Confronting robotization in Mexico

Resumen

Este artículo discute el relativamente inexplorado riesgo de la disrupción social a partir del reemplazo del trabajo humano por el uso de robots e inteligencia artificial en México. Se aborda el contexto amplio y los antecedentes de la llamada cuarta revolución industrial, y analiza datos del impacto de la automatización en el trabajo. Mientras que la mayoría de los estudios se han hecho en Europa y Estados Unidos, se argumenta que este tema debería ser una preocupación seria para los investigadores y políticos en México. El marco del artículo ofrece posibles políticas públicas a esta amenaza, clasificando las respuestas en políticas preventivas, mediadoras y compensatorias. Después de ofrecer una discusión de ellas, este artículo concluye en el argumento de que si este reto social emergente se toma con seriedad, una combinación de las políticas preventivas, mediadoras y compensatorias deben de ser investigadas, en lugar de buscar una solución única.

Palabras clave

Automatización, robots, desempleo, políticas sociales, pobreza

Key words

Automatization, robots, unemployment, social policy, poverty

Sumario

1. Introduction

> This is how one pictures the angel of history. His face is turned toward the past. Where we perceive a chain of events, he sees one single catastrophe which keeps piling wreckage upon wreckage and hurls it in front of his feet.

> The angel would like to stay, awaken the dead, and make whole what has been smashed. But a storm is blowing from Paradise; it has got caught in his wings with such violence that the angel can no longer close them. The storm irresistibly propels him into the future to which his back is turned, while the pile of debris before him grows skyward. This storm is what we call progress.[1]

The automatization of the economy due to advances in robotics and artificial intelligence is amongst the most daunting societal challenges of the next decades. The so called "fourth industrial revolution"[2] comes with numerous ethical and political concerns. One of the most prominent concerns surrounding this new "storm of progress" is the prospect of (mass) unemployment due to the permanent replacement of workers by machines. Such disruptions of the societal tissue hold potential risks of increasing structural poverty and threatening the social position and life purpose for those affected, as well as broader ripple effects for the economy due to drops in demand. Concerns regarding machines can be traced back centuries, but rapid developments in automatization revived scholarship on this issue in recent years.

Amongst others, Ford[3], Karabarbounis and Neiman[4], and Frey and Osborne[5] have described concerns about this new threat of unemployment. This wave of innovations is special because it encompasses explicit attempts to automatize specific "human" functions and skills involving highly motorial, mobile or intelligent tasks such as driving or building. The topic has also (re)sparked debates on innovative responses such as Universal Basic Income[6] or on radically rethinking the forms and functions of labor markets in our society.[7]

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[1] Benjamin, Walter, *Theses on the Philosophy of History*, New York, Schocken Books, 1940/1969, p. 249.
[2] Schwab, Klaus, *The Fourth Industrial Revolution*, New York, Crown Publishing Group, 2016.
[3] Ford, Martin, *Rise of Robots: Technology and the threat of a jobless future*, New York, Basic Books, 2015.
[4] Karabarbounis, Loukas and Neiman, Brent, "The Global Decline of the Labor Share", *Quarterly Journal of Economics*, vol. 129, no. 1.
[5] Frey, Carl and Osborne, Micheal, "The Future of Employment: How Susceptible are Jobs to Computerisation?", *Oxford Martin School*, September, 2013. Available at: http://www.oxfordmartin.ox.ac.uk/publications/view/1314
[6] Standing, Guy, *Basic Income: and how we can make it happen*, Pelican, Milton Keynes, 2017.
[7] Srnicek, Nick and Williams, *Alex, Inventing the Future: Poscapitalism and a World without Work*, London, Verso, 2015.

What much research on the topic has in common is that it is primarily concerned with the United States and European welfare states, while research on the social effects of robotization in other parts of the world is largely missing. Yet such technologies could have an equal or even stronger disruptive effect on industrialized economies that stand lower in the global value chain and depend more heavily on manufacturing, while typically featuring less robust welfare systems.

Countries like Mexico, that need to find answers to these challenges in a context of already high poverty and inequality rates. In this discussion paper we will discuss the threat that robotization and the related risk of mass unemployment poses to countries like Mexico, and develop an overview and basic classification of policy responses. Since the debate on robotization is still premature in Mexico, this article aims to stimulate debate on how to handle the social consequences of such transition. So far governments are still embracing technological innovations of this type. This is especially true for the industrialized northern states like Nuevo León, which has developed explicit governance programs (Nuevo León 4.0)[8] for facilitating the fourth industrial revolution.

This paper is based on a broad literature study. We incorporate a state of the art overview of international writing on automatization, supplemented with specific data on Mexico. In terms of policy responses, we supplement our own analysis with literature both directly on responses to automation, as well as broader literature dealing with poverty and unemployment. In the first part of the text we discuss automatization and the related risk of technological unemployment; and reflect on how this could translate into related social problems such as poverty and loss of purpose. We will argue that since robotization is to be taken serious as a potential structural cause of poverty, it both requires and deserves structural and collective solutions. In the second part we will discuss various potential solutions and policies, developing a basic classification of preventive, mediating and compensation responses, depending on the stage of intervention.

[8] Nuevo León 4.0 is a governance network that unites some of the main industrial groups in the state and their surrounding syndicates and organization with government and university actors around the topic of introducing automatization to Nuevo León. The authors participated in this network as researchers for the ethics committee.

This raises the question who is willing to consider “upstream” reactions that aim at protecting human work itself, or limit the focus to “downstream” responses such as basic income that implicitly accept the loss of jobs by seeking to alleviate the effects. We conclude by arguing that if this emerging societal problem is to be taken serious, a mix of preventive, mediating and compensating responses must be investigated, rather than limiting the discussion to one particular “fix”.

