *A human, circular, and natural economy will become a strategic necessity.* Once considered a "nice to have" matter for corporate social responsibility, public relations and philanthropy, social and environmental sustainability become business imperatives. The survival of nations, societies and, indeed humanity as we know it today, will depend on environmental sustainability. Circular business models will become the new normal.

Figure 5. The Economies of the 4th Industrial Revolution



This is not a world in which most Mexican companies with business models designed for efficiency and diminishing returns to scale can easily compete. As Brian Arthur argued prophetically in 1996, new ways of thinking will be needed in a world where the world's largest transportation company owns no vehicles, the world's largest hotel chain owns no buildings, a social media company is introducing a new cryptocurrency, and the market for office space has been upended by a company that provides shared office space. (See text box)

W. Brian Arthur on Competition in a Knowledge Economy

From "Increasing Returns and the New World of Business" *Harvard Business Review* July-August 1996

"So we can usefully think of two economic regimes or worlds: a bulk-production world yielding products that essentially are congealed resources with a little knowledge and operating according to Marshall's principles of diminishing returns, and a knowledge-based part of the economy yielding products…. with a little resources and operating under increasing returns. The two worlds are not neatly split.

Competition is different in knowledge-based industries because the economics are different. If knowledge-based companies are competing in winner-take-most markets, then managing becomes redefined as a series of quests for the next technological winner—the next cash cow. The goal becomes the search for the Next Big Thing. In this milieu, management becomes not production oriented but mission oriented. Hierarchies flatten not because democracy is suddenly bestowed on the workforce or because computers can cut out much of middle management. They flatten because, to be effective, the deliverers of the next- thing-for-the-company need to be organized like commando units in small teams that report directly to the CEO or to the board. Such people need free rein. The company's future survival depends upon them. So they—and the commando teams that report to them in turn —will be treated not as employees but as equals in the business of the company's success. Hierarchy dissipates and dissolves….

…the style of competition in the increasing-returns arena is more like gambling. Not poker, where the game is static and the players vie for a succession of pots. It is casino gambling, where part of the game is to choose which games to play, as well as playing them with skill. We can imagine the top figures in high tech—the Gateses and Gerstners and Groves of their industries—as milling in a large casino. Over at this table, a game is starting called multimedia. Over at that one, a game called Web services. In the corner is electronic banking. There are many such tables. You sit at one. How much to play? you ask. Three billion, the croupier replies. Who'll be playing? We won't know until they show up. What are the rules? Those'll emerge as the game unfolds. What are my odds of winning? We can't say. Do you still want to play?

High technology, pursued at this level, is not for the timid.

In fact, the art of playing the tables in the Casino of Technology is primarily a psychological one. What counts to some degree—but only to some degree—is technical expertise, deep pockets, will, and courage. Above all, the rewards go to the players who are first to make sense of the new games looming out of the technological fog, to see their shape, to cognize them. Bill Gates is not so much a wizard of technology as a wizard of precognition, of discerning the shape of the next game. "

W. Brian Arthur, Increasing Returns to Scale and the New World of Business, *Harvard Business Review*, July-August 1996.

b) Innovation ecosystems are weak

Many of the major research universities in the world have spawned regional business innovation ecosystems that leverage university research and resources to spin off businesses based on university research. In contrast to high innovation countries where businesses and research universities are closely aligned, researchers at Mexico's great research universities and scientific research centers are often disdainful of "commercial work." The government-run National System of Researchers (Sistema Nacional de Investigadores, SNI) rates and ranks academic researchers and advocates for scientific research based on the quality of their scientific output. Even among private universities, the personal and professional motivations of reaching the highest levels in the SNI often far outweigh the financial benefits of participating in creating startup businesses. A vibrant human society cannot ignore the pursuit of knowledge for its own sake, but neither can it ignore the application of knowledge to addressing human needs.

Since most research is largely funded by the federal government, intellectual property restrictions have compounded the separation between research and commercial innovation. Profits from intellectual property developed with government funding have not accrued to private individuals or companies. Even academic researchers, who might otherwise have been interested in establishing links to commercial enterprises, encounter bureaucratic obstacles to commercializing their research. This is in contrast to universities such as MIT that actively encourage their researchers to "take our intellectual property and remember us in their wills."[43]

This situation is changing slowly. The 2015 Ley de Ciencia y Tecnología (Law of Science and Technology) facilitated the appropriation of the product of government-funded research with private partners. Following up on the provisions of the 2015 law, the National Autonomous University through its chemistry faculty has moved to enabling industry partners in jointly funded

[43] Here I insert a personal anecdote. Over 30 years ago, I directed a project for the US National Science Foundation designed to determine why some US universities created more spinoff businesses than other universities. When I interviewed the provost of MIT he gave two reasons why MIT generated spinoff businesses: 1) they gave all their professors one day a week for their personal consulting and they encouraged them to work with private sector companies; 2) they facilitated their professors appropriating intellectual property developed with MIT funding: "They will manage it better than we ever could *and* they will remember us in their wills."

research to participate in the economic benefits of that research. Nevertheless, bureaucratic and cultural obstacles to the commercialization of government-funded research persist.

A weak innovation ecosystem fails to support startup entrepreneurs. Entrepreneurs require financial, intellectual, physical and (importantly) psychological support systems--access to angel and venture investor capital, training and mentorship, co-working spaces and peer support. Recently, incipient entrepreneurship support systems funded by local governments, the federal government (through the now-defunct INADEM, Instituto Nacional del Emprendedor), foundations and foreign development agencies (USAID and GTZ) have begun to take hold. Even in major cities and academic centers, however, these systems are not self-sustaining and have not reached the scale of similar systems in innovation economies. INADEM, moreover, has been discontinued by the López Obrador administration.

The problem is not the absence of entrepreneurial initiative; it is the absence of support ecosystems. Mexican entrepreneurs frequently develop their inventions within entrepreneurship support systems abroad. According to the Kaufman Foundation, immigrants to the United States are twice as likely to form startup businesses in the United States and Latinos are the ethnic group that is most likely to form startups. Young entrepreneurs move to other countries in search of supportive ecosystems. (Clínicas del Azúcar referenced by Christensen et al in *The Prosperity Paradox* and was developed by a Mexican student at MIT's Sloan School with the encouragement of Julio Frenk, then Dean of the Harvard School of Public Health and formerly Mexico's Minister of Health. Cinepolis was conceived by a Mexican student while at Harvard Business School.)

c) The educational system fails to develop talent

In too many public schools, students are taught with rote methods that prepare them to participate in the economy of the 20th century, not the 21st century. Students are taught to learn facts, follow rules and respect institutions. At its best, the system has increased literacy and produced trained engineers and a disciplined workforce, but it does not produce creative innovators ready to compete a 21st century knowledge economy. The New Educational Model developed under the previous administration sought to develop more dynamic educational models based on critical thinking, group learning and "learning to learn." At this time, however, it is unclear whether the new administration will adopt these innovations.

An important 2009 report on Mexican education by the World Competitiveness Report, *Producing Superstars for the Economic Mundial: The Mexican Predicament with Quality of Education*, [44] argues that the abilities of intellectually gifted students as well as social, ethnic, cultural and regional diversity assets, important for the "economic *mundial*" (World Cup) are underappreciated and underutilized. By contrast, the authors suggest, the Mexican Football Federation scours the countryside, including in the poorest, most remote, communities looking for soccer talent. Once identified, future soccer stars are channeled into specialized academies where their talents are developed. Potential academic superstars, however, are left unattended.

The same report reviewed the results of the 2003 OECD Program for International Student Assessment (PISA) test in mathematics for 15-year old students. Out of 1,000 students taking the test, 182 Korean students and 65 United States students score above the test's "high achievement" threshold (625 points, 1.25 standard deviations higher than the test's average score). Three Mexican students did so. In 2018, as part our joint work for CCE, we asked the Centro de Investigación y Decennia en Economía (CIDE) to update the results to the most recent (2015) data. The results were almost identical. It is difficult to compete in the economic World Cup without intellectual superstars.

2) *Mexico is highly vulnerable to the social and environmental consequences of future sustainability trends*

Historically, social and environmental sustainability have been regarded by business as a government responsibility or as matter for corporate philanthropy assigned to "corporate social responsibility" programs, which are part of public relations not strategy. In public policy with a few exceptions, addressing environmental sustainability and social and economic inequality have taken a back seat to macroeconomic stability, growth, economic competitiveness and poverty reduction. Future trends will produce challenges that are quantitatively greater and qualitatively more fundamental than any the country has faced before. Failure to address them could create the conditions of a failed state across wide swaths of the country.

a) Technology will exacerbate inequality quantitatively and qualitatively

[44] Lant Prichett and Martina Viarengo, World Competitiveness Report, 2009, *Producing Superstars for the Economic Mundial: The Mexican Predicament with Quality of Education*.

As other nations and regions have found in the past decade, technology drives economic inequality. The late economist, Alan Krueger wrote shortly before his untimely death, in *Rockonomics, A Backstage Tour of What Music Can Teach Us About Economics and Life* that technology gives rise to a "superstar economy." Where once the experience of listening to a star singer required attending her concert in person, today that experience has been "democratized" (to use the term popularized by Peter Diamandis) by music streaming. Anyone can access the music of the superstars at low cost. The same applies to anything that can be digitized—knowledge, skills, designs, management. It can be scaled at low cost and made available to a broad audience. The result is that a few "superstars" are very highly compensated, but mere stars are less appealing because everyone can access the superstars digitally at low cost. Krueger argues that the economy is increasingly driven by a "power curve," an exponential relationship where one variable varies exponentially as a function of the power of another variable. A few performers at the apex of the power curve account for a disproportionate share of sales.

Marco Inasiti and Karim Lakhani writing in *Harvard Business Review* argue that the same applies to technology "hub firms" such as Alibaba, Alphabet/Google, Amazon, Apple, Baidu, Facebook, Microsoft, and Tencent, which control the platform networks that the technological economy depends on. By their nature technology companies operate in a world of increasing returns to scale and are not subject the diminishing returns to scale that inhibit the formation of monopolies in traditional economies. The marginal cost of serving the billionth customer is less than that of serving the millionth customer. Networks effects, moreover, benefit established players within complex business ecosystems.[45] Technology-driven hub companies form natural monopolies, concentrating wealth and political influence.[46] A new class of "tech billionaires" emerges among those talented and fortunate enough to have founded or work in market-dominant technology companies in a winner take all economy. A technologically advanced society also rewards a few highly talented workers handsomely. The result, in cities such as San Francisco, Boston, London, Pittsburgh and Austin, has been high demand and wages for technology workers and skyrocketing real estate prices.