2. Robotization and societal disruption

2.1. Concerns on machines in historical perspective

Worries about the relation between human labor and machines are as old as the (first) industrial revolution itself. Some of the earliest concerns go back to David Ricardo. In the third edition of his 1821 classic work *On the Principles of Political Economy and Taxation*,[9] Ricardo notes that machines offer a growth in production and profit without necessarily growing the industry (hiring more people). In the competition between labor and machine, capitalists will often favor machines. At first the amount of labor still grows with the growth in capital, but at an ever-diminishing rate. Karl Marx made a similar analysis in chapter 25 of *Capital*.[10]

While profit primarily comes from exploiting workers in the Marxist framework, it could be increased by replacing them by machines, which leads to a slow shift in the composition between constant (tools, machines) and variable (workforce) capital. Marx links this to the birth of what he called the industrial reserve army: a pool of barely surviving workers created by a situation of relative overpopulation (not enough jobs) that place pressure on wages. In the 20th century, amongst others J.M. Keynes was pessimistic about the risk of future technological unemployment in his *Economic possibilities for our grandchildren*.[11]

It must be noted that most of the 19th and 20th century concerns dealt with machines in the sense of immobile *tools* designed to do one specific function, not robots. Things are different now. Although debates on the implicated technologies

[9] Ricardo, David, *On the Principles of Political Economy and Taxation*, Whitefish, Kessinger Publishing, 2010.
[10] Marx, Karl, *Capital, volume one. A critique of political economy*, Mineloa, Dover Publications, 2011.
[11] Keynes, John Maynard, *Essays in Persuasion*, New York, Harcourt Brace, 1932.

are older, since the 2016 World Economic Forum the term “fourth industrial revolution”[12] got popularized to refer to the next wave in advancements in robotics, machine interaction, artificial intelligence, etc. The prefix “Fourth” reminds of the three previous industrial revolutions; roughly referring to: *a)* The steam engine and other early sources of inanimate force; *b)* electricity and assembly lines; *c)* computing and ICT. Although the fourth industrial revolution also includes other innovations, this paper will focus specifically on the aspect of robotization. *Conceptually*, we understand this as technologies that *a)* replace specific human functions (such as speech, motoric functions, navigation, construction, etc.); *b)* do so with a higher degree of independence. They are thus not just “tools” used by humans to perform tasks, but often replace the human herself in doing the task. Part of this “revolution” is also the ability to produce and operate such technologies at increasingly lower costs. In practice our use of the terms “robotization” or “automation” refers to a combination of technologies including artificial intelligence, robotics, cloud data, machine learning, drones, etc.

2.2. Understanding the challenge of labor replacement

Diverse ethical concerns arise from the fourth industrial revolution. These range from worries about the increased autonomy of artificial intelligence or concerns for privacy; to the increased centralization of control and the economic inequality these technologies could foster. In this paper we limit ourselves to ethical concerns regarding replacing human work and the social risks that follow from the fact that people are highly depending on paid labor for their livelihoods in societies like Mexico.

Some date the start of the current debate on robotization and labor back to the 1995 warnings in Rifkin’s *The end of work*.[13] Some of the more influential works that discuss these questions include Brynolfsson and McAfee’s *The Second Machine Age: Work, Progress and Prosperity in a Time of Brilliant Technologies;*[14]

[12] Schwab, Klaus, *The Fourth Industrial Revolution*, New York, Crown Publishing Group, 2016.
[13] Rifkin, Jeremy, *The end of work*, New York, G. P. Putnam’s Sons, 1995.
[14] Brynolfsson, Erik and McAfee, Andrew, *The Second Machine Age: Work, Progress and Prosperity in a Time of Brilliant Technologies*, London, W. W. Norton, 2014.

and Ford's *Rise of Robots: Technology and the threat of a jobless future*.[15] The topic is also discussed in more futuristic literature on so called postcapitalism.[16] However not all commentators discuss robotization as a future threat. Amongst others Karabarbounis and Neiman[17] point at evidence of the impact that the early stages robotization are already having on labor markets, and Oppenheimer[18] explores ongoing transformations on this topic around the world.

Various estimations of the actual impact of these changes on jobs exist. An early figure comes from Frey and Osborne[19] who in 2013 estimated that 47% of jobs in the United States had a high risk (≥70%) of automation. This was based on estimations of experts on the possibility of automating occupations and the presence of capacities robots were unable to do. This method was repeated for Finland[20] and by ING for Germany[21], both providing alarming risk estimates. In 2016 Arntz *et al.*[22] gave a much lower estimate of 9% jobs with a ≥ 70% risk in the United States, using variations within jobs and conservative estimations of what robots could do. **Table 1** summarizes the estimates for the percentage of jobs with a high risk (70%) of automatization (understanding that a much larger number carries a significant risk), since this is the only comparable indicator across studies.

Table 1. Estimates of high risk of automatization

Study	Jobs at very high risk
Frey & Osborne (2013)	47% for United States
Pajarinen et al. (2014)	49,2% for United States
Carsten & Burk (2015)	59% for Germany

[15] Ford, Martin, *Rise of Robots: Technology and the threat of a jobless future*, New York, Basic Books, 2015.
[16] Srnicek, Nick and Williams, Alex, *Inventing the Future: Poscapitalism and a World without Work*, London, Verso, 2015; Mason, Paul, Postcapitalism, a guide to our future, London, Allen Lane, 2015.
[17] Karabarbounis, Loukas and Neiman, Brent, *op. cit.*
[18] Oppenheimer, Andrés, *¡Sálvese quien pueda! El futuro del trabajo en la era de la automatización*, México City, Debate, 2018.
[19] Frey, Carl and Osborne, Micheal, *op. cit.*
[20] Pajarinen, Mika and Rouvinen, Petri, *Computerization Threatens One Third of Finnish Employment, ETLA Brief*, no. 22, 2014. Available at: http://pub.etla.fi/ETLA-Muistio-Brief-22.pdf
[21] Brzeski, Carsten and Burk, Inga, "Die Roboter kommen: Folgen der Automatisierung für den deutschen Arbeitsmarkt, Frankfurtam Main", *INGDiBa Economic Research*, 2015.
[22] Arntz, Melanie, "The risk of automation for jobs in OECD countries: A comparative analysis", *OECD Social, Employment, and Migration Working Papers*, no. 189, Paris, OECD Publishing, 2016.

Arntz et al. (2016)	9% for United States
Nedelkoska & Quintini (2018)	14% across OECD countries

We will mainly focus on a 2018 study of the Organisation for Economic Co-operation and Development (OECD) by Nedelkoska and Quitini,[23] since this is the most recent, refined[24] and international estimation: it takes into account evolutions in machine learning and looks at 32 OECD countries. Their estimations hold the middle between both previous studies. The report estimates that almost half of jobs can be affected in some way. One type of estimation is that 14% of jobs are at very high risk (<70%) of being automated, while 32% are have a risk between 50 and 70 percent. This still means that 46% of jobs have a high risk. Another way of presenting this is their estimation that the median job has 48% chance of being automatized (and average 47%).[25]

This impact of such risks are unevenly spread across the labor market, yet possibly more even than during past waves of machination: "Automation is found to mainly affect jobs in the manufacturing industry and agriculture, although a number of service sectors, such as postal and courier services, land transport and food services are also found to be highly automatable".[26] It would affect routine functions in production, in which it (conceptually) does not differ that much from previous waves in mechanization. Yet robotization would also affect service jobs, as well as unexpected sectors such as construction or logging. Examples of current new technologies include self-driving cars replacing taxi drivers, AI manning call centers, or the use of robots in managing warehouses and fast food restaurants. Even typical jobs with "low" median risks of automation such as teaching professionals (28%) or health professionals (30%) are not entirely safe.[27] As Standing remarks: "The

[23] Nedelkoska, Ljubica and Quintini, Glenda, "Automation, skills use and training", *OECD Social, Employment and Migration Working Papers*, no. 202, Paris, OECD Publishing, 2018.
[24] They translate the 70 occupational categories of Frey and Osborne with a more detailed (4656 individual level job tasks) and recent datasets, while still taking into account bottlenecks in machine learning. For full methodology, see: *ibidem*, pp. 42-44. Note that any of these estimations are risk estimates about what jobs *can* be automated given current technology, without providing a timeframe of when this would happen.
[25] *Ibidem*, p. 48.
[26] *Ibidem*, pp. 8-9.
[27] *Ibidem*, p. 51.

disruptive character of what has been dubbed the “fourth technological revolution” also appears to be more generalized than in preceding seismic changes, which predominantly hit low-skill manual jobs”.[28]

Countries are not equally affected either. While earlier studies focused on the U.S., the study of Nedelkoska and Quintini[29] estimates this can greatly vary across countries: from 33% (Slovakia) to 6% (Norway) for jobs with very high risks; to a 39% – 62% variation when it comes to automatizing the job of the median worker. Unfortunately, despite being an OECD member Mexico is not included in their study, and the only Latin country in this estimation (Chile) had an above average risk on all indicators. A survey by Boston Consulting Group (Küpper et al, 2019) indicates that 87% of Mexican companies plan to adopt advanced robotics in the next three years. Additionally, despite expected growth in productivity, 51% of companies expect an absolute reduction in their number of workers in the next five years as a consequence of this.

There are good reasons to believe automatization is also a serious threat to countries with the profile of Mexico. In general, Northern countries have a lower risk than southern and eastern countries. This has partly to do with the sectoral composition of countries (for example high manufacturing), but also in the job content within those. Given Mexico’s past policy of attracting investment with cheap low-skill labor, there is little reason to be optimistic. In similar vein, Bowles[30] (2014) mentions that within Europe, the economically less advanced countries are highly vulnerable, due to their reliance on low-skilled occupations. Nedelkoska and Quintini[31] also conclude that there is a strong correlation between education level and vulnerability to automatization. In the 2019 OECD indicator for population with tertiary education,[32] Mexico ranks amongst the lowest with only 22.6% of young people enjoying this (OECD average is 44.5). Mexico also has the largest part of adult

[28] Standing, Guy, Basic Income: and how we can make it happen, Pelican, Milton Keynes, 2017, pp. 105-106.
[29] Nedelkoska, Ljubica and Quintini, Glenda, *op. cit.*, pp. 46-48.
[30] Bowles, Jeremy, “The Computerisation of European Jobs”, *Bruegel*, 2014. Available at: http://bruegel.org/2014/07/the-computerisation-of-european-jobs/
[31] Nedelkoska, Ljubica and Quintini, Glenda, *op. cit*.
[32] OECD, *Population with tertiary education (indicator)*, 2019. Available at: https://data.oecd.org/eduatt/population-with-tertiary-education.htm

population (62.6%) with an education level below secondary.[33] These are indicators that job loss due to robotization poses an above average risk for Mexico, therefore more precise estimations are very much needed.

2.3. Debating the challenge

However, there are also those who question or downplay the risk of technological unemployment. This often includes proponents of robotization and A.I, or those arguing against specific responses to it like basic Income.[34] Besides the use of low estimates or only counting high risk jobs (instead of medians), optimistic arguments regarding the labor market effects of automatization usually resolve around two key arguments. One standard argument, advanced by for example Autor[35], is that despite previous industrial revolutions and population growth there are on aggregate still many jobs.

Technological advances might destroy jobs, but in the big picture also help create other industries and free up labor for new activities. The second argument (going as far back as the aforementioned David Ricardo) resolves around the hope that profits from increased productivity are reinvested in non-productive labor. Speaking of the Netherlands, Boone, *et al*.[36] think that the higher productivity of robots will lead to higher wages, which will be spend on new needs for human services and thus create jobs.

The arguments of sceptics are usually made in the context of vastly different countries than Mexico. Still, they are useful in reminding us that job destruction or alteration does not automatically translate into net unemployment. Yet we believe that there are good reasons to take the threat of robotization serious.

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[33] OECD, *Adult education level (indicator)*, 2019. Available at: https://data.oecd.org/eduatt/adult-education-level.htm#indicator-chart

[34] For example: Boone, Jonas, et al., *Feit en fictie omtrent het basisinkomen in Nederland*, Antwerpen, Universiteit Antwerpen, 2018; Sage, Daniel and Diamond, Patrick, *Europe's New Social Reality. The case against Universal Basic Income*, London, Policy Network, 2017.