[45] See W. Brian Arthur, "Increasing Returns and the New World of Business" *Harvard Business Review*, July-August 1996. Arthur suggest three sources of increasing returns to scale: *high R&D* costs distributed greater volumes, *network effects* the position of the dominant players is consolidated as more customers adopt their products and *customer groove-in* once customers have adopted a product they are reluctant absorb the costs of changing.

[46] Marco Inasiti and Karim Lakhani, Managing our hub economy, *Harvard Business Review*, Sept/Oct 2017 https://hbr.org/2017/09/managing-our-hub-economy

Our analysis of Mexico in a technologically advanced "Exponential World" suggests that similar trends will exacerbate already-extreme inequality. Even if Mexico does not participate directly in creating new technological businesses, an educated upper class tied to the global economy will find highly paid technological and creative work adapting technologies to the Mexican market. Meanwhile a heterogenous "gig economy" will emerge in parallel to the existing labor system. Low paid gig economy work will become disguised unemployment without access to social safety nets. While some sophisticated gig economy jobs will be very well paid, most will be involuntary disguised unemployment among those displaced by technology and markets.[47]

As shown in figure 6 below, in our analysis of the technologically advanced Exponential World the number of highly compensated workers with technological jobs that generate value added above one million pesos per year decreases from 7% to 5%, but their contribution to GDP increases from 30% to 40%. At the other end of the scale, low wage jobs with limited social safety nets with value added per worker per year below MN$ 200,000 increase from 39% of the workforce to 72%. Their GDP contribution increases from 12% to 32% (value added per worker per year increases slightly due to technologically driven productivity increases). [48]

The big losers are those in the middle with jobs whose value added per worker per year is between MN$ 200,000 and 300,000. These are the workers in routine manual and cognitive jobs in manufacturing, commerce and transportation who are displaced by automatization and by a shift to a shared economy.[49] Their share of employment decreases from 54% to 22% and their share of GDP decreases from 58% to 38% (for those who remain employed productivity increases slightly as advanced technologies are disseminated).[50]

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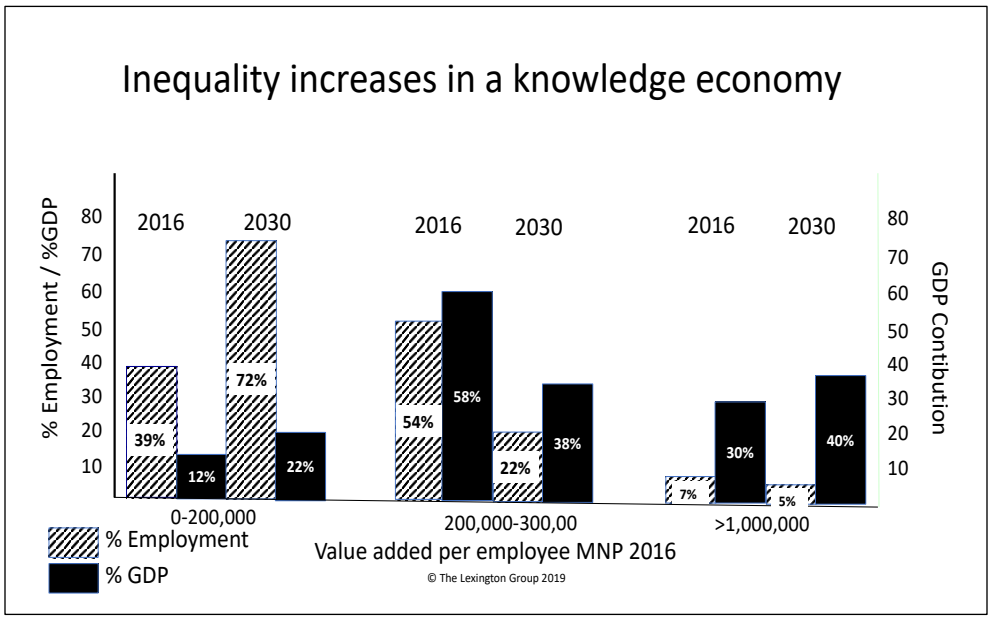
[47] Anecdotally, differences between Uber and Lyft drivers in Boston and Mexico City are interesting to note. Based on non-scientific research (conversations en route to the airport), the majority of Boston drivers have entrepreneurial businesses on the side or are students. In the early days of Uber in Mexico City the same pattern applied. Uber drivers were the "first adopters" of mobile technologies and often were highly entrepreneurial. More recently, Uber drivers appear increasingly to be individuals who have lost their jobs or former taxi drivers who have joined the enemy.

[48] Value added per worker does not equate to wages, It is divided among owner's retained earnings, worker wages and well as taxes, depending on the power relationship between owners and workers.

[49] While dematerialization and a shared economy have positive environmental consequences, aa noted in a forthcoming book by Andrew Mcafee of MIT, *More from Less: The Surprising Story of How We Learned to Prosper Using Fewer Resources—and What Happens Next,* the jobs consequences of dematerialization for countries that depend on middle income manufacturing jobs.

[50] For resource reasons the analysis of the impact of scenarios on work was conducted at the sector level rather than at the task level. The basics studies on this topic (for example those of David Autor of MIT) are conducted at the task

Figure 6. Inequality Increases in a Knowledge Economy



A recent report by an MIT Task Force on the Future of Work focused on the United States confirms the analysis described above.[51] It argues that work is a societal good—it enables people to be self-sufficient, to contribute to society and to enhance their sense of self-worth: "A society is unhealthy when all material needs are met by the state with no reciprocal contribution or when most people live off the surplus provided by a sliver of ultra-wealthy workers or capital owners." The report notes an increasing disparity in earnings in the U.S. from 1963 to the present between those with graduate degree whose real earnings have nearly doubled and those without high school degrees whose earnings have stagnated: "We see no shortage of careers for highly educated workers. And we see no shortage of work for less educated workers. But we see a paucity of good careers for workers without significant post-secondary training." It notes, moreover, that, "The failure of the U.S. labor markets to provide well-paying jobs over the last four decades is not an inevitable byproduct of current technologies nor of free markets." Other nations, notably Germany, Switzerland, Japan, Korea, Sweden, and the U.K. have had similar productivity growth to the U.S. without similar increases in inequality. The difference lies in institutions and governance.

level. This should be done for Mexico, but it was beyond the scope of projects The Lexington Group conducted in Mexico. Our sector level approach resulted in some anomalies.

[51] MIT Task Force on the Future of Work, *The Work of the Future: Shaping Technology and Institutions, 2019*

The MIT report has important implications for Mexico:

1. Our analysis suggests that in the coming decades Mexico will be affected by the same trends that have affected the U.S. Low skill jobs will decrease with automation and dematerialization, but Mexico's economy is less dynamic and innovative than the U.S,'s and it is unlikely to generate a compensating increase in high-skill jobs.
2. Like those in the U.S., Mexico's institutions and governance systems have fostered inequality and hyper-concentration of wealth. Absent important changes in the governance of private companies, this tendency is likely to persist.
3. Demographics are not in Mexico's favor. Mexico has a still-growing working age population with a greater proportion of low-skill workers and greater dependence on the routine manual and cognitive jobs that are most threatened by technology, and it is less prepared to benefit from the gains in new categories of work that are likely to accompany the dissemination of technology.[52]

b) Poverty is likely to increase and employment decrease

It is also possible that historical trends toward the alleviation of poverty and extreme poverty will reverse. In the more dystopian low growth, low innovation "Save yourself if you can" world, the global economy undergoes a profound recession driven by a breakdown of global trade. Wages decrease and fewer jobs are available. Poverty and extreme poverty become prevalent. More people revert to subsistence agriculture and fishing (with devastating environmental consequences). It is also likely that the more positive "Green" world would also be unable to generate a sufficient number of "green" jobs to employ a workforce that is just emerging from a demographic bonus and is on the threshold of becoming middle class. (While a green economy may supply sufficient green jobs in the United States and Europe where working age populations are steady or declining, it does not do so in Mexico and Latin America, which will have a growing working age population to around 2035).

[52] In *The Technology Trap; Capital, Labor and the Age of Automation*, Carl Benedikt Frey differentiates job replacing and job enhancing technologies. The first industrial revolution in early 19th century England was traumatic and led to social and political unrest because it displaced workers who had few work options. The fourth industrial revolution could have similar divisive effects in Mexico, but not in other countries that are better prepared to benefit from its job-enhancing effects.