[35] Autor, David, "Why Are There Still So Many Jobs? The History and Future of Workplace Automation", *Journal of Economic Perspectives*, vol. 29, no. 3.

[36] Boone, Jonas, *op. cit.*, p. 19.

To start, in most cases the reduction of employment is an *intended, not an unintended consequence*. Some odd new (heavily marketed)[37] application aside, many of these technologies (farming robots, self-driving cars, shops without cashiers) are developed with the explicit goal of replacing human labor. The burden of proof thus also lays on those assuming they will fail to achieve this. Secondly, we must understand that robots are not just more productive machines, neither is artificial intelligence an euphemism for better software.

The difference is conceptual, not quantitative. Robots are machines that mimic specific human capacities and try to do so autonomously. The latter should raise question marks about arguments regarding increased wages for those "operating" robots. Does the cleaning robot raise the productivity of a cleaner the way a vacuum cleaner improved the broom, or does it replace him? Either a car can independently drive and transport clients or packages, or it can't. If it can, the company could as well replace all its drivers. Third, a key difference between the fourth and previous industrial revolutions is that the latter consisted of both process and product innovations.

Process innovation refers to innovations that help us produce the same thing better; while product innovation involves new products. For example, the third revolution (internet and computers) opened vast new markets, products and jobs: from videogames, websites, to online community managers or the production of keyboards. This is not as clear with the fourth revolution, which granted exceptions so far (still) predominantly resolves around process innovation (*or* new services offered by robots/A.I. instead of people). Finally, we should not underestimate the broadness and speed of these innovations. Brysnolfsson and Mc Afree[38] point out that this revolution threatens a much wider range of jobs and whole new skills than in previous times. One could argue that the loss of jobs in the primary and secondary sector is just the continuation of a longer historical shift to services. However Nedelkoska and Quintini[39] estimate that some of the most threatened sectors

[37] Consider for example the advertisement campaigns surrounding Microsoft's "A.I. for good" program, which amongst others promises to save wales: https://www.microsoft.com/en-us/ai/ai-for-good

[38] Brynolfsson, Erik and McAfee, Andrew, *The Second Machine Age: Work, Progress and Prosperity in a Time of Brilliant Technologies*, London, W. W. Norton, 2014.

[39] Nedelkoska, Ljubica and Quintini, Glenda, *op. cit*.

actually include service jobs such as cleaning, food preparation and transport. A recent example is the announcement that Walmart, the biggest employer in the world, started to automatize its shelves, cleaning and scanning jobs.[40] This again shifts the burden of evidence to show *what* human jobs will be created in an economy like Mexico's to those who suggest profits will be invested in services.

2.4. Societal impacts

Before assessing possible responses, we will briefly discuss how such technological employment impacts society. First of all, it could be an important new source of structural poverty. We understand poverty as a situation in which persons have such a lack of resources in relation to the general distribution and living patterns, that they become socially excluded in multiple domains of life.[41] Poverty is both related to the production of relative shortages in economic resources for certain groups, and to how the organization of society allows them to become socially deprived because of this. We thus agree with Peter Townsend[42] that poverty cannot be seen in isolation of general wellbeing and the organization of society and is thus relative to generally valued living standards.

These somewhat theoretical distinctions matter, since solving absolute (~ hunger) or relative poverty (~ inequality and exclusion) are radically different goals when debating responses. Robotization's main structural contribution to poverty is through the sharply increased risk of unemployment. Given the overall weak social protection against unemployment in Mexico,[43] this will translate into poverty for those families whose income depends on paid labor.

Furthermore, the societal impact of unemployment goes beyond lack of resources. The loss of occupation and social position in itself possess certain ethical

[40] See: Green, Dennis and Cain, Alne, "Walmart is assembling an army of thousands of robots that it's putting to work in its stores", in *Business Insider*, April 9, 2019. Available at: https://www.businessinsider.com/walmart-robot-army-stores-expanding-2019-4

[41] Ghys, Tuur, "Introduction: Structural poverty and political agency", in Tuur Ghys, *et al.* (comps.), *Poverty and Politics: North Mexican and International observations*, Mexico, AM Editors, 2018.

[42] Townsend, Peter, "The meaning of poverty", *The British Journal of Sociology*, vol. 61, Issue supplement s1.

[43] See: Velásquez, Mario, "An analysis of unemployment protection in Latin America", in Alberto Isgut and Jürgen Weller (comps.), *Protection and training Institutions for improving workforce integration in Latin America and Asia*, ECLAC Books, no. 140, 2016.

concerns regarding the inclusion and sense of purpose of affected individuals. Writing on Latin American societies, Abramo, et al.[44] note that "work is a fundamental mechanism for building autonomy and identity, upholding dignity and expanding the scope of citizen action; it is also the main avenue for social and economic integration".

Foster reminds us that "Not only do human beings need creative labour in their roles as individuals, they also need it in their societal roles".[45] In her seminal work on unemployment, Jahoda[46] suggests that employment generates five latent social functions at affect the individuals wellbeing besides paid income: *a)* structuring people's time; *b)* a source of social contacts and experiences; *c)* connecting people with goals beyond their personal life; *d)* status and identity within society; and *e)* development and expression of competences. These functions might not be unique to work or found in all jobs but are threatened all *at once* during prolonged unemployment.