The only scenario world in which poverty and inequality do not increase markedly is the business as usual "Inertial" world where present trends toward a gradual decrease in poverty persist and inequality increases, but as not as rapidly as in the highly technological "Exponential" world. Nevertheless, the environmental consequences of business as usual are devastating.

c) Environmental impacts are likely to increase dramatically and pose novel challenges:

In 2015, the United Nations General Assembly promulgated a set of 17 Sustainable Development Goals (SDGs). The SDGs place the preservation of the environment within the broader fabric of sustainable development (defined as development that meets the needs of the current generation without jeopardizing the capacity of future generations to meet their needs). To achieve this goal, our report to the Consejo Coordinador Empresarial suggested a broader vision of the environment:

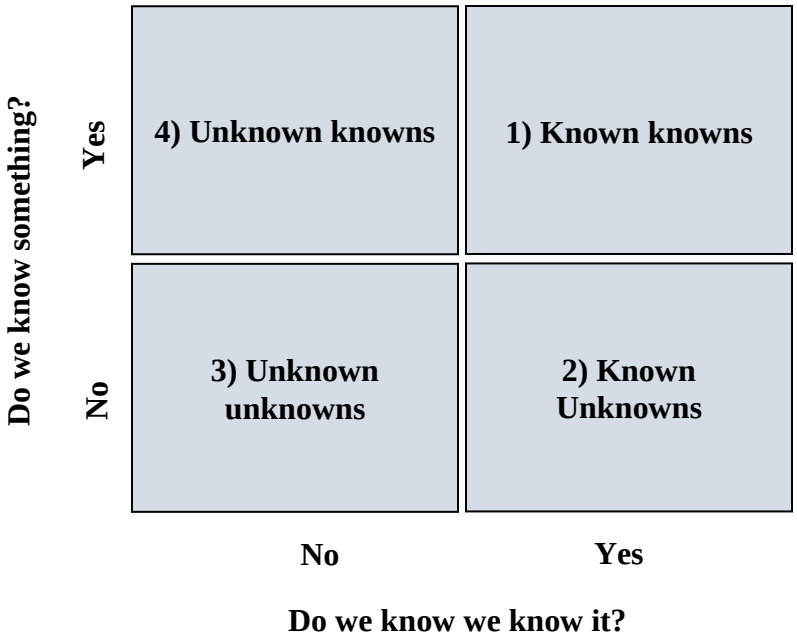
> "Mexico has an opportunity to transition from a focus on balancing economic necessities against environmental limits, to a vision of value generation through the environment and natural resources: to use the livability of cities and natural and cultural assets to attract talent and to develop businesses necessary to compete in a knowledge economy."[53]

We also noted in our 2014-2015 project for SEMARNAT that the environmental challenges of the future will be both like and unlike those we have faced in the past. We used a 2x2 matrix based on whether we know something and whether we know we know it, to illustrate the environmental issues Mexico will face the coming decades (Figure 7).[54]

[53] The Lexington Group, *México Frente al Futuro y el Desarrollo Sustentable,* Reporte Final 2018 (Translated from Spanish)

[54] In a 2002 speech Donald Rumsfeld, then U.S. Secretary of Defense popularized the concept of "known knowns" and "unknown unknowns, "there are known knowns; there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. But there are also unknown unknowns—the ones we know we don't know…It is the latter category that tend to me the difficult ones."

Figure 7. Known Knowns and Unknown Unknowns



1) ***Known Knowns***—*issues that are serious or extremely serious but are reasonably well-understood, and the necessary actions have been defined, although difficult: climate change, deforestation, biodiversity and habitat loss, air pollution and waste.*

Two UN reports published in 2019 present a stark assessment of the future of the environment. The commonalities between the two reports, published within six months of each other are striking. Both:

- *Address fundamental drivers of "ecological services" on which human life on the planet as we know it depends*. Climate change and biodiversity loss imply, not the inconvenience of warmer temperatures or the loss of iconic species in remote areas of the planet, but the vulnerability of the underlying vital biochemical systems that make the planet habitable for humans.
- *Express alarm that current trends in climate change and biodiversity loss are unprecedented in human history*. These threats are have evolved more rapidly and more severely than had been anticipated even by pessimistic recent scientific models.
- *Assert that current initiatives, approaches and technologies are inadequate to meet the challenge.* Even the most "successful" initiatives such as the Paris Climate Accords and

the UN Convention on Biological Diversity are woefully inadequate. "Transformative change" in human activities will be required.

The UN reports address climate change and biodiversity loss on a global scale, but Mexico is more vulnerable than most countries to their local impacts. Climate change is likely to increase the incidence of weather extremes, including droughts in the north of the country and inundation in the south. Though its three largest cities are not on the coasts, Mexico has an extensive coast that will be affected by sea level rise. Mexico is also one of the world's most megadiverse countries. Its diversity is an important (and often ignored) part of its national patrimony and essential to the lifestyles and survival of many of its indigenous communities.

Additionally, climate change and biodiversity loss raise environmental equity considerations that aggravate existing economic and social inequities. Indigenous people and subsistence communities in the poorest southern regions of the country are likely to be the most affected by both climate change and biodiversity loss. The well-to-do are insulated from the losses of environmental amenities and they are located in regions of lower vulnerability. Residents of Santa Fe, a wealthy suburb of Mexico City, receive better quality drinking water more reliably and at lower cost than do residents of Iztapalapa, a low-income community also in Mexico City.

One solution might be degrowth. Degrowth solutions have gained traction in Europe as a way to halt environmental deterioration, and Mexico's President Lopez Obrador has frequently argued against growth as the sole measure of success of an economy. Growth is important only to the extent that it contributes to human well-being. Arguably, a growth imperative could be balanced with a concern for environmental sustainability. Nevertheless, the problem for Mexico is more complicated. In Europe, which faces a declining working age population, degrowth is an often-advocated option. Unlike Europe, in the next 15 years Mexico will have to find employment for a growing working age population, absorb the effects of technological change on jobs, potentially repatriate migrants returning from the U.S., absorb migrants from Central America as well as address existing poverty and inequality in its population. Degrowth alone is not an option for Mexico. Mexico will have to focus on environmentally sustainable growth.

2) ***Known unknowns****—issues associated with the environmental impacts of new technologies that we currently know about such as so-called "technologically critical elements" or the potential energy consumption of technologies such as blockchain.*

Technology will bring additional environmental challenges. A report by the Environmental Law Institute (ELI) for the Global Environmental Fund, *Novel Entities and the GEF*, highlights the difficulties of governing "technology-critical" elements and entities in the environment.[55] The topic is too broad and technical to be treated in this paper, but Figure 8 gives a sense of the new process and substances that will need to be addressed as new technologies are disseminated.

Figure 8. ELI Framework: The Known Unknowns

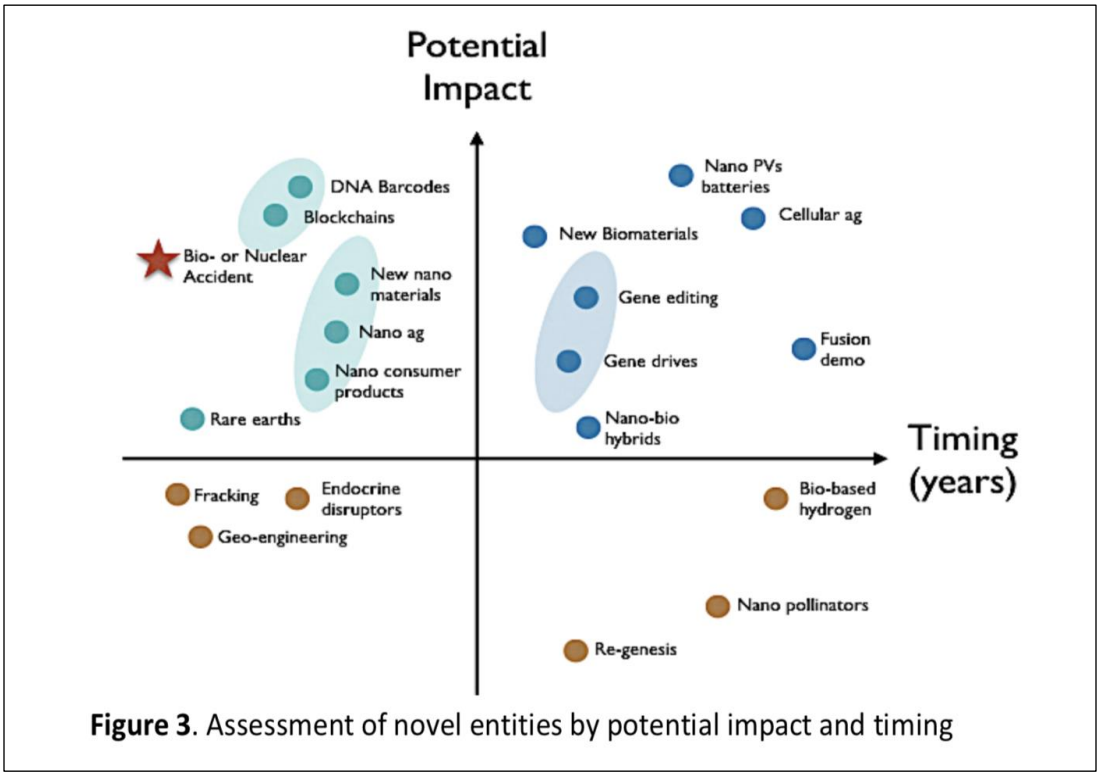


Figure 3. Assessment of novel entities by potential impact and timing

3) ***Unknown unknowns***—*by definition we cannot know the unknown unknowns, but we can be sure they will manifest themselves.*

Perhaps one of the most critical emerging challenges of the future will involve the environmental societal impacts of as yet unknown or nascent technologies that are known only to a small set of researchers working in secrecy. These technologies may pose complex ethical and social issues. If

[55] David Rejeski, Christina Libre, *Novel Entities and the GEF; Background Paper*, The Environmental Law Institute, 2018.

it becomes possible to edit the human genome, what guidelines should guide this process? If we can recover extinct species using their DNA, should we? If, as seems inevitable, we develop fully autonomous machines capable of making decisions using "artificial general intelligence,"[56] how can we ensure that they act in a "just and ethical" manner?

*4) **Unknown knowns**—we are aware of some things, but we do not appreciate their importance.*

Logically the matrix has a fourth category— things we know exist, but whose importance we do not appreciate. In Mexico, these include the economic, cultural, ecological and psychological value of physical, biological, ethnic and cultural diversity and indigenous knowledge that have been under-recognized and sacrificed in the quest for growth. One particularly interesting underappreciated asset is Mexico's cities: if they can be made sustainable, safe and livable, their climate, cultural vibrancy, fortuitous time zone can make the global magnets for talent.

3) Mexico's public and private institutions are unequal to the challenges of the future.

A disturbing gap exists in the *future readiness* of public and private institutions in Mexico. Neither the public sector, the private sector, nor the academic community has demonstrated a willingness to come to terms with the challenges that the future presents (or even an awareness that such a challenge exists).

Government agency "strategic" planning has been confined to the short term (at best the "*sexenio*," or six-year term of presidential administration). The new Lopez Obrador administration has recognized the problems of poverty and inequality that Mexico confronts. As we have noted, these problems are fundamental to Mexico's future and historically little has been done to address them. Mexico is not one of the poorest societies in the world, and poverty has been alleviated in past decades (if slowly), but Mexico *is* one of the most unequal societies in the world and little progress has been made in reducing inequality or increasing social mobility. The Lopez Obrador administration has rightly made these problems central to its platform.