To conclude, we must recognize that automatization is a potential major structural cause of poverty, introduced largely by forces outside the direct reach of those whom it will affect most. This additional poverty is thus created by more powerful actors altering the organization of the economic structure of society, vastly increasing the risk of sustained incomes crisis for others. The latter matters in terms of allocating responsibility, given the general tendency to blame the poor for their misfortune[47] (for Mexico specific, see the work of Inzunza[48] and Bayón).[49] Structural problems demand structural solutions; given structural poverty reduction logically concerns the actual reduction of aggregate poverty by addressing structural

[44] Abramo, Laís, et al., *Social programmes, poverty eradication and labour inclusion: lessons from Latin America and the Caribbean*, ECLAC Books, no. 155, 2019, p. 24.
[45] Foster, John Bellamy, *The Meaning of Work in a Sustainable Society: A Marxian View, Centre for the Understanding of Sustainable Prosperity*, 2017, p. 12. Available at: http://www.cusp.ac.uk/wp-content/uploads/03-Bellamy-Foster-online.pdf
[46] Jahoda, Marie, *Employment and unemployment: A social-psycho logical analysis*, Cambridge, Cambridge University Press, 1982.
[47] Gans, Herbert, *The war against the poor*, New York, Basic Books, 1995.
[48] Inzunza, Beatriz, "Cultural Perceptions on Poverty in the City of Monterrey, Mexico", in Tuur Ghys, et al. (comps.), *Poverty and Politics: North Mexican and International observations*, Mexico, AM Editors, 2018.
[49] Bayón, Maria, "El 'lugar' de los pobres: espacio, representaciones sociales y estigmas en la ciudad de México", *Revista Mexicana de Sociología*, vol. 74, núm. 1.

causes.[50] This thus generates a collective responsibility to generate societal responses to this threat.

3. Confronting the issue: a framework for discussing potential policy responses

In what follows we will give an overview and basic classification of possible policy responses to the threat of robotization. Two qualifications: first, this list is not exhaustive and offers only a limited assessment of these alternatives (the underlying debates are much deeper than we can replicate here). We primarily seek to broaden the discussion. Second, not all the policies listed below are mutually exclusive. One can pursue multiple policies simultaneously or sequentially, and they should thus be thought of as a flowchart of responses rather than a menu.

We offer a loose categorization of responses depending on at which stage and how they interact with technological unemployment due to automatization: First are *preventive* responses that target or contain both robotization and the replacement of human labor directly. These tackle the problem at the source (upstream) and are usually not compatible with economic agenda's that favor automatization. The second layer of *mediating* alternatives aims at reducing the impact of the fourth industrial revolution, by mediating how job loss translates into increases of actual aggregate unemployment. These are to some extend compatible with robotization but can involve structural changes in social organization. The third layer of *compensating* responses aim at protecting the population from the resulting poverty, through compensating the victims of technological unemployment. These responses deal with and often implicitly accept the consequences (downstream) of automatization. As mentioned earlier, many of the alternatives of this loose framework (see table 2.) might overlap or even synergize with each other.

Table 2. An overview of policy responses

Type of response	Type of policy
1. Preventive	

[50] Royce, Edward, *Poverty and power. The problem of structural inequality*, Lanham, Rowman & Littlefield, 2015; Ghys, Tuur, *op. cit.*

a)	Disinvesting in and stopping automatization
b)	Taxing robots
c)	Investing in creative/labor intense industries
2. Mediating	
a)	Retraining
b)	Active labor market policies
c)	Work time reduction
d)	Cooperative ownership
e)	Depopulating labor market
3. Compensating	
a)	Universal basic income
b)	Unemployment insurance

3.1. Containing the fourth industrial revolution

Earlier we argued in favor of taking the threat that automatization poses serious. However, this does not dictate that such a projected future is unavoidable. An inconvenient truth is that the clearest remedy of this risk is to simply avoid or contain the replacement of people by robots.

In the second half of the twentieth century, scholars in the field of science and technology studies have pointed out the fallacy of assuming that society simply undergoes technological change, as if technology is an independent variable. For example, the paradigm of Social Construction Of Technology (SCOT)[51] shows us that technologies and their implementation are instead shaped by the struggle of various relevant social groups. Relevant social groups that interact with technology can influence its design or oppose the construction altogether. Societies can stop

[51] Pinch, Trevor and Bijker, Wiebe, "The social construction of facts and artefacts: or how the sociology of science and the sociology of technology might benefit each other", *Social Studies of Science*, vol. 14, no. 3. Bijker, Wiebe, *Of Bicycles, Bakelites and Bulbs. Toward a Theory of Sociotechnical Change*, Cambridge-MA-MIT Press, 1995.

technological innovations, for example France practically banned Genetically Modified Organisms. Additionally, studies on technological transitions have paid increasing attention to the role of social and political forces in resisting innovations.[52] Nedelkoska and Quintini mention that regarding automation the adaptation of technologies can vary between countries: “Adoptation, in particular, could be influenced by several factors, including regulations on workers dismissal, unit labour costs or social preferences with regard to automation”.[53] Additionally, powerful actors such as governments have considerable influence over the research and development of technologies, as well as the conditions for implementation. We must not forget that automation itself is a political question, in which the will to protect society (if present) can take various forms.

A first cluster of policy responses resolves around directly stopping or slowing down the replacement of people by robots. According to Gans the government could: “reinvent a more labor-intensive economy, which might not only prevent the further proliferation of job-destroying technology […], but could also consider when, where, and how human beings could replace some existing machines that have eliminated a sizable number of good jobs”.[54]

The most conservative measure would be to simply ban the use of robots/A.I. in functions where they would replace (quality) jobs, or some form of democratic governance over what and how innovations are implemented. The defunding of research and development of automating technologies (currently encouraged on both federal and various state levels in Mexico) fits in this cluster of responses.

Less radical options include a tax on robots, or other sanctions to contain rather than abolish robots, as well as financial and social incentives to preserve jobs.[55] Although the actual implementation of such a robot tax might be challenging (what counts as a robot?), the idea has been coined amongst others in France by 2017 presidential candidate Benoît Hamon. One advantage of this policy is that is it compatible with many other responses, both buying time and providing funding for the compensating measures discussed below such as basic income.

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[52] Geels, Frank Willem, *Technological transitions and system innovations: A co-evolutionary and socio-technical analysis*, Cheltenham/Northampton, Edward Elgar, 2005.
[53] Nedelkoska, Ljubica and Quintini, Glenda, *op. cit*., p. 8.
[54] Gans, Herbert, *op. cit*., p. 137.
[55] *Ibidem*, p. 138.

The logical counterpart to containing robotization is the stimulation of human oriented and labor intensive economic activity. Examples of this could be focusing on tourism; creative industries or a knowledge intense economy that focuses on others forms of expertise. This can go hand in hand with the stimulation of existing "human made" industries, such as labor intense and/or high added value products (f.e. wine). Such policy can both take the form of fiscal advantages, as well as marketing support and awareness campaigns targeting consumer choice.

3.2. Mediating labor market effects of robotization

The policies discussed in this section are aimed at mediating the loss in jobs that would be caused by automatization rather than containing the technology itself. The goal is to minimize the transformation of job-loss into actual unemployment, keeping in mind that policies from both the previous and next section might have similar (side)effects.

We start with two mainstream responses. A first policy path is the retraining of (potentially) affected workers, since the OECD report on automation and skills[56] stresses the relation between risk and education level. Nedelkoska and Quintini strongly stress the need for *active* reeducation policy:

> Adult learning is a crucial policy instrument for the re-training and upskilling of workers whose jobs are being affected by technology. Unfortunately, evidence from this study suggests that a lot needs to be done to facilitate participation by the groups most affected by automation. The odds of participating in any type of training, on the job or outside the jobs, are found to be significantly lower amongst workers in jobs at risk of being automated.[57]

Taking automation serious implies a much more active approach than encouraging individuals to "retrain themselves". The focus should be drawing those into education who enjoyed it the least, which could be done in conjunction with other new policies, for example linking the unemployment benefits discussed below to retraining. This

[56] Nedelkoska, Ljubica and Quintini, Glenda, *op. cit.*
[57] *Ibidem*, p. 9.

mainstream solution is extra relevant in the Mexican context, which traditionally lags behind in both overall (higher) education and adult learning.

Additionally, adopting a more active labor market policy could be of particular interest to Mexico, which historically lags behind in this field.[58] This includes public employment services (that help with the registration and search for employment); training, hiring subsidies and other recruitment incentives, and targeted job creation. One could also count unemployment benefits in this category, although they will be discussed separately below. According to an OECD comparison,[59] in the past Mexico spend in total 0.01% of its GDP on such policies, by far the lowest of all OECD countries. This only changed in 2019 with the Lopez Obrador government, which started experimenting with amongst other employment and training programs for youth (for example Jóvenes Construyendo el Futuro). Actively helping unemployed people find work or creating opportunities for the long term unemployed might not directly relate to the problem of robotization but could contribute to stabilizing or buffering the overall unemployment risk.

Moving to more daring alternatives, one potential response is work time reduction. A drastic reduction of work hours could allow for the available jobs to be spread over more people, easing unemployment rates.[60] This was proposed early on in the United States by Gans[61] as a defensive policy (saving jobs rather than creating new ones), and he estimated that the number of saved jobs correlates to roughly 40-50% of the time reduced.

This can be achieved in various ways, from encouragement to take vacation days to policies reducing the official work week or work days. This measure deserves specific discussion in relation to the Mexican context, since the (justice) arguments behind it differ from the Western welfare states where these ideas were coined. We must consider that on average Mexicans work more than their counterparts in any other country in the OECD. According to OECD statistics,[62] a Mexican worker

[58] Velásquez, Mario, *op. cit*.
[59] OECD, *Public spending on labour markets (indicator)*, 2019. Available at: https://data.oecd.org/socialexp/public-spending-on-labour-markets.htm
[60] Meyer, Henning, "The Work and Inequality Challenge of the Digital Revolution: How Should Government Respond?", *Social Europe*, 2015; Sage, Daniel and Diamond, Patrick, *op. cit*.
[61] Gans, Herbert, *op. cit*., pp. 112-113.
[62] OECD, *Hours worked (indicator)*, 2019. Available at: https://data.oecd.org/emp/hours-worked.htm

performed 2258 hours/year, compared to the OECD average of 1746 hours/years (and 1356 hours more than Germany). While a reduction from a 40 hour workweek to a 24 or 30 hour workweek might seem radical in Europe, establishing the forty hour workweek as an actual reality could already makes a difference in Mexico.[63] In this discussion special attention should be paid to the maintenance of income levels, since replacing a certain number of decent fulltime jobs with more precarious part time work either leads to people working multiple jobs or increased poverty.

In this we should be sensitive to the gender perspective, since reductions in working hours and part time work are more often encountered with woman. Another (complementary) road is for the government to compensate for this loss of income either through services or income support. For example, even a low basic income (see discussion below) payed from a progressive tax or common resource (such as oil) could enable people to work fewer hours.

A distinct alternative path that mediates (but also contains and compensates for) the effects of robotization is the stimulation of the cooperative economy. Worker cooperatives are companies that are owned and democratically managed though participation of the employees, instead of being under the rule of external owners. It is one of the few responses that raises the fundamental question of ownership, often lacking from discussions on automation.[64] Ownership is relevant for two reasons. First, a more cooperative (thus democratic) economy might be more resilient in the face of challenges.[65] To start, democratization of the economy will increase engagement which could promotes value creation.[66] When workers can participate in decisions on the organization of the work floor, they might be less inclined to replace themselves and/or be more active in finding alternative employment options. Furthermore, since employees have a long term stake in the company, they are often more productive and more willing to accept wage cuts in moments of crisis.

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[63] Concrete, it could turn many two twelve hour shift jobs (for example security guards) into three eight hour shifts.
[64] Sage, Daniel and Diamond, Patrick, *op. cit.*, p. 29.
[65] Ranis, Peter, *Cooperatives Confront Capitalism. Challenging the neo-liberal economy*, London, Zed Books, 2016; DeFilippis, James, *Unmaking Goliath: Community Control in the Face of Global Capital*, New York, Routledge, 2004.
[66] Johannessen, Jon-Arild, *Automation, Innovation and Economic Crisis. Surviving the Fourth Industrial Revolution*, London, Routledge, 2018.

The second reason is that one of the effects of automation is an increase in inequality by further concentrating capital in the hands of fewer people[67]. Since cooperatives fundamentally alter the property structure within the productive realm, the benefits of increased productivity might be more equally distributed within a society of worker-owners.