Nevertheless, the administration's current policies apply 20th century solutions to 21st century problems. By ignoring the challenges (and opportunities) of the future, the administration limits its ability to anticipate them and to leverage them to create a more just and more sustainable future.

[56] Artificial general intelligence is that intelligence that is indistinguishable from human intelligence

The new Plan Nacional de Desarrollo (PND) posits a future that is a return to the past with little recognition of dramatic changes that inevitably will arise in the coming decades. It gives short shrift to needed investment in a modern education system, innovation and technology.

While the private sector has been highly critical of AMLO, it has not demonstrated a willingness to address the profound challenges of the future or to engage with the skewed rewards system of shareholder capitalism. “Long term strategic planning” in the private sector all too often projects current “forces” driving business into the future, focusing on continuous macroeconomic variables, but seldom taking into account potentially discontinuous social, technological or environmental changes. Responses from business executives when we asked how they think a about the future have included, “We recognize the future is an issue, but we need to survive in the short term,” “We believe change in our industry is unlikely to come fast; we will be able to adapt,” “Robotization is unlikely because wages in Mexico are low,” “They have the most advanced technology; they have automated their processes” (The latter describing a maker of engine blocks for internal combustion engines that will soon be replaced by electric vehicles).

Hitherto, the private sector as a whole has approached sustainability not as a strategic priority but as a tradeoff against competitiveness or as a matter for philanthropic programs or public relations-oriented “corporate social responsibility programs.” While business groups have almost uniformly opposed significant taxes on carbon, there have been few significant private sector initiatives to address climate change at the scale required and as a matter of urgency; while many recognize that inequality exists, there has been no concerted private sector program to address the roots of inequality in the economic system or to share the benefits of the efficiency-based economic system that leverages low wages as a source of competitiveness. The private sector would do well to heed the statement of Bjorn Stigson when he was President of the World Business Council for Sustainable Development, “The private sector cannot flourish in a society that fails.”

B) Key Opportunities

It is easy to focus on the negative when working with scenarios. The vulnerabilities are real and important. Nevertheless, it is important to recognize the, also real and important, opportunities that the future presents. Peter Diamandis, co-founder with Ray Kurzweil of Singularity University posits a techno-optimistic world:

> *"The greatest tool we have for tackling our grand challenges is the human mind. The information and communications revolution is… rapidly spreading across the planet…three billion people new individuals will be coming online, joining the global conversation, contributing to the global economy. Their ideas—ideas we´ve never before had access to—will result in new discoveries new products and inventions that will benefit us all."*[57]

Alan Krueger's concept of the superstar economy focuses, correctly, on the thick, short end of the power curve distribution—music that can be digitized, where superstars can be differentiated from mere stars, and that can be taken to scale through digital distribution. It is important to note, however, that the long, narrow tail presents a different type of opportunity. Krueger points out that the 101st ranked music group streamed on Spotify was the Mexican/Californian group, *Los Tigres del Norte.* It had only 10% of the sales of the top-ranked group, Drake, but Spotify enabled it to reach a much wider audience than it would otherwise have reached. The platforms that concentrate economic power also create opportunities in global markets for niche players.[58]

At their best, which they often do not attain, economic hubs like Amazon, Alibaba, E-bay and Etsy open global markets for local products that cannot be digitized, for example for creative works, sustainable and local agriculture products, cuisine, personal services, medical services.[59] As digitization has had concentrating effects, it has also enabled small, local entrepreneurs and NGOs to reach global markets. Kiva is a technology-enabled crowdfunding platform that allows lenders to fund local entrepreneurs in underserved communities. As loans are repaid, lenders can either recycle them to other borrowers or withdraw their money. According to its website, it currently has 3.2 million borrowers and has made $1.3 billion in loans with a 96.7% repayment rate. Kiva

[57] Peter Diamandis, *Abundance,* p xi

[58] Krueger, *Rockonomics*, p.88. For a treatment of this topic see, Chris Anderson, *The Long Tail; Why the Future of Business is Selling Less of More,* Hachette Books, 2008

[59] I had occasion some years ago to conduct an evaluation for the International Finance Corporation and Peru Orient Express of a program funded by the two organizations to developed entrepreneurs along the Valle Sagrado connecting Cuzco and Machu Picchu, Peru. My strongest impression from the study was of the weakness of the market for the local entrepreneurs products. I suggested at the time that access to global markets through technology-enabled platforms could increase the market reach of local entrepreneurs.

has now created a marketplace where borrowers can access markets in developed countries. Mexico, with its high biological and cultural diversity and creativity, has an important opportunity to participate in global "local to local" or "local to global" markets that are differentiated by their place of origin. Blockchain enables small-scale record keeping and registries that are an important avenue to decentralize and develop local capabilities. [60]

So-called low-income "base of the pyramid" (BOP) markets are an important opportunity to develop products and services that address human needs and provide income and employment in low-income communities. In his most recent book, *The Prosperity Paradox*, Clayton Christensen and his colleagues pick up on a theme originally developed by C.K. Prahalad and Stuart Hart: "non-consumption" by the poor of goods and services such as banking, insurance, medical services, potable water, telecommunications, housing, transportation, entertainment because they are too expensive or not available. Since the original *Strategy+Business* article by Prahalad and Hart, we have learned a great deal about how to address BOP markets, largely through the work of Hart and his colleagues internationally. Most importantly, we have learned products and services must be co-created with local communities participating in the design, production and sale of local products. The resources and technological capabilities of large organizations can be important to develop markets, but ultimately it is the local community that matters. Local BOP markets can also be a source of innovation that leapfrogs legacy technologies. M-Pesa, a mobile banking system that originated because communities in Africa did not have access to conventional banking services, may well represent the future of retail banking worldwide.

As many have noted, the enormous environmental challenges of the future represent important opportunities for "green" products, ranging from renewable energy to the circular economy. Green product markets are in their nascent stage, but they are an opportunity for innovations that can meet human needs while reducing environmental impacts. While the technologies to address these needs are often global, implementation is necessarily local. Moreover, local solutions, for example, how the poor meet basic needs with low environmental footprints, can be an important source of innovation that translates into global innovations. Technologies such as blockchain, 3-D printing

[60] Merriam Webster defines blockchain as "**:** a digital database containing information (such as records of financial transactions) that can be simultaneously used and shared within a large decentralized, publicly accessible network."

and synthetic biology can enable new generations of locally based "green products." It is important to note, however, that these technologies may also bring with them a panoply of as-yet-unaddressed environmental "rebound effects."[61]

Lastly, Mexico will continue to participate in its traditional markets based on large-scale local demand, proximity to markets, resources and global supply chains. These will not disappear overnight, and they will be important to sustain basic levels of employment and growth. The example of Delphi Automotive noted above remains instructive today. As the global economy shifts and political, economic and technological drivers drive relocation of production, it will be important to develop non-transferable capabilities. Operations that are based on cheap labor are easily closed and transferred to countries with cheaper labor, or cheap labor can be replaced by automation. Operations such as Delphi Automotive that embody a significant amount of local technology and know-how are less easily relocated. They are a much better bet.

[61] "Rebound effects"are the paradoxical negative environmental consequences of a positive environmental action. Lower cost and impact renewable energy may increase consumption or may make more income available for other polluting activities.

V. Path Forward

"…if it (the market capitalist system) continues to function in the next 25 years as it has in the past 25, we are in for a violent ride or, worse, a serious breakdown in the system itself."

These words were not uttered by a populist, left-wing politician. They appeared in *Harvard Business Review*, summarizing a Harvard Business School study based on research with 2,500 alumni worldwide.[62] Unless capitalism addresses profound societal issues—poverty, social, economic and educational inequality, environmental degradation—it will lose legitimacy in the eyes of society. Though the challenge is worldwide, it is particularly acute in Mexico.

Public, academic and civil society institutions face the same quandary. Popular revolts against both right-leaning and left-leaning governments worldwide demonstrate that in a social media-connected world public institutions that fail to address their societies' needs rapidly lose legitimacy in the eyes of their constituencies. Academic and civil society institutions also risk losing relevance. The challenges are existential, but Mexico has the economic, societal and natural capabilities needed to overcome the challenges if, and only if, its public, private, academic and civil society sectors come together. To succeed, each sector will need to put the common interest above the parochial interest.

This section outlines a framework for thinking about a path forward and possible actions. We deliberately do not describe possible solutions in detail. Solutions must emerge from a national conversation that engages all sectors of society and all regions. Mexico must meet the needs of a hard-working, diverse and creative population but also of a population that is divided by extreme inequality in well-being and opportunities, one that has lost faith that the economic system serves its interests fairly. It occupies a privileged geologic and geographic position that makes it one of the world's most mega-diverse countries, and it benefits from proximity to the world's largest market. But its geology also breaks it up into isolated enclaves, and its natural capital is threatened by climate change, deforestation and biodiversity loss.

In retrospect: Mexico did what it was supposed to do

For three decades after it acceded to NAFTA, Mexico did what it was supposed to do to participate in a global economy. It played by the rules of the game: it opened its borders to global trade and

[62] Joseph L. Bower et al, "Capitalism at Risk," *Harvard Business Review,* August 31, 2011

integrated itself in global value chains; it partially de-regulated its economy; it pursued responsible macro-economic policies; it attracted foreign direct investment to its firms and plants; it established a modern environmental agency that took a global leadership role in climate and biodiversity; it invested in education to create a literate, hard-working, workforce capable of participating in the global economy; it reduced extreme poverty; it created social safety nets designed to protect its most vulnerable citizens; its universities and business schools turned out talented engineers and managers capable of running world class manufacturing facilities.

It did not get everything right.

Most importantly, it failed to address festering problems of violence and corruption and impunity in federal and state governance. These problems are real and important, but an exclusive focus on them risks ignoring their underlying causes that undermined the confidence of important segments of the population that the system worked for them.

Growth was inadequate to enable a growing population to emerge from poverty. Well-intentioned social programs created perverse incentives that kept capital and labor from flowing to the most productive firms; inequality increased as the winners of the globalization game captured its gains and the losers were left out; the education system did not create opportunities for the most disadvantaged in society; natural capital was lost to habitat loss and deforestation; too often businesses opted for short term gains over long-term economic and societal sustainability; investment in innovation was inadequate; few new businesses were created.

The failures might have been less serious had the rules of the game not changed. But they did.

The global losers in the globalization game asserted themselves. In the United States, they elected an avowed opponent of a global economy; in United Kingdom they voted to exit the European Union; in Brazil, southern and eastern Europe they elected populist nationalists with little faith in democracy or the rules of the game. China asserted itself with a new model of authoritarian capitalism; Russia became a rogue actor in the international system.

Technology is upending business models. It is likely that in the future knowledge and ideas will contribute more value than resources and labor; shared services will displace products as the primary drivers of economic value; distributed record keeping technologies such as blockchain will transform economic transactions, creating new businesses and enabling insurgents in

established businesses; automatization and new manufacturing technologies will transform and decentralize manufacturing; autonomous machines powered by artificial intelligence will displace activities formerly performed by human intelligence; fundamental ethical issues about the relationship between humans and technology will arise.

The projects on which this paper is based were conducted before the current administration took office, and the issues it discusses will transcend any single presidential administration (or indeed any generation of leaders). Nevertheless, it is impossible to talk about the future while ignoring the present. Our conclusions share the administrations critiques of Mexico's current political, social and economic structure; the new administration can be a catalyst for needed change, for a "Fourth Transformation."

Our analysis, however, suggests that the Fourth Transformation must embrace the Fourth Industrial Revolution. Mexico needs an energy policy that promotes a modern, distributed, renewable energy system; it urgently needs an inclusive education system that gives all students, regardless of their social economic status, the skills to "learn to learn" and to participate in a modern economy; its businesses require entrepreneurship and innovation that leverage the creativity and talent of its people; its environment needs an institutional capacity to leverage its natural and human capital as assets that provide future sustainable advantages; and, above all, its society needs a broader distribution of benefits of economic activity.

The Road Ahead Will be Difficult

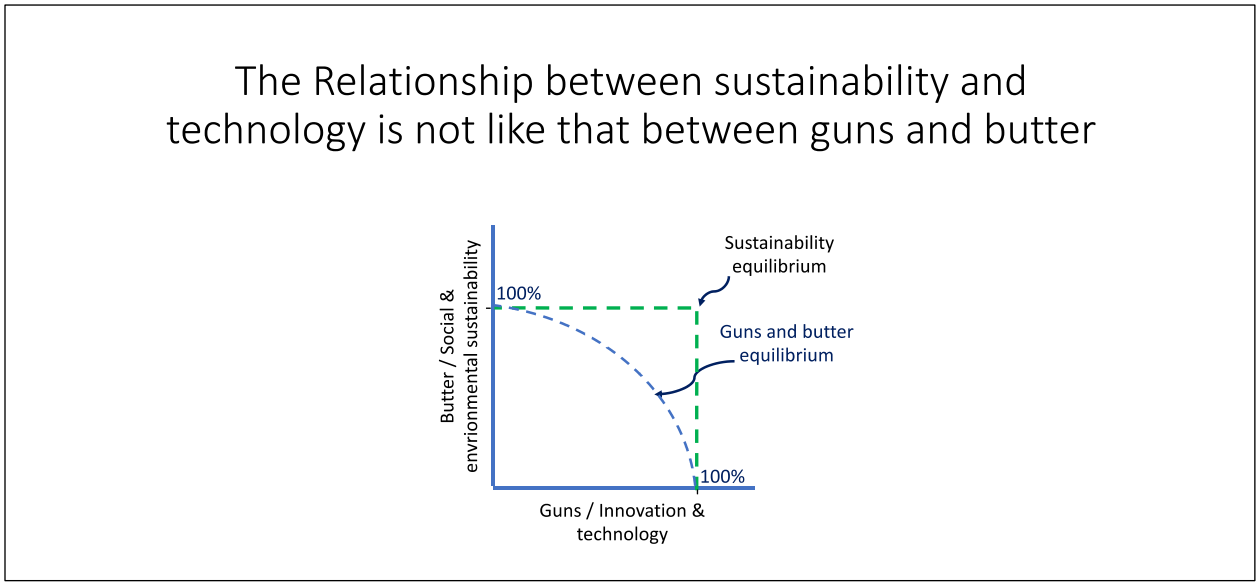
The road ahead for Mexico, if it is to remain a vital member of the global economy and meet the needs of its people, will be difficult. It will need to recognize that the issues it will face are fundamental and existential. Business as usual is not an option; it will need to peer clearly and realistically into its future and give priority to the long term over the short term. Businesses, governments and academic institutions will need to revamp their governance systems to put the needs of society over their parochial interests; governments must find new ways to engage with society and business to solve common problems. The education system must be transformed to teach all students, no matter their socio-economic or ethnic status, to learn, to be creative, to question authority, to collaborate and most of all to be responsible members of society. Mexican business must recognize that social and environmental sustainability are not a philanthropic responsibility but an existential, strategic imperative. Mexico must find a way to leverage its

physical, biological, ethnic and cultural diversity and the creativity of its people as a source of enduring competitive advantage rather than as an obstacle to progress. Entrepreneurs must create new businesses that meet the needs of society as well as those of their shareholders. Most of all, all Mexicans must feel they have a stake in a system that they see as fair.

Economists use the relationship between guns and butter to illustrate the fact that a nation has to choose what goods it produces. If it produces more guns, it must produce less butter. It must choose how much butter and how many guns it requires along a "production possibilities curve. Businesses and government regulators have traditionally seen the relationship between sustainability and competitiveness as a guns and butter tradeoff. An increase in environmental protection, for example, must come at the expense of competitiveness. In Figure 9 we refer to this relationship as the "Guns and butter equilibrium."

The relationship between technological innovation and social and environmental well-being is not like that between guns and butter. Rather, they can be complementary and mutually reinforcing (Sustainable equilibrium in Figure 9). This result, however, is not preordained as some technology proponents would have us believe. Technology is not always socially and environmentally benign. It can destroy jobs, concentrate economic and political power, increase inequality, invade privacy introduce new categories of environmental impacts as well as enable internal and external groups to undermine social cohesion. Conscious efforts by the public and private sectors, academia and civil society will be needed to realize the potential benefits of technology.

Figure 9.



More than other nations, Mexico will need to focus on its particular vulnerabilities in competitiveness, innovation, economic inequality and environmental sustainability. To accomplish this, it must grow sustainably. Sustainable growth cannot be defined by GDP alone; it must be measured as well by human social and environmental well-being. Mexico has under-invested in quality education and innovation; these will be fundamental if it is to achieve sustainable growth. But Mexico has important advantages. Its people are among the hardest working and the happiest in the world; it has underutilized assets in its physical, biological, cultural and ethnic diversity and the creativity of its people; it has an extensive network of bilateral trade relations and it benefits from macro-economic stability.

The choice is clear. Mexico can continue with business as usual—anemic growth, concentration of wealth in the richest sectors of society, deterioration of its natural capital and decreasing competitiveness in the global economy. Or, government, businesses, academic institutions and society can come together to embrace new technologies and business models for the benefit of all the population and spur the development new more inclusive businesses. They can leverage the capabilities of the fourth industrial revolution to bring about a "fourth transformation" that addresses the interests of all society, not just elite corporate shareholders. It can become a society that is just, sustainable, inclusive and competitive.

Facing the Future

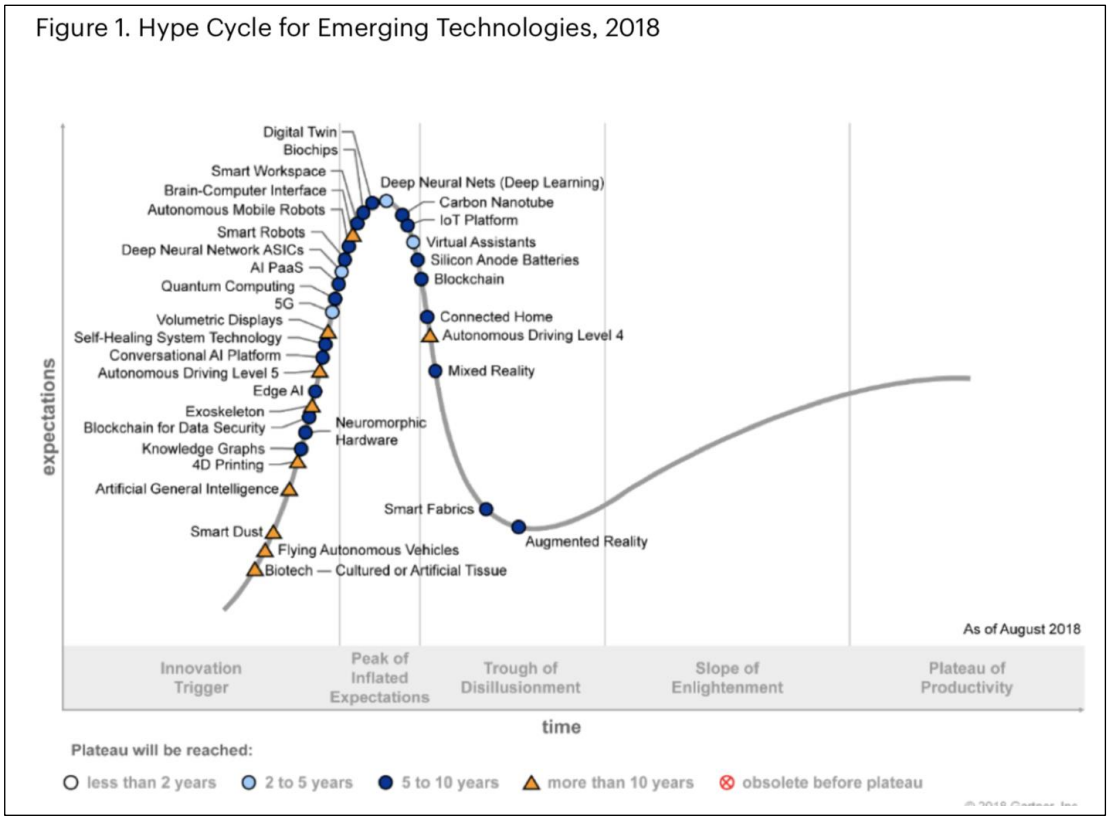
The focus must be on the future. But, as the American baseball player Yogi Berra observed, "predictions are difficult, especially about the future."[63] Uncertainties about science and technology and social, economic and institutional acceptance of innovation bedevil our ability to predict the impact of technology on the society. We can, however, think systematically about these uncertainties and establish priorities for action in terms of two dimensions:

1. *Scientific/technological developments:* The economy of the future will witness scientific and technological developments and impacts of technology that are unimagined today. Other advances in science and technology and their impacts are already well-understood. The speed of innovation is also uncertain. The research and advisory firm, Gartner publishes a "hype cycle" that tracks innovations from early "innovation triggers," when a

[63] Yogi Berra was a prominent American baseball player who was also known of his colloquial aphorisms, "Yogi-isms," such as "It ain't over 'til it's over." He was in a sense, the American Cantinflas.

technology's potential is first identified, through "inflated expectations" and a "trough of disillusionment," when obstacles to implementation become apparent, to a "slope of enlightenment," when its potential is demonstrated, and finally to a "plateau of productivity," where mainstream adoption takes off (Figure 9). As the name implies, not all the technologies in Gartner's hype cycle will reach their promise. The trick will be to anticipate and prepare for those that do.