The last cluster of alternatives relates to depopulating the labor market: an absolute decrease in available jobs can be mediated by a decrease in the working population. This is of course largely governed by demographic factors such as birth rate, life expectancy and female participation, but policy can influence this. For Mexico this is primarily a matter of allowing old people to retire without creating poverty. In 2018 Mexico was amongst the countries that had the lowest pension replacement rates[68] (especially for old age). In 1995 Mexico abolished the old defined benefit system and replaced it with individualized contributionary systems for public and private sector employees. The fragmented system was less generous with lower pension replacement rates, as well as stricter eligibility conditions and larger inequalities between groups[69]. Given the high rates on informal work and self-employment in Mexico, contribution to the private pension funds (AFORE) is problematic. Additionally, the 2013 (re)addition of the Mexican variant of public guaranteed non-contributionary pensions (Pensión para Adultos Mayores) provided benefits far below even absolute poverty lines. The establishment of a higher and universal minimum pension in 2019 is a step forward. Yet even at double the height (1300 pesos/month) of the previous system, in 2019 it is still not a true alternative to employment when avoiding poverty is concerned.

More generous pension schemes and lower age requirements (currently 68) would yield two results in relation to robotization: 1) it provides protection against poverty for those who cannot stay employed at older age; 2) it allows older

[67] See Karabarbounis, Loukas and Neiman, Brent, *op. cit*.

[68] OECD, Gross pension replacement rates (indicator), 2019. Available at: https://data.oecd.org/pension/gross-pension-replacement-rates.htm#indicator-chart

[69] OECD, *OECD reviews of pension systems: Mexico*, Paris, OECD Publishing, 2016, pp. 42-44. Available at: https://read.oecd-ilibrary.org/finance-and-investment/oecd-reviews-of-pension-systems-mexico_9789264245938-en#page1

Mexicans to leave the labor market and free up jobs for others. The latter matters because young people are both at a higher risk of being replaced by robots, and the same time are better placed to adopt to new jobs[70]. This means that shifting jobs from old to young people is a strategic choice in coping with automation.

A minor parallel policy to depopulate the labor market could found in measures regarding parenthood. For example the extension of paid parental leave for both sexes in the formal sector could free up a certain amount of (temporary) jobs. Sage and Diamond[71] propose this, as well as a more flexible system of time credit (a system for taking time off for family obligations during the whole career). Current policy trends in Mexico are carefully going in the latter direction by offering direct cash transfers to parents to buy childcare *or* compensate themselves or relatives for taking care of young children.

3.3. Compensating labor market effects of automation

This section discusses "downstream" responses that aim at compensating for the collective failure to avoid technological unemployed and protect the population from (absolute) poverty. On this level discussions typically resolves around two models: the welfare state model of social security on the one hand, with at the center unemployment insurance; and Universal Basic Income on the other. The two are often pitted against each other's as mutually exclusive options, although as we will discuss this depends on the implementation. We will offer only a brief and stylized discussion of both systems, due to the complexity of different implementations regarding funding, height, eligibility, etc., and the scale of the literatures behind welfare policies.

Universal Basic Income (UBI) commonly refers to: "a modest amount of money paid unconditionally to individuals on a regular basis (for example monthly). It is often called a universal basic income (UBI) because it is intended to be paid to all".[72] It is universal, because it is paid to literally all citizens (including the wealthy), and basic since most proposals don't aim at an income that by itself keeps people out of relative

[70] Nedelkoska, Ljubica and Quintini, Glenda, *op. cit*., p. 8.
[71] Sage, Daniel and Diamond, Patrick, *op. cit*., p. 34.
[72] Standing, Guy, *Basic Income: and how we can make it happen*, Pelican, Milton Keynes, 2017, p. 3.

poverty. This uniformity is said to allow for simpler administration. This older idea[73] has seen a revival as various authors[74] suggested it as a response to the labor market effects of automation. UBI is unique because it offers a long term response in case work were to disappear as a social institution; while at the same time being also the ultimate "downstream" option that does not contest automatization. In this context is it understandable that UBI received support from various wealthy technology entrepreneurs such as Elon Musk and Mark Zuckerberg; as well as politicians looking for a singular solution. This included Ricardo Anaya, Mexico's candidate for the conservative National Action Party during the 2018 elections. However, his idea and the surrounding discussion on automatization received little attention in Mexico.

Despite its surge in popularity Universal Basic Income is an extremely contested idea. Since this paper discusses potential solutions within a hypothesis of (mass) unemployment, we will leave aside concerns regarding work incentive.[75] Other criticisms involve concerns regarding the effectiveness of preventing poverty. Navarro[76] and Ikebe[77] indicate that modest implementations of basic income would have minimal effects on precariousness. In their simulation for the Netherlands, Boone, *et al*.[78] show that UBI fails to reduce poverty because the high costs associated with universality leave less resources to be spend for those in need. However, this does leave the door open for *combining* even a low UBI with other policy measures suggested above, such as work time reduction.

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[73] See: Van Parijs, Philippe, Arguing *for basic income: Ethical foundations for a radical reform*, London, Verso Books, 1992.

[74] Ford, Martin, Rise of Robots: *Technology and the threat of a jobless future*, New York, Basic Books, 2015; Srnicek, Nick and Williams, Alex, *Inventing the Future: Poscapitalism and a World without Work*, London, Verso, 2015; Mason, Paul, *Postcapitalism, a guide to our future*, London, Allen Lane, 2015.

[75] Based on a review of more than hundred pilot studies Wilderquist concluded that the effect of reduction in paid labor should not be a concern, because the registered effect were small or statistically insignificant. See: Wilderquist, Karl, "What (if anything) can we learn from the Negative Income Tax experiments?", *Journal of Socio-Economics*, vol. 34, no. 1, pp. 49-81.

[76] Navarro, Vincente, "Why The Universal Basic Income Is Not The Best Public Intervention to Reduce Poverty or Income Inequality", *Social Europe*, 2016.