Figure 10. Hype Cycle for Emerging Technologies, 2018



2. *Non-scientific/technological uncertainties (institutional and societal impediments)*: Science and technology are not the only sources of uncertainty. Some scientific advances, technologies and business model changes are readily adopted by markets and society, sometimes with surprisingly little resistance. (For example, in most societies workplace automation has proceeded with little resistance in the 21st century in contrast to the resistance to workplace mechanization in the 19th century, which gave rise to the Luddite

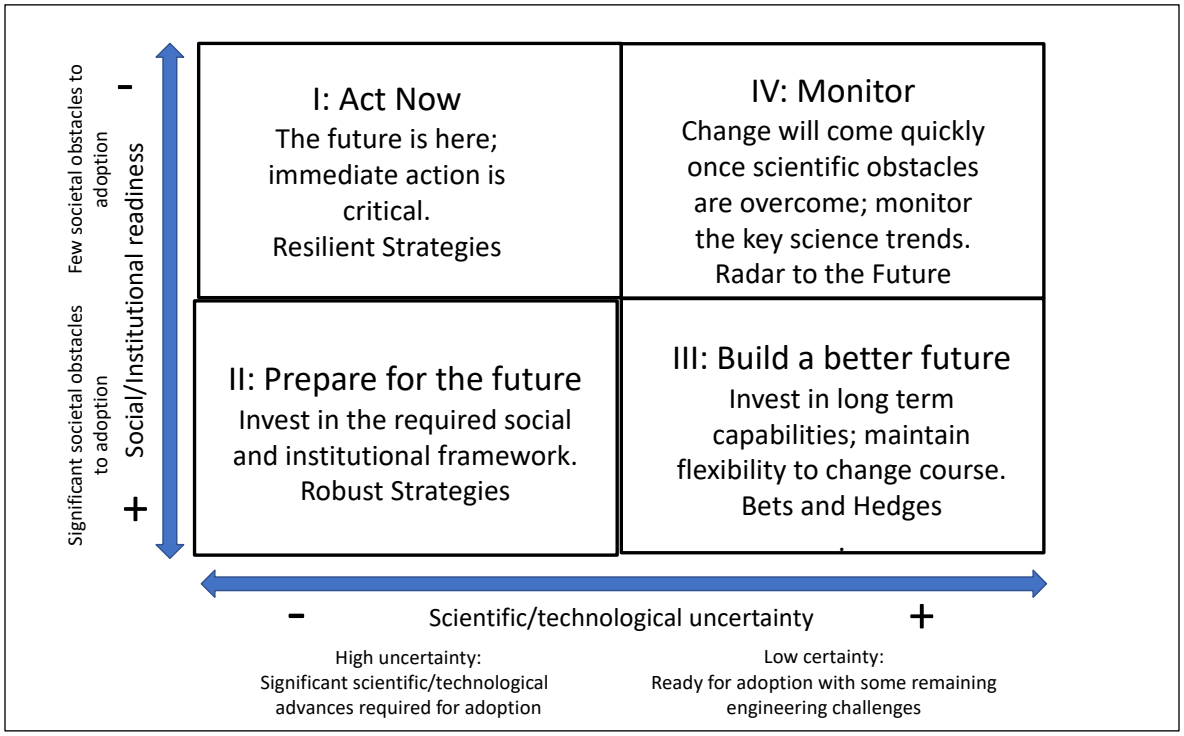
rebellion, the *Communist Manifesto* and widespread workplace and social unrest64). Other technologies and business models encounter greater resistance due to social concerns about trust, privacy, cybersecurity or safety. In some cases, the obstacles are profound: if we think of the widespread adoption of autonomous (self-driving) vehicles we might ask, "Will parents trust self-driving vehicles enough to send their kids to school in one?" In other cases, such as the displacement of internal combustion vehicles by electric vehicles, the obstacles are less fundamental: "will sufficient charging infrastructure be available?"

A Framework for Action

As shown in Figure 10, these two dimensions can be incorporated in a 2x2 matrix that serves as a framework for action. The policy responses in each quadrant are different. The difference among quadrants lies less on the urgency of action than in the type of action and the timeframe within which action will yield results. Action is required now, and success will depend on acting in each quadrant, not on focusing on each quadrant separately. In the sections that follow, we give examples to illustrate actions that would be appropriate in each quadrant. These examples are not are not intended as exhaustive, fully developed policy prescriptions. Such prescriptions are necessary, but they must emerge from national and regional multi-stakeholder conversations.

[64] See for example, Carl Benedikt Frey, *The Technology Trap; Capital, Labor and Power in the Age of Automation.* Princeton University Press, 2019, pp. 8-9. Near-term living standards regressed in Britain during the industrial revolution despite the long-term benefits the machine age.

Figure 11. A Framework for Action



I. ***Act now***—in some realms, there is little remaining scientific uncertainty and little social flexibility to avoid change. The choice is between deliberate change and reactive change. Policy responses in these realms must focus on preparing for the unavoidable. Scenario practitioners refer to this type of action as "resilient" responses, intended to adapt flexibly to anticipated change. After the 2007 financial crisis, for example, the U.S. Treasury Department required major banks to undergo, "stress tests" to assess their financial capacity to absorb renewed financial stress. Analogous tests could assess the resiliency of institutional, physical and human systems:

   – *Institutional systems and their governance*—public, private, academic and social institutions will undergo unaccustomed stresses--to adapt to rapid and fundamental social changes, changing climatic conditions, changes in the nature of (and availability of) work, migration and inequality. Do social institutions (governments, businesses, academic institutions, civil society) have the capacity necessary to engage stakeholders and develop responses that are effective and fair? Can they work together to move beyond their parochial interests to those of society as a whole? Do they have the capacity to anticipate change and adapt to it? Are they

willing and able to make the changes that will be required to bring about a better future?

- *Physical systems*—climate-resilient cities and physical structures. We can anticipate that climate change will have severe consequences for coastal communities in the South and water-stressed communities in the North. Additionally, it is likely that climate- and economically-induced migration will affect communities in these regions. Major investments in resilient infrastructure are needed to prepare for the inevitable. What should the cities and physical infrastructure of the future look like? How can cities and communities be designed to attract talent and facilitate sustainable lifestyles?
- *Social safety nets*— disruptions brought about by automation, the "gig economy," and changes in the nature of products and services will profoundly alter the nature of work in manufacturing, commerce, transportation and services. Routine manual and cognitive work tasks will be displaced by artificial intelligence and automation. New modalities of work enabled by ubiquitous smart devices will become prevalent. Nevertheless, Mexico's social safety nets are set up for formal work in a 20th century economy. As Santiago Levy points out, these systems often distort employment in both the formal and informal economies. In a 21st century economy, they will become anachronistic and may inhibit effective adjustment to change. What social safety nets will be appropriate for the future?

II. ***Prepare for the Future.*** Quadrant I actions are primarily defensive. Their objective is to limit the potential disruptions of now-inevitable developments in society and the environment. Quadrant II actions are fundamentally different. Their objective is to prepare to compete and flourish in an economy of the future by addressing underlying causes and leveraging Mexico's ample human, natural and intellectual capital endowments for the benefit of all. These actions target social and institutional impediments to Mexico's ability to adapt to benefit from the 4th industrial revolution. Scenario practitioners refer to actions in this quadrant as "robust strategies" that will serve the organization well independently of what future emerges. Policy prescriptions focused on the longer term may include:

- *Education*— the educational system must be transformed to develop citizens capable of participating in a 21st century economy. While "hard" science, technology, engineering and mathematics (STEM) will be important, "soft" socio-emotional skills and attitudes—learning to learn, creativity, initiative, adaptability, persistence, teamwork, collaboration, and importantly compassion and ethical behavior—will be equally or more important. STEM skills complemented by soft skills are sometimes referred to as "STEAM" (science, technology, engineering, *art*, mathematics). Future generations will increasingly require STEAM skills to interact with machine intelligence. Humans must learn to do what computers cannot do and to, and to do so ethically and compassionately. While top-down educational innovations will be important, it will be more, important to engage teachers, families and communities in the design of educational system changes. Without their involvement, support and commitment educational system change is unlikely to take hold.
- *Innovation and competition.* In a separate Woodrow Wilson Center publication, *Innovation Happens in Mexico; It Should and Could Happen More*, Viridiana Rios has outlined 15 policies to promote innovation in Mexico. These proposals range from teaching English at all levels in school so students can participate in the *lingua franca* of the 4th industrial revolution, promoting entrepreneurship, teaching business skills, establishing public-private partnerships to foster innovation, reducing regulation, improving the effectiveness of public funding of innovation to reducing corruption. Santiago Gutierrez in *Innovation is a job, not a miracle*, also published by the Woodrow Wilson Center, focuses on the role of corporate managers and the need for disciplined, structured management systems.