[77] Ikebe, Shannon, "The Wrong Kind of UBI", *Jacobin*, 2016. Available at: https://www.jacobinmag.com/2016/01/universal-basic-income-switzerland-finland-milton-friedman-kathi-weeks/

[78] Boone, Jonas, et al*., Feit en fictie omtrent het basisinkomen in Nederland*, Antwerpen, Universiteit Antwerpen, 2018.

The combinability of UBI with other social policies is at the heart of the second concern, voiced by those who see UBI as a neoliberal Trojan horse to eliminate the welfare.[79] The concrete concern is that UBI's considerable costs will be funded through far reaching cuts in social policy. We should note that within the Mexican context this was exactly what the conservative 2018 presidential candidate Anaya proposed: a low basic income funded through the elimination of the entire social policy budget. As Standing[80] points out, none of this implies that basic income by definition in incompatible with other welfare policies.

The alternative system to compensate the victims of the fourth industrial revolution is the establishment of a social insurance against unemployment. Broadly, social insurance would refer to: "programs [that] are generally comprehensive, compulsory schemes designed to protect workers and their families against the risks of lost earnings due to injury, sickness, old age, disability or unemployment".[81] We will focus on the unemployment variant, which exists in many Western as well as various Latin countries. This would be innovative in a Mexican context,[82] which lacks this nationwide (it exists in Mexico City) and only has a system of severance pay that covers only a fraction of the workforce.[83]

The idea is that during their working life, people built up an insurance against unemployment, which provides them with earnings when work is not available. Although this also includes redistribution across different social groups, it is primarily aimed at providing stability over the work-life cycle. There are myriad variants of this policy, depending on how it deals with concerns regarding eligibility and abuse. Social insurance can be limited in time; demand a certain minimum contribution; pay a regressive amount over time; demand evidence of job searching or other requirements or forms of control. This of course does come with the costs of the administrative apparatus to implement it.

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[79] For example: Alaluf, Mateo and Zamora, Daniel, *Contre l'allocation universelle*, Montréal, Lux, 2017.
[80] Standing, Guy, *op. cit.*, p. 21.
[81] Garland, David, "The Welfare State: A Fundamental Dimension of Modern Government", *European Journal of Sociology*, vol. 55, no. 3, p. 341.
[82] Velásquez, Mario, *op. cit.*
[83] Valencia, Enrique, et al., *Social protection systems in Latin America and the Caribbean*, Mexico-Santiago, United Nations, 2012.

The main advantage of these policies over UBI is that because their selectivity, support only goes to those affected by unemployment (and for example not to owners). This more targeted approach implies that *a)* the available amount of social funds has to be divided over less people; and *b)* there exist more possibilities to counter political and popular concerns regarding deservingness in terms of needs. This in turn allows for more budgetary and political space to pay higher replacement incomes than most versions of UBI can. Note that this would mainly cover the formal sector, leaving out sizeable parts of the workforce.

The fact that these programs are often temporal and have (formal) labor market re-integration as an implicit or explicit goal serves as a double edged sword in our discussion: on the one hand, although it is still a compensating measure social insurance is less "defeatist" than UBI since it doesn't give up on human labor (and requires it to function). On the other hand, while suitable to buffer economic shocks and transitions; it does not offer a permanent compensation to all in scenarios of prolonged unemployment. That is, unless we see unemployment insurance policies innovate by adjusting themselves to the new context of robotization, for example by extending the benefit duration (allowing more retraining options) in times when unemployment increases.

4. Conclusion

In this paper we discussed the threat that the increased use of robots and artificial intelligence poses to Mexican society, noting that technological unemployment could be an important new source of structural poverty. As Georg Simmel already knew in 1908, structural causes require structural solutions: "The fundamental economic and cultural circumstances which create [poverty] can only be changed by the collectivity".[84] In the second part we offered a basic classification of various preventive, mediating and compensating alternatives.

Our aim was to contribute to the debate on appropriate policy responses, and invite the reader to consider or reconsider various options. The context of automation sheds new light on social and economic policies that must be examined in greater

[84] Simmel, Georg, "The Poor", *Social Problems*, vol. 3, no. 2, p. 133.

detail, both in isolation but also in relation to each other. The feasibility of proposals like basic income can only be truly estimated in the light of the surrounding policy landscape. Focusing on isolated solutions can also obscure potential synergies between them, such as between a low basic income and worktime reduction; or improving pensions, unemployment insurance and investing in training of young people.

Furthermore, since much of these debates take place in Europe and the United States, various measures require translation to national policy contexts. What a mature social democracy like Finland does to additionally protect its citizens, should not necessary guide Mexican governments that only recently started experimenting with for example active labor market policies. The Mexican reality of having both one of the highest inequality rates and lowest tax regimes in the industrialized world[85] might further influence the assessment of factors like responsibility, funding, and corresponding justice claims.

In conclusion, we like to offer that the challenge of robotization is most intelligently faced by exploring multiple measures instead of one "catch all" response. Unless that response is the radical containment of automating technologies, one single fix is unlikely to avert societal dislocation. We saw that Universal Basic Income, the most commonly suggested "catch all" measure, is insufficient by itself. A further danger in reducing the debate to a single measure is that it can create a sense of false safety that prevents us from seriously engaging with the challenge. This is especially true for compensating measures that reduce the problem to income, which ignores other social functions of human work and take place *after* the problem is allowed to manifest itself.

Nedelkoska and Quintini[86] note that even the most conservatives estimates of nine percent job loss (for United States) are in practice still dramatic disruptions of millions of lives, unseen in recent history. If this new social problem is taken serious at all, the discussion risks shifting to "last resort" options without considering more active policies that actually contain or at least negate the threat. A structural and integrated approach to protect society from the intended and unintended effects

[85] See: OECD, *Tax revenue (indicator)*, 2019. Available at: https://data.oecd.org/tax/tax-revenue.htm#indicator-chart

[86] Nedelkoska, Ljubica and Quintini, Glenda, *op. cit.*, p. 6.

of robotization engages in measures that prevent, mediate and compensate technological unemployment. Which measures these will be, and how their various implementations synergize or conflict with each other, is food for both academic and political debate in the coming decades.

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