  These policy proposals are important and necessary. The analysis in this report suggests an additional area of focus—transforming the nature of competition among companies operating in Mexico to create more "gazelles." We found that Mexican companies competing in quasi-monopolistic settings have dominated economic activity in Mexico for decades. Another set of foreign and domestic companies tied to global value chains applies innovations developed abroad to Mexico. Both sets of companies (with some important exceptions) compete on the

basis of efficiency and scale, not innovation. *They do not innovate because their business models do not require innovation.* (See text box for a Mexican gazelle).

In a sense, it has been too easy to do business in Mexico. In contrast to Israel, Taiwan, South Korea, and Finland, which faced an extraordinarily challenging external environment after World War II and had no choice but to innovate, Mexico had mostly positive relationships with the largest and fastest growing economy in the world. Innovation was not an imperative for survival then. Today innovation is critical. Mexico must develop a core sector of its economy that consists of a set of mid-sized companies, gazelles, whose mind-set is to compete in the global economy applying Mexican market-creating innovations.

– *Regionalization*—recent economic history suggests that economic growth takes place regionally, not nationally or globally, around local ecosystems that are linked to the global economy. These ecosystems are based on local capabilities, strong academic institutions tied to strong local businesses, attractive sustainable communities that develop, attract and maintain talent, and local public institutions that foster collaboration among businesses and communities. Local ecosystems are particularly important to develop the regional capabilities in Mexico as a source of development in marginalized regions of the country.

Sucroliq: A Mexican gazelle among elephants and mice

Enrique Bojorquez is an inventor and entrepreneur. His eyes shine when he talks about his company, Sucroliq—a Mexican gazelle, a mid-sized, agile company that thrives among large company elephants and microbusiness mice.

The cane sugar industry is an important employer in Mexico that provides 2.5 million jobs and has existed with little change for the past 500 years. The market is complex: large oligopolistic sugar processors compete in the Mexican market and in the U.S. for a share of the U.S. market. The U.S., however, has restricted entry of cane sugar into the U.S. and flooded the Mexican market with excess high fructose corn syrup (HFCS).

Refined powdered sugar competes directly with HFCS. In the traditional process, sugar cane is soaked and crushed to extract juice which is then boiled, spun and crystalized to produce raw sugar. The raw sugar is melted, crystalized, dried and packaged before being shipped to the customer. Traditional producers sell the highly refined powdered sugar to industrial customers who in turn liquify it before incorporating it into their final products.

Enrique had a better idea. Rather than selling refined, powdered sugar, Sucroliq uses a patented technology to produce high quality liquid sugar directly from raw sugar. It thereby eliminates the purifying, clarifying and drying steps. The process supplies a high-quality final product from lower grade raw sugar than that required by traditional producers, and by eliminating energy-intensive steps, it also reduces greenhouse gas emissions.

Sucroliq's liquid sugar can be incorporated directly into the customer's process. In fact, in their most recent iterations in the U.S. and Mexico, Sucroliq plants are being sited adjacent to the customer's installations so they can be integrated directly into the customers' manufacturing process.

Designing the process required re-thinking the product and developing a means to transform raw sugar into liquid sugar with a patented technology. The initial design required a substantial R&D investment, and, more importantly, a willingness to take risks. Currently Sucroliq has three plants in Mexico and it is developing additional plants that will be housed within customer facilities in the U.S. Its Irapuato plant is the only recognized Industry 4.0 plant in Mexico. The plant is fully automated and all departments (manufacturing, logistics, operations, finance) have a real-time view of the status of each process using internet of things and cloud technologies.

Alicia Ramirez Mata, the engineer responsible for designing the automated system control process at Sucroliq's Irapuato plant was named one of the global "40 under 40" engineer leaders under 40.

- *Globalization for local purposes.* Tools such as blockchain enable a radical decentralization of economic activity. These can be coupled, for example, with drone technology and artificial intelligence to leverage Mexico's biological diversity and diverse microclimates to enable a revitalization of the countryside through small-scale, local, sustainable agriculture that supplies specialty local products to local and global markets.
- *Redefinition of the purpose of the corporation.* On August 19, 2019, 181 of the 192 members of the Business Roundtable, chairs and chief executive officers of the largest corporations in the United States released a Statement on the purpose of the Corporation. This statement steps back from a historical focus on short-term shareholder value. It focuses instead on "long-term shareholder value creation" and "a commitment to *all* of our stakeholders" (emphasis in the original).[65] It reflects the similar conclusions of a study noted above, *Capitalism at Risk*, Rethinking the Role of Business, conducted by three Harvard Business School professors for its centennial as they reconsidered the purpose of a business education. The thesis of the study was, "*....that, to preserve market capitalism as we know it, both companies and their leaders must change. Instead of seeing themselves as narrowly self-interested players in a system that is tended and overseen by others, business leaders must take a more active role in protecting and improving the system."*[66]

III. ***Design a Better Future.*** Both technology and social adoption of technology are uncertain. It is very difficult to project technology and social trends 10-15 years in the future. The best we can do is to develop plausible scenarios of what might happen. That does not mean, however, that we should ignore the longer-term future. By understanding its implications, we can focus and manage the implications of technology. To use a sports metaphor, the Canadian hockey player Bobby Orr said that he skated not to where the puck was, but to where the puck was going. Mexico can determine where it wants the puck to go and skate

[65] It is interesting to note that the day after the Business Roundtable statement the Council of Institutional Investors issued a counter statement suggesting the Business Roundtable had gone too far, ignoring the role of shareholders as owner of companies. The common ground, however, was in the focus of both institutions on the creation of long-term shareholder value.

[66] Joseph L. Bower, Herman B. Leonard, and Lynn S. Paine, "Global Capitalism at Risk, Harvard Business Review, September, 2011

toward it. For this purpose, scenario practitioners suggest well-considered "bets" on high-payoff future developments and hedges on these bets. For Mexico, these may include:

- *Focus on a new generation of leaders with new ideas.* One of the rewards of teaching in a Mexican businesses school (Instituto Tecnológico de Monterrey /EGADE Business School) as well as working with the COPARMEX Jóvenes Empresarios (young business owners of the association Mexican business owners) has been the opportunity to work with Mexico's future business leaders. Anecdotally, I would argue that there is a strong generational divide among Mexican current and future business executives. The new generation is more entrepreneurial, more committed to addressing societal needs and innovative than their elders. Their ideas for new businesses are practical as well as innovative.

Ideas for New Businesses from Future Business Leaders

The final team assignment in my 2019 MBA class on Corporate Sustainability was to design a business that would address Mexico's needs and vulnerabilities in the coming decades. The business could be a for-profit business or a nonprofit. The ideas that three the teams proposed were innovative and addressed real future customer needs

I. *A Tu Salud*—a nonprofit designed to link participants in the gig economy who do not have access to health insurance to health care providers. The core of the company would be a database network of healthcare providers--medical facilities and health care providers (primarily medical interns and their supervisors)—and a mobile device app that would link the gig economy customers to low-cost medical care.
II. *Chambaton*—an app-based system to link workers displaced by technology to skills training providers. The business would not itself be a skills training business; rather its mission would be to understand the available on-line skills training services and provide a seamless process by which workers could select the needed skills training.
III. *Nuberry*—an app-based provider of training and access to expertise to small scale farmers. The business would provide technical sustainable agriculture training as wells as agricultural inputs, access to markets, quality control and blockchain-based record keeping.

While all three business ideas would need to be market-tested, they all leverage technology to address clear needs and opportunities. All three are also notably asset free. Like Uber and AirBnb, the company itself does not own assets; it uses technology to link supply and demand.

– *Channel technological development to high priority needs*. In his 2016 book, *Competing Against Luck; The Story of Innovation and Customer Choice*,[67] the Harvard Business School student of innovation, Clayton Christensen argues that companies should focus systematically on customer's "jobs to be done." That is, on the needs of their customers that are currently unmet or only partially met by existing market players. Similarly, academic and private sector researchers can systematically target areas where Mexico has high priority unmet needs. For example:

  - *Sustainable agriculture*—Mexico has witnessed decades of abandonment and destruction of habitat as those who could, moved to the cities, and those who could not, engaged in environmentally destructive subsistence agricultural and fishing practices. The development of new technologies promises capabilities that enable environmentally and economically sustainable local or urban agriculture and fishing, which reduce the pressure of urbanization and compensate in part for declining employment in manufacturing, commerce and transportation.

[67] Clayton Christensen, Taddy Hall, Karen Dillon, and David S. Duncan, Competing Against Luck; The Story of Innovation and Customer Choice, Harper Collins, 2016.

- *Renewable energy infrastructure*—A post-fossil economy will depend on affordable, distributed, renewable energy, particularly if, as expected, transportation is based on non-fossil fuels by the 2030's.
- *New materials development*—Mexico can leverage its strong capacity in chemistry and chemical engineering to develop new sources of raw materials as substitutes for fossil-based raw material inputs. For example, Mexican researchers have found an important need for effective catalysts, mainly enzymes that would permit the production of ethane or ethylene from sugar industry by products.
- *Sustainable cities*—Sustainable cities can be the focal point for regional development, attracting world-class talent and resources. For sustainable cities to meet their promise, important advances will be necessary in sensor technology, artificial intelligence (and artificial general intelligence if autonomous vehicles are part of the solution). Water supply and treatment for human and agricultural use are ripe for creative new solutions. Some of these technologies are on the horizon; others will need to be developed.
- *The circular economy*—for the sustainable economy to reach its promise, it will require important changes both in social infrastructures and in materials that can be effectively decomposed and reused without degrading their quality. Mexico's strong base in engineering and materials can provide the talent for new generations of environmentally sound materials that promote a circular economy.
- *Job creating and job enhancing technologies*—Many technologies associated with the 4th Industrial Revolution are job-replacing technologies. Like many technologies of prior industrial revolutions, they replace human workers to produce the same output without a significant reduction in quality and at a much lower cost. A new focus on human-machine interactions could develop technologies that leverage and enhance, but do not replace, human actors.
- *Medical technologies and biotechnology*—Mexico has highly sophisticated medical, pharmaceutical and biotechnology sectors. It is well positioned to

leverage this expertise to address key future human needs—obesity, an aging population, chronic and communicable diseases.

- *Decide what guardrails to establish or technologies **not** to pursue.* The fact that technologies allow us to do something does not necessarily mean we should do it, or that we should have no restrictions on technologies. A group of leading artificial intelligence thinkers and ethicists developed the Asilomar AI principles to ensure that research on artificial intelligence focuses on applications that are beneficial to humanity. Similarly, the U.S. National Academies of Science and Medicine recently convened a panel of experts, stakeholders, ethicists to establish guidelines for human genome editing.[68] The report of the panel gave qualified green light to non-heritable genome editing to address genetic conditions such as those causing cystic fibrosis.[69] It proposed strict guidelines of heritable gene editing, but recognized these may need to be modified. When a Chinese researcher violated these guidelines he caused an international furor as well as condemnation in China. China is now developing human gene editing guidelines. Similarly, the Global Environmental Fund engaged the Environmental Law Institute to assess and prioritize the potential environmental impacts of on-the-horizon technologies. Notably, neither the National Academies nor the Global Environmental Fund studies oppose emerging technologies. Rather they suggest guidelines to anticipate and mitigate the unintended negative consequences of technologies.

  For Mexico, there is an urgent need for consensus guidelines concerning future of work. Automation can replace backbreaking, numbing routine work and enable workers to engage in more productive activities. Nevertheless, it can also eliminate jobs that are the entry point to middle class work. The history of mechanization in the mid-19th century provides both hopeful antecedents and important cautions. While in the long-term society as a whole historically benefitted enormously from advances in mechanization, the short-term impacts of technological innovation

[68] Gene editing is enabled by a technology called CRISPER-- clustered regularly interspaced short palindromic repeats

[69] National Academies of Sciences, Engineering, and Medicine. 2017. *Human Genome Editing: Science, Ethics, and Governance*. Washington, DC: The National Academies Press. https://doi.org/10.17226/24623.

were devastating for the workers affected (and largely ignored or suppressed in 19th century Britain).[70] An important topic for a multi-stakeholder national conversation must be the co-design of the future of work: What guidelines are necessary for labor replacing technologies? How can displaced workers be supported? What training and capabilities will workers require? Who should bear the costs? How can labor-enhancing technologies be spurred? What social safety nets are needed to address new work modalities?

IV. ***Monitor new developments***— that enduring font of wisdom, Yogi Berra, is said to have said that, "*the future ain't what it used to be."* Once unimagined technological capabilities are today readily available even in remote communities. Just as the smartphone is changing how people think, communicate and work, new technologies, for example, universally available augmented and virtual reality, artificial general intelligence, blockchain, tailored medicine, will continue the process. Mexico must develop a much stronger capacity to think about the future and to anticipate emerging developments.

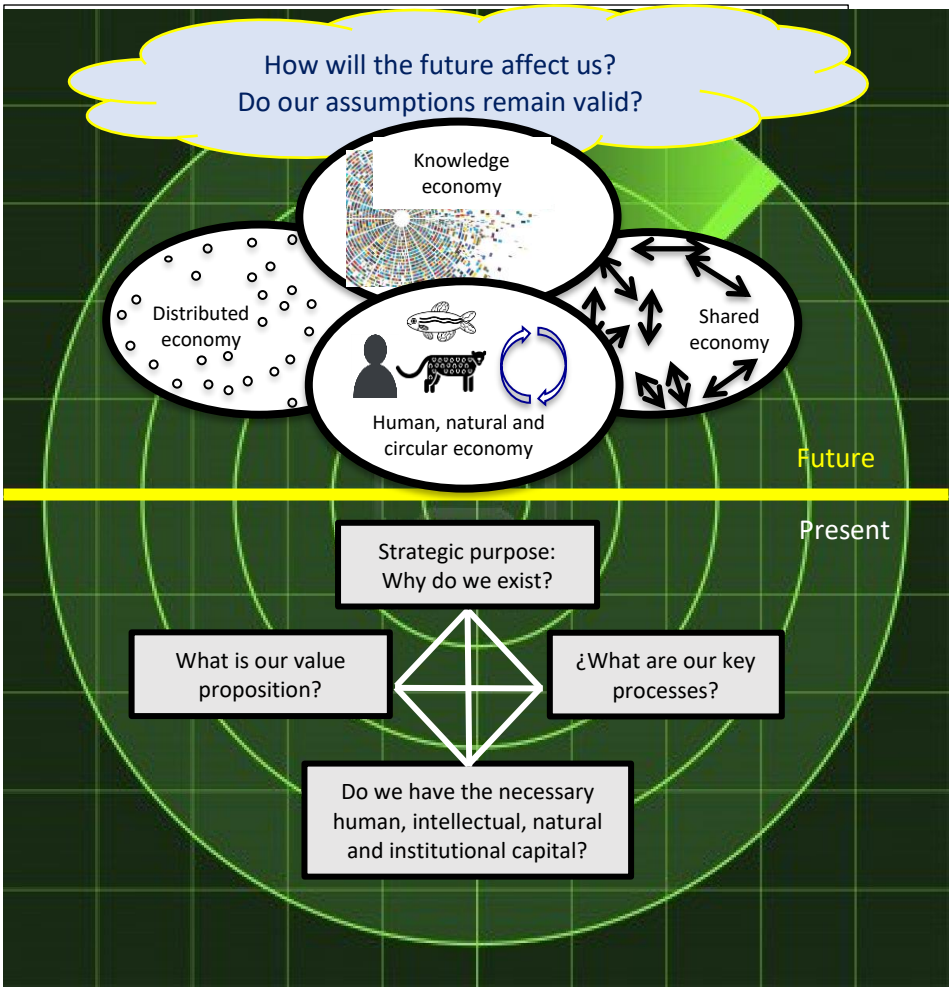
Monitoring the future is not a one-time process; rather it is a continuous process. In our experience in Mexico (as in other countries), few organizations have such a process in place. Private organizations tend to project the future as a continuation of the present trends into the future (possibly conducting sensitivity analysis around critical patterns). Occasionally, they examine specific issues such as the future of work, but they do not examine the interaction of diverse technological, social and economic forces that will affect their future. Likewise, Mexico's recent Plan Nacional de Desarrollo makes no mention of possible future technological and attendant societal and environmental challenges.

A useful resource is The Millennium Project, which tracks the status of 15 global trends in science, technology, environment, society and ethics. It maintains a Global Futures Intelligence System and publishes an annual *State of the Future* report. Resources such as those maintained by the Millennium Project can be used to examine how these future developments could apply to Mexico. These can be applied using scenarios to examine the implications of the interactions among trends in the global economy.

[70] See op cit., Benedikt Frey, *The Technology Trap;Capital, Labor and Power in the Age of Automation.*

We also propose a "Radar to the Future" as a tool for public and private institutions to think systematically about the future. A radar to the future complements management tools such as the balanced scorecard that focus on the present-day strategic purpose, value proposition, processes and capabilities of an organization. These can be thought of as the instruments in the cockpit of an airplane that tell the pilot where he is in the present--the compass, altimeter and fuel gauge. The radar, by contrast, tells the pilot what is ahead. It asks explicitly and systematically whether the assumptions on which an organization currently operates will remain relevant. Just as the pilot of an airplane continuously monitors its radar. The application of the radar to the future is not a one-time activity. Rather its part of a continuous process of organizational reassessment and renewal.

Figure 12. Radar to the Future



VI. Conclusion

We argued at the beginning of this paper that geologically Mexico sits atop four socio-economic tectonic plates. Like their geophysical counterparts, these plates are constantly shifting. Today, they are shifting more rapidly than ever in the country's history. We can neither predict nor control the shifts of either the geophysical or the socio-economic tectonic plates. That does not mean, however, that we are helpless in the face of them. We can study them, identify the direction of their movement, determine where the fault lines are and take action to adapt.

In the studies that form the basis for this paper, we used a structured scenario process to investigate the fault lines under different sets of assumptions. Because the starting point was Mexico in the second decade of the 21st century, the vulnerabilities identified by the three projects were often similar—education, innovation, competitiveness, poverty, inequality and environmental sustainability. Underlying all of them was the pervasive weakness of public, private and academic institutions as Mexico confronts the challenges of the mid-21st century.

There were also differences in how the challenges manifested themselves. In a highly technological "Exponential" world, competitiveness and inequality driven by technology emerged as most important in an innovation-driven global economy. In a "Business as Usual" world, Mexico was able to avoid a loss of competitiveness, and inequality remained high but did not increase as Mexico maintained its current economic model. Without technological or business model innovation, however, climate change and environmental deterioration increased rapidly. In a dystopian "Save Yourself if You Can" world, poverty and extreme poverty increased dramatically, economic and environmentally driven migration within, into and out of Mexico increased driven by extreme poverty, but paradoxically climate change was less significant than in the other two scenarios because global economic activity declined.[71]

Independently of what future awaits it, Mexico needs to take action *now* to prepare for the future. We presented a framework of four categories of action as a Path Forward for Mexico. We emphasize that these categories of actions are not either/or propositions. All four are critical and must be undertaken together urgently.

[71] In this scenario, there was significant environmental deterioration, driven by subsistence/survival farming that resulted in extensive habitat loss.

The categories are:

I. ***Build resilient physical, social and institutional systems.*** As with seismic events, we know bad things will happen. We need to prepare for them by ensuring social and physical systems will have the flexibility adapt to events that will inevitably take place.

II. ***Make robust investments.*** Investments in a socio-economic equality, education, innovation, and a competitive model that leverages Mexico's significant human and natural assets will serve it well independently of what future emerges.

III. ***Make bets for a better future.*** Mexico must look ahead to the opportunities that will create a better future for all Mexican's—businesses and social initiatives that leverage Mexico's unique capabilities.

IV. ***Monitor emerging trends.*** Lastly, we do not expect pilots to fly without radars or seismologists to do their jobs without seismographs, but both public and private institutions base key decisions on backward looking data. Both private and public institutions require a capacity to think systematically about the future. The goal is to predict the future but to anticipate what might happen and to reassess and renew institutions and the purposes continuously.

About the Author

